

Satellites enabling the integration in non-segregated airspace of UAS in Europe

UAS/RPAS Air Traffic Insertion Starts Now

Dirk-Roger Schmitt, Frank Morlang, Henk Hesselink,

AT-One EEIG

AT-One combines the strength of NLR and DLR in ATM Research

UAS/RPAS are becoming more and more in use

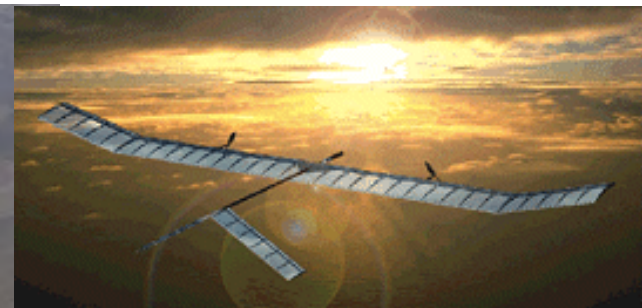
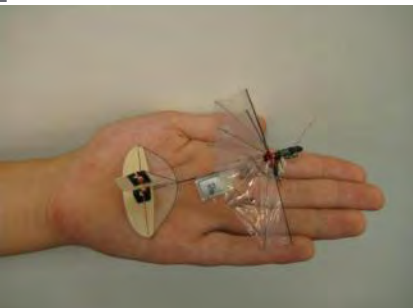
In civil world: a lot of interest

Now, they are restricted to fly

- limited locations
- permission to fly on case-by-case basis
- segregated airspace

Our goal is to fly the aircraft anywhere

- VFR, IFR
- file-to-fly
- controlled and non-controlled airspace (class A to G)



Perform simulations with air traffic controllers

- to gain awareness with controllers of UAS issues
- to learn what are the issues

To set up realistic scenarios in realistic environments

- normal operation in other traffic
- emergency situations

Restrict to IFR and controlled airspace

Projects: USICO, SINUE and DESIRE

- international context –
ensure acceptance

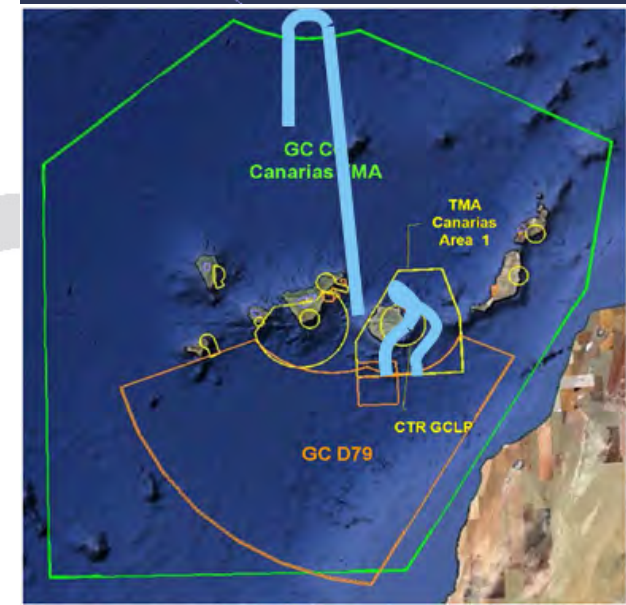
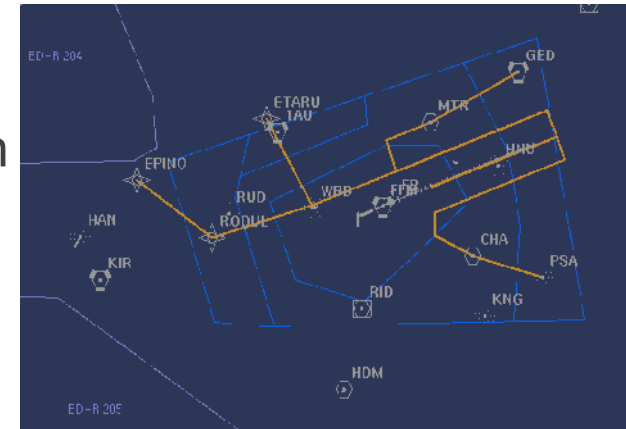


USICO: Unmanned Aerial Vehicle Safety Issues for Civil Operations,

- EU project (2004)
- First time investigation of RPAS integration
- Frankfurt area
- ATC integration proved to be possible

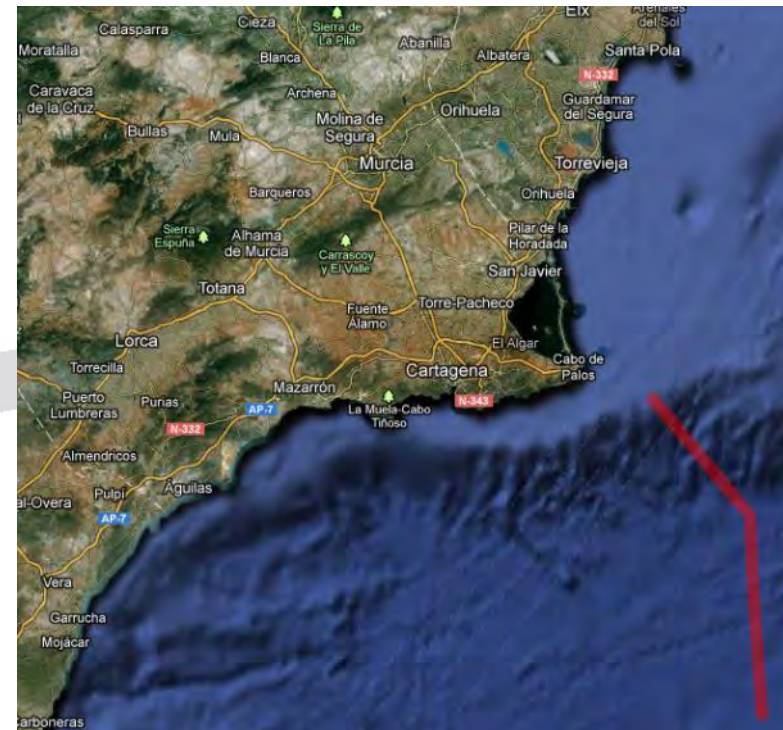
SINUE: Satellites enabling the integration in non-segregated airspace of UAS in Europe

- EDA/ESA project 2011
- Canary Islands area
- First time investigation of use of satellites for ATC integration



DESIRE: Demonstration of Satellites enabling the Insertion of Remote Piloted Aircraft Systems in Europe

- EDA/ESA project 2012/2013
- ATC simulation conducted end of 2012
- Flight trials in Spring/Summer 2013
- Integration procedures validated
- Mediterranean area

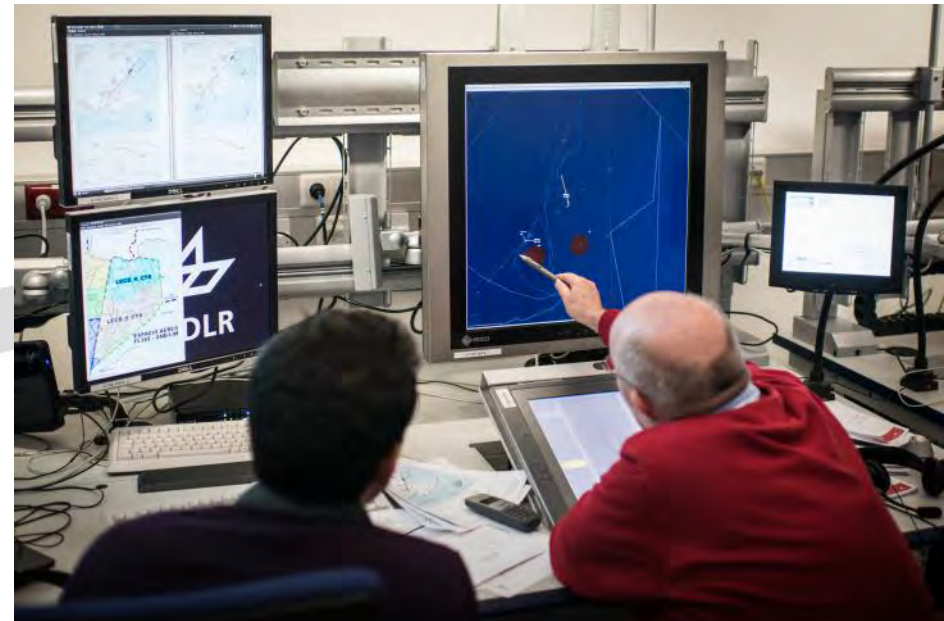


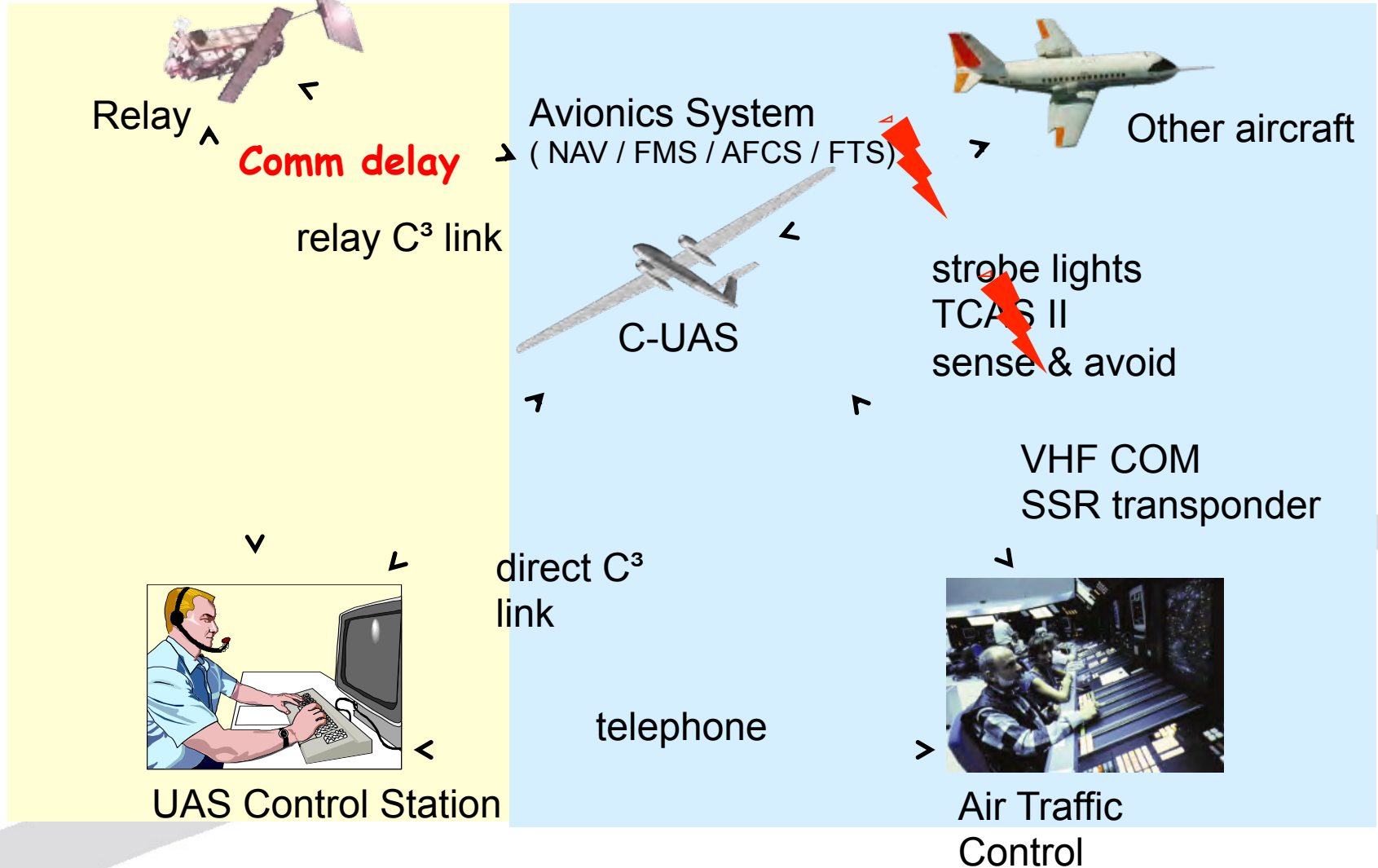
What architecture do we need?

What procedures do we need?

What emergency procedures do we need?

Experience from air traffic controllers is crucial

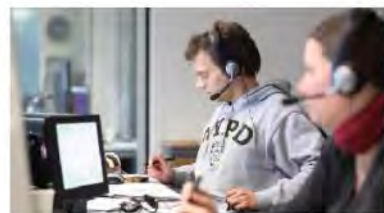




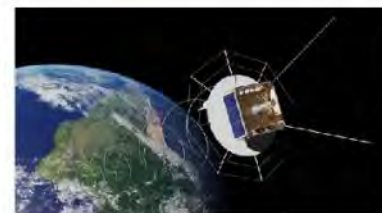
- **Aircraft: Heron I**



Characteristic	Value
Wingspan	16.6 m
Total Length	9.5 m
Maximum Take Off Weight (MTOW)	1100 Kg
Maximum Payload Weight	250 Kg
Maximum Fuel Capacity	400 litres
Maximum Take Off Run (@SL, ISA) (*)	450 m
Maximum Airspeed (@ 20000 ft, ISA) (*)	120 Kt
Ceiling (*) ()	22000 ft.
Maximum Endurance (*)	16 hours



Simulation Pilots



Satellite

R/T

R/T
Radar

R/T
C2

R/T C2



RPAS

Back up telephone



NARSIM



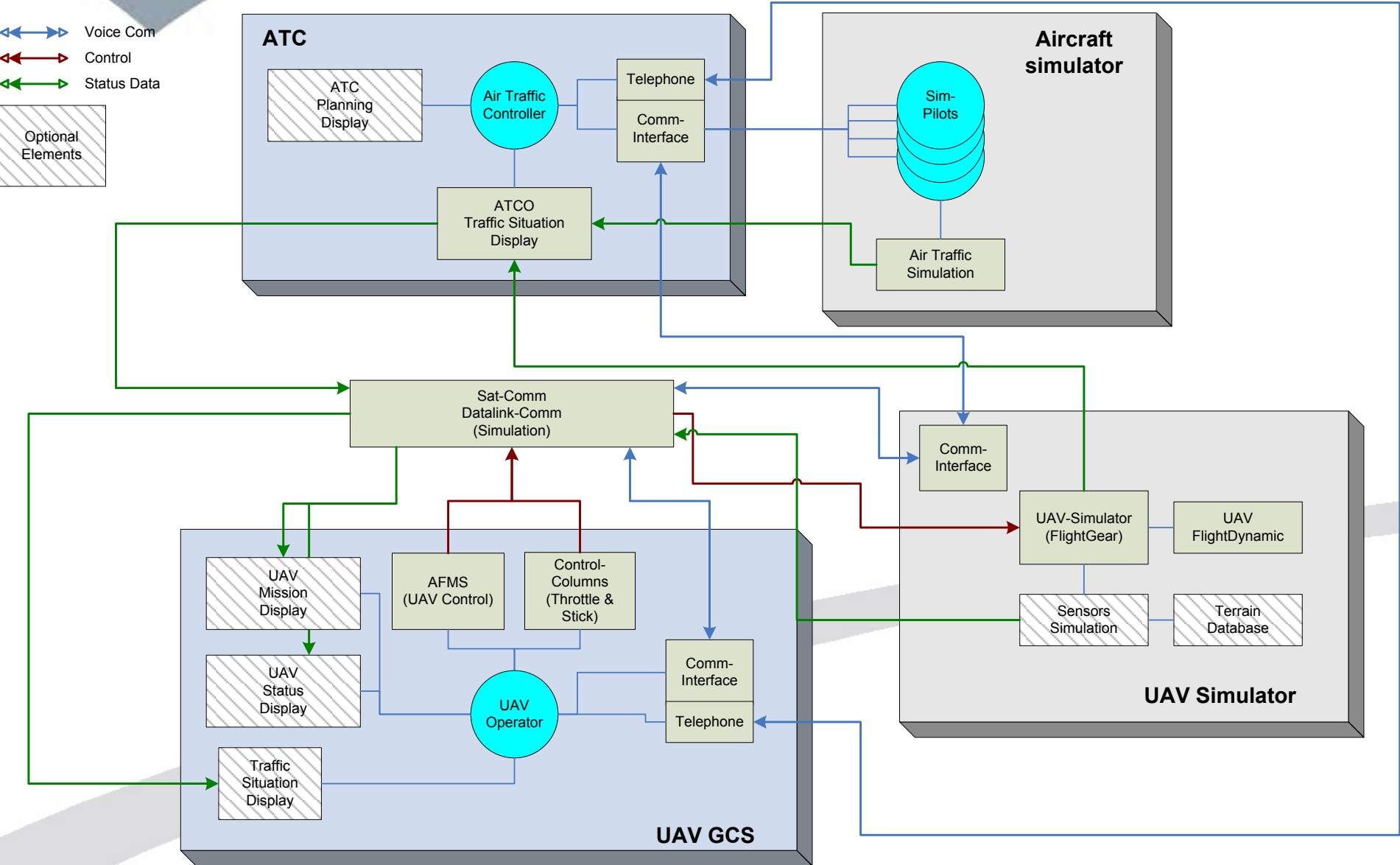
Ground Control Station

Communication

- Telephone communication between controller and UAS pilot if requested

Simulated Radio Telephony

- Radio telephony for the controller / pseudo pilot voice communication
- Specially designed intercommunication device operation over wire link
- Communication delay for satellite link is implemented:



Special procedures for RPAS could be developed

Considerations

- use of special routes
- special call signs
- special transponder codes
- special symbology on ATC display

BUT:

Aim is to integrate UAS in traffic, we decided to have the unmanned aircraft act like other aircraft

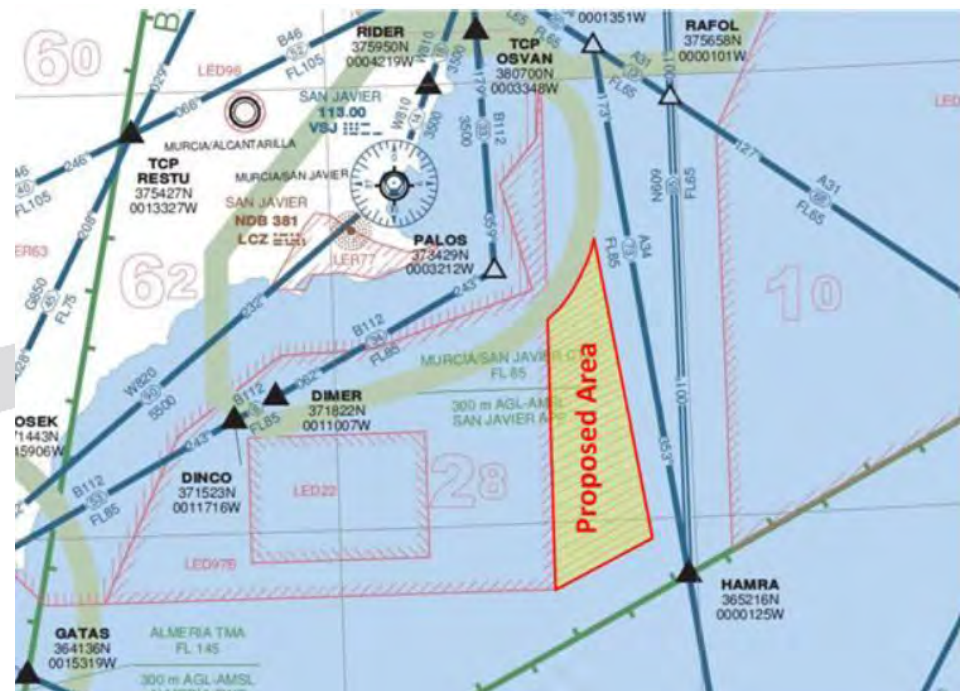
- only a dedicated call sign was used
- special transponder codes were use for emergency situations

- Loss of voice communications between RPAS pilot and ATC
- Interruptions to voice communications between RPAS pilot and ATC
- Intelligibility and latency of voice communications between RPAS pilot and ATC
- Loss of command and control link between RPAS and GCS
- Interruption of command and control link between RPAS and ATC
- Loss of surveillance information feed to ATC
- Interruption of surveillance information feed to ATC

A “go home” manoeuvre is programmed

- fly to the home base
- fly to an alternate airport
- climb in order to try to re-establish communication
- crash in a safety area

To reach the home area, a manoeuvre needs to be defined, which is safe and separates the RPAS from other traffic



- Normal operations
- Emergency Operations:
 - Standard emergency procedures:
 - Comm Loss Squawk 7600
 - Thrust Loss Squawk 7700

Delays in communication:

800ms, 2s, 4s

- Controller Workload

ATCo

- callsign labelling of the UAS on the air traffic display
- use of special emergency transponder codes
- UAS flight performance
- Workload

Communication with UAS pilot

- what to do in emergency situations
- time delay in satellite communication
- back up phone protocol

Three experiments

- Frankfurt area (USICO project)
- Canary Islands area (SINUE project)
- Murcia/Mediterranean (DESIRE project)

Check the number of conflicts

Questionnaire after each run

Questionnaire at the end of the day

Discussion session with

- air traffic controller

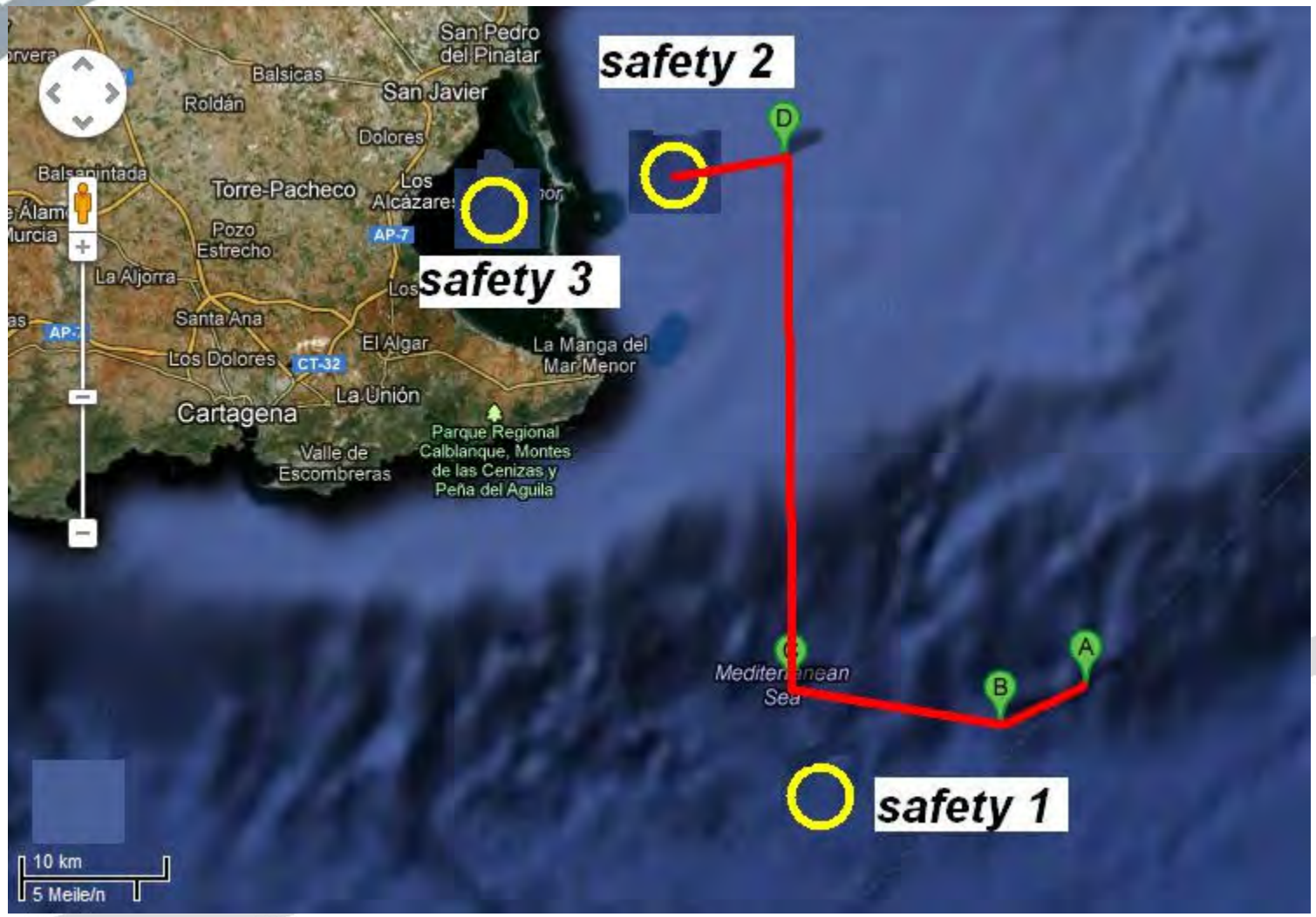
- UAS pilot

- pilot that controlled the other traffic

- route designers

- experiment supervisor

Murcia area in simulation




Sim set-up (1)



UAV Ground Control Station


STATUS

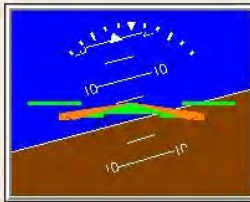
Map




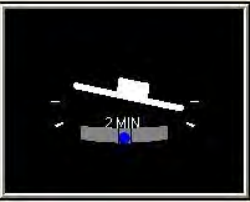
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Instruments
















AUTOPILOT CONTROL


Altitude

<p>Commanded</p> <p>FL 72</p> 	<p>Actual</p> <p>1015</p>
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ROCD

<p>Commanded</p> <p>ft/s 300</p> 	<p>Actual</p> <p>218</p>
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Speed

<p>Commanded</p> <p>kts 90</p> 	<p>Actual</p> <p>89</p>
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Heading

<p>Commanded</p> <p>° 73</p> 	<p>Actual</p> <p>35</p>
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Start
C:\Dokumente und Ei...
C:\Programme\delay...
Unbenannt - Paint
X-System
UAV_delay_module
UAV Ground Control ...
10:54

No need for further specialising SSR codes:

- 7600: comm loss
- 7700: emergency
- 7660: datalink loss, proceed as planned
- 7661: datalink loss, return home
- 7662: datalink loss, fly to emergency field

Use of the phone for backup communication is appreciated

- remote pilot must initiate the call
- initially contacts ATC supervisor



No events:

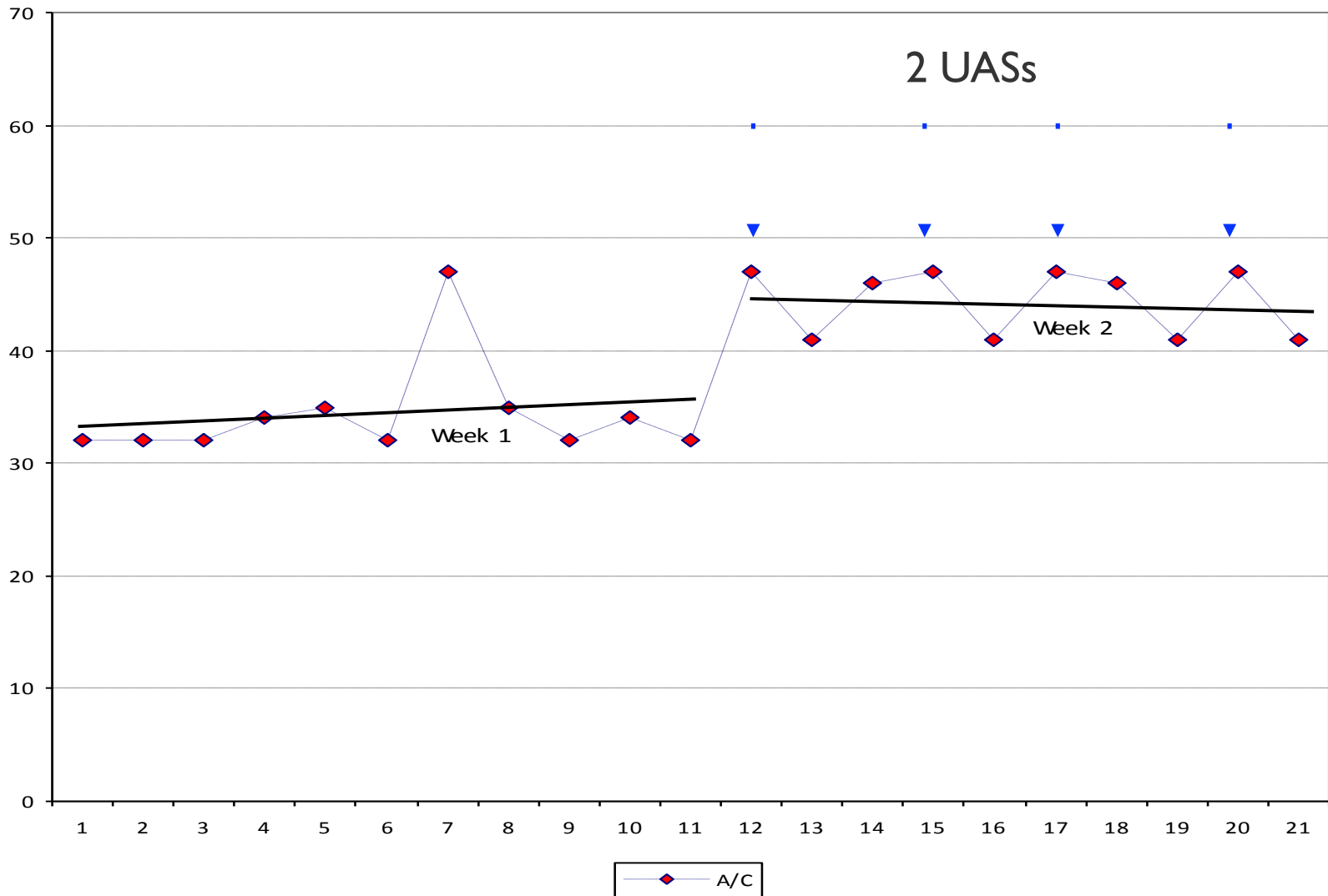
- No problems for 800 ms and 200 ms delay
- 4000 ms delay was regarded as “to be considered” -> having influence when more traffic is present
- Low UAV performance as a limiting factor

Sense/Detect & Avoid

- still an issue to be solved with highest priority

Emergency:

- Emergency RPAS operations were regarded as adequate
- Automatic emergency procedure easy to understand and to handle
- Larger separation as a key issue, especially against time delay in combination with the low UAV performance:
delay of 4000 ms = NO !
- Fly home-procedure must be consistent with emergency procedures for manned aircraft
 - Indication of call sign (SSR code)
 - Special go-around procedure on final approach
 - normal route diversion procedure (two minutes straight flight and then climb/descent towards the emergency route)



Real time ATC simulations to prepare for real integration of UAS in the air traffic

Show to controllers in each case how it will work, through real time simulation the safety case on procedures and emergency situations can be supported

Design emergency procedures is necessary in consultation with ATC

We have demonstrated the possibility!

Airport Integration will still be an issue!



Missions are feasible in near future



AT-One **The ATM Research Alliance**

