ADS-B SYSTEM FOR TRACKING OF LAUNCH VEHICLES

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Payload Concept for Rockets

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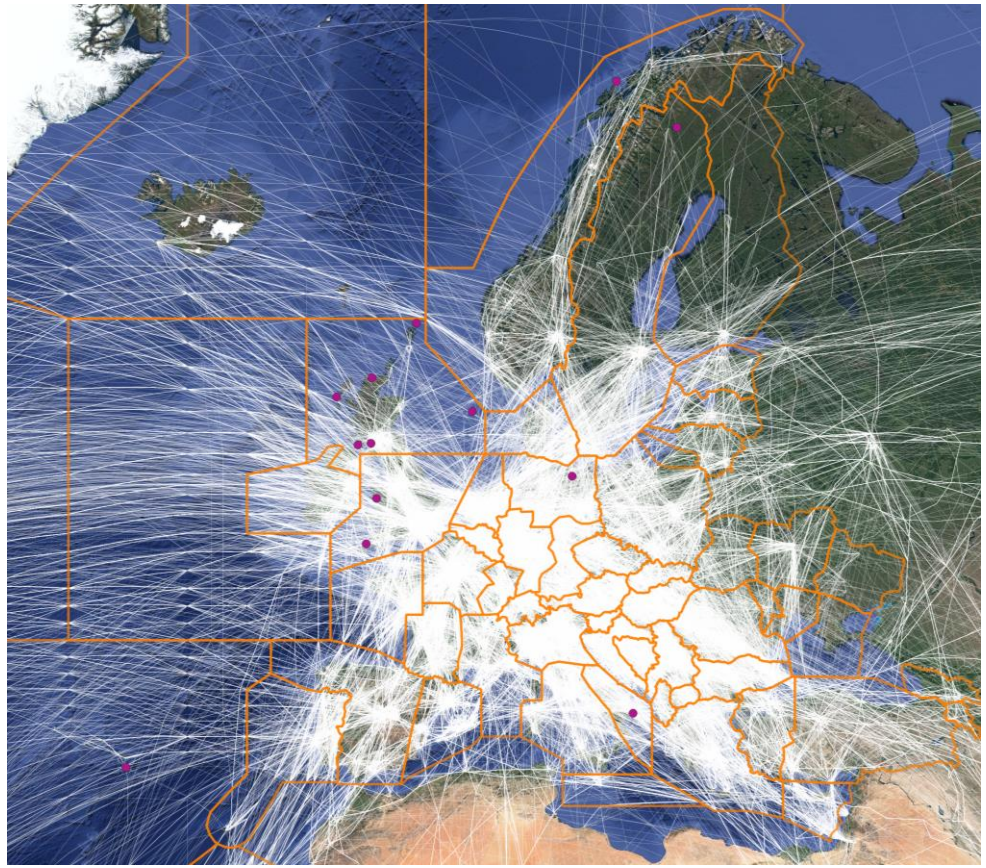
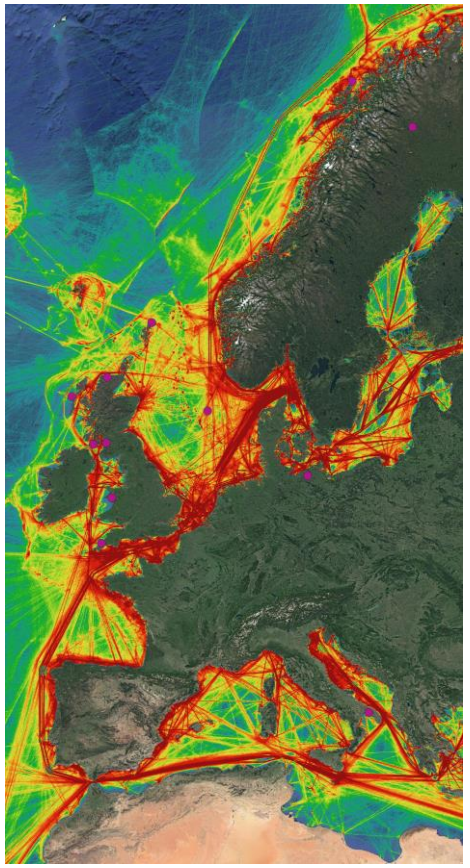
Motivation

Need for Coordination and Cooperation

- Commercialization and increase of space flight activities
- Complex and highly frequented European airspace with multiple actors
- Impact of space operations on air and maritime traffic
  - Hazard Areas
  - SpaceX 2018: additional 34,841 NM and 4,645 min [1]
- FAA requests restrictions on launches, i.e. only night launches [2]



Map: Google, Traffic Data & FIRs: Eurocontrol



Map: Google, Traffic Data: EMSA

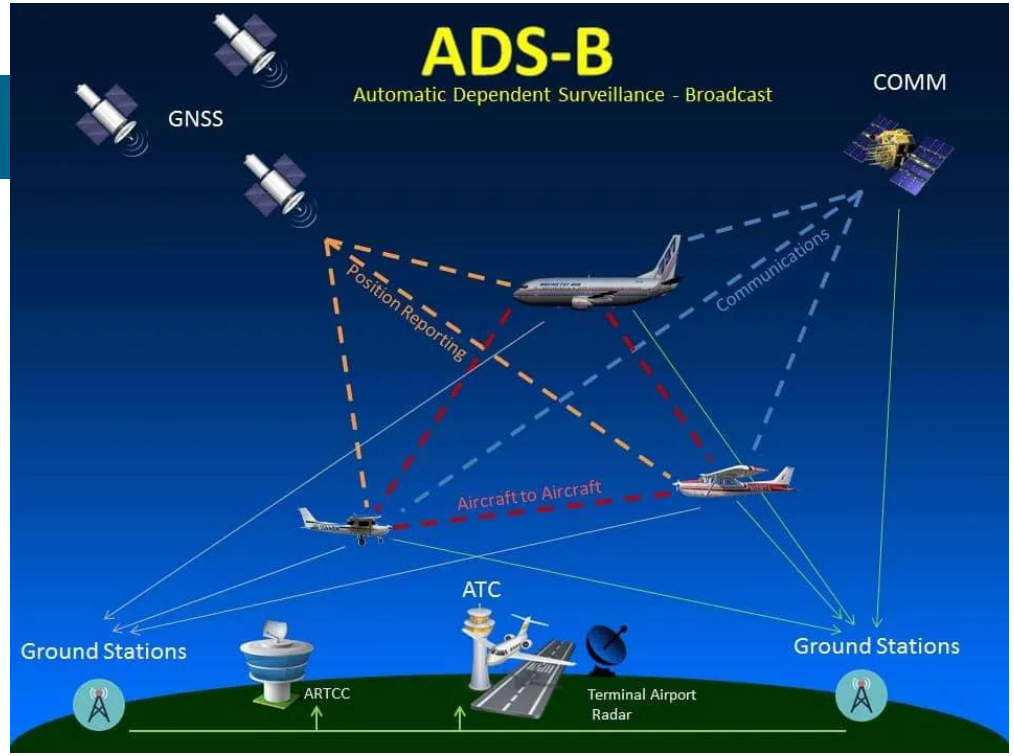
[1] **Air Line Pilots Association.** *ALPA White Paper: Addressing the Challenges to Aviation from Evolving Space Transportation.* Washington: Air Line Pilots Association, 2018. p. 10.

[2] 2023-04-13, FAA PR on Equitable Access

Project Idea

ADS-B for enhanced situational awareness

- Seamless integration of air, space, and maritime traffic
- Increased stakeholder situational awareness
- Safe and efficient operations for all actors




Korneel Luth/Pixabay


SpaceX/Flickr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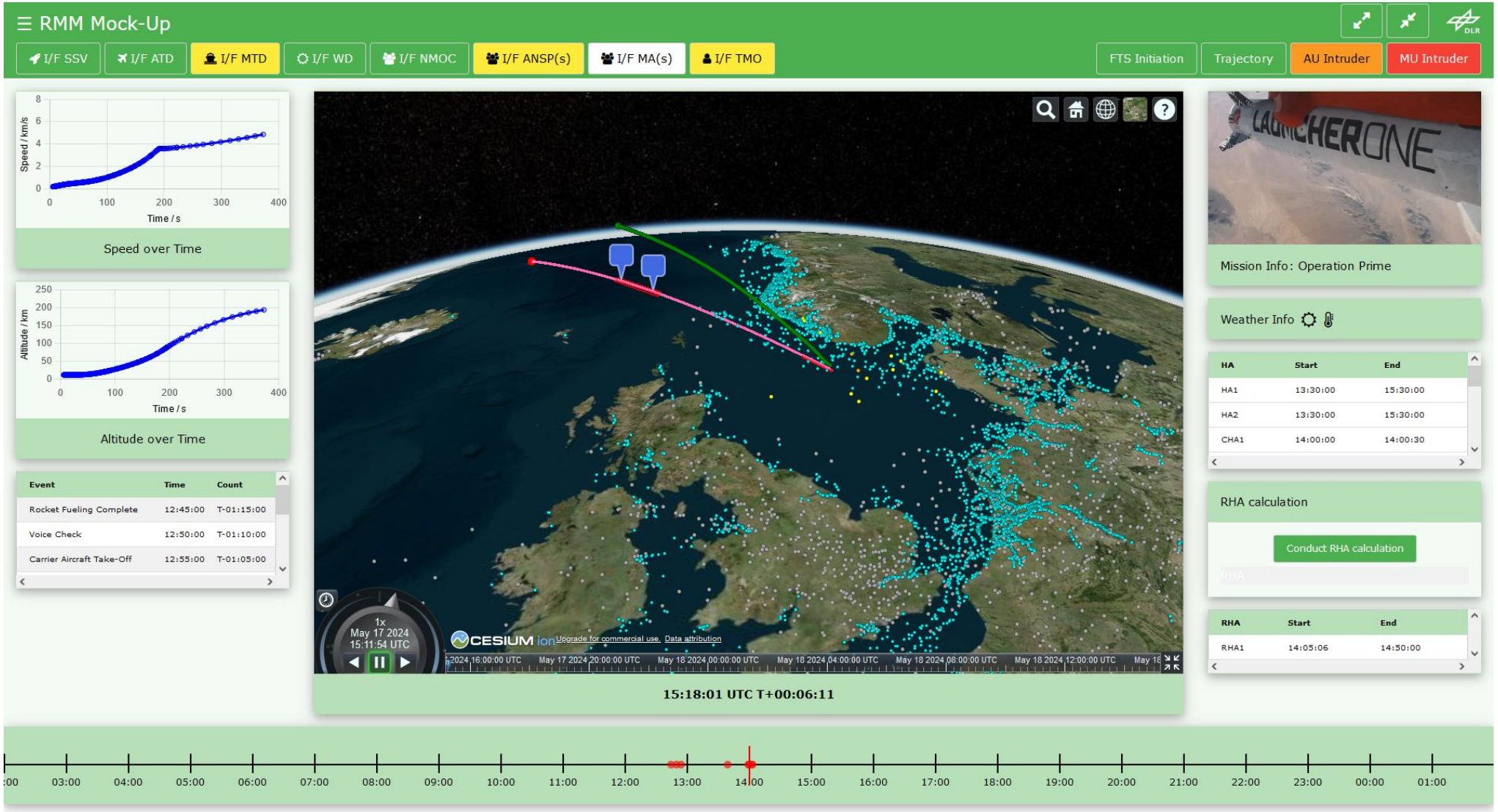
Possible Application:
Maritime orbital and sub-orbital Launches



ADS-B Technology

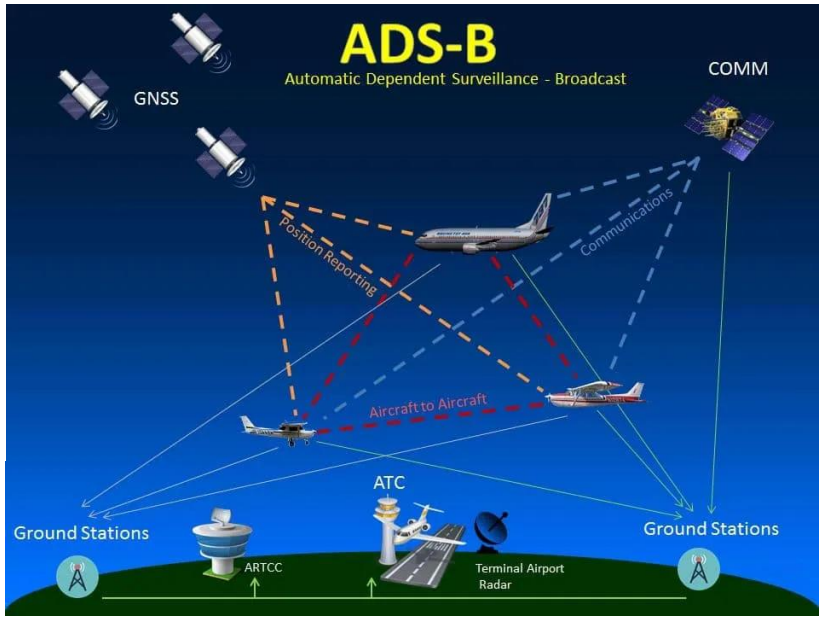
- ADS-B mandatory for most aircraft:
  - Additional situation awareness aircraft and ATC
  - Additional Situation Awareness means of tracking
- ADS-B transceiver: Signal out only
- ADS-B signals received on ground, by other aircraft and in space

- ADS-B Mode-S transponder: ADS-B signal out & tracking by ATC secondary radar.
- Secondary radar receives additional transponder signal

ADS-B Technology on a Rocket

- Transceiver: Transmitting GPS Position, heading and barometric height
- Seamless integration into Air Traffic Control
- Additional means for specific radar tracking

Messages	TC	Ground (still)	Ground (moving)	Airborne
Aircraft identification	1–4	0.1 Hz	0.2 Hz	0.2 Hz
Surface position	5–8	0.2 Hz	2 Hz	-
Airborne position	9–18, 20–22	-	-	2 Hz
Airborne velocity	19	-	-	2 Hz
Aircraft status	28	0.2 Hz (*no TCAS RA and Squawk Code change*)		
		1.25 Hz (*change in TCAS RA or Squawk Code*)		
Target states and status	29	-	-	0.8 Hz
Operational status	31	0.2 Hz	0.4 Hz (*no NIC/NAC/SIL change*)	
			1.25 Hz (*change in NIC/NAC/SIL*)	



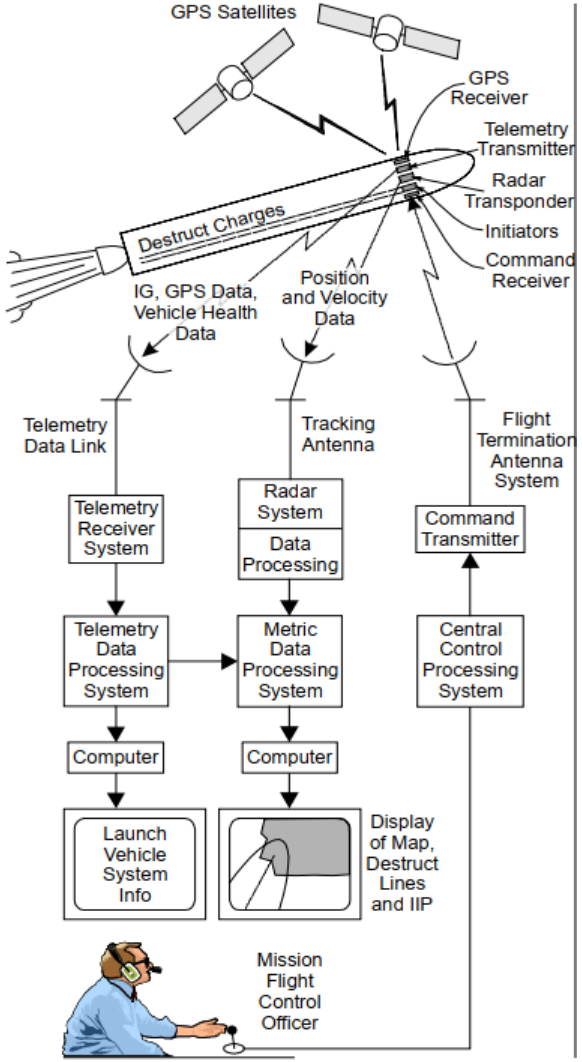


Fig. 2: Traditional Flight Safety System Elements.

Demonstration / Feasibility on a Rocket Mission (1)

Demonstration Mission on suborbital/ sounding rockets proposed

Objectives:

- Feasibility demonstration for seamless rocket launch integration into airspace,
  ATM-STM integration, enhanced integrated airborne surveillance
- Responsive – Tactical - Launch: More safe, fast and reliable operations and integration into airspace
- Obtain experience für future Microlauncher orbital missions with GPS/ADS-B use

Demonstration / Feasibility on a Rocket Mission (2)

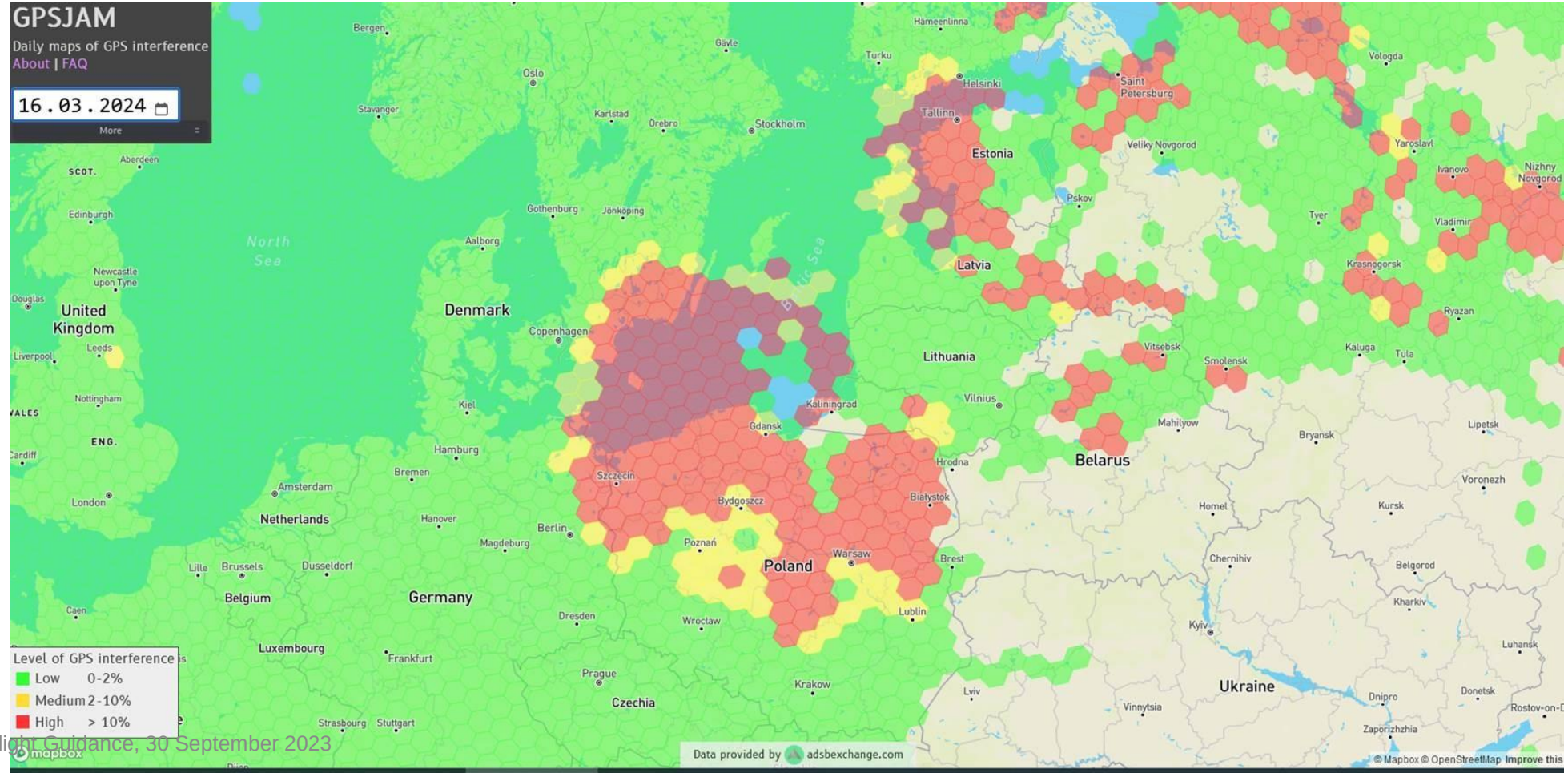
Technical contraints

- Sample rate 2 Hz (vs. FAA launch certification requirements of 10 Hz)
- Using ADS-B only transceiver or ADS-B Mode-S transponder:
- Mass/volume limitations, form factor, in/out antennas:
- Design of special in/out antennas @ spinning rocket:
- Interfaces to rocket or to rocket GPS receiver:
- Power supply: Interface to rocket power. Remote activation
- Rocket shock/vibration profile (GMRS G-Acceleration, Randomized Serration Profile)

Demonstration / Feasibility on a Rocket Mission (3)

Open technical questions

- GPS receiver performance at hight acceleration (150 g)
- GPS Jamming/Spoofing expected in launch area? www.gpsjam.org/



Demonstration / Feasibility on a Rocket Mission (4)

CoCoM & ITAR-Restrictions combined issue:

- CoCoM restrictions on velocity and height data
  1 000 kts, 1 850 km/h, 513 m/s; 18 km, 60 000 ft
- Update from Manufacturers:
  - ITAR: MAX Speed 600 m/s; MAX Altitude 18Km
  - COCOM: MAX Speed 515 m/s; MIN Altitude -1.5Km; MAX Altitude 100Km
- It will stop delivering a position fix when either:
  - Both ITAR limits are exceeded
  - One COCOM rule is exceeded
- ADS-B standard altitude limit for coding at 126 000 ft

Project activities

- Selection and procurement of appropriate transceiver/transponder on board.
- Flight qualification/testing
- Interfacing the telemetry data of the launcher with the device
- Delivery/installation of receivers for integration into a VPN-secured receiver network for the North Sea (drilling platform, ship etc.)
- Data recording and analysis of the experimental launch

- ADS-B as means for Recovery Tracking TBD

Future Integration to the Interface with Eurocontrol NM

Eurocontrol

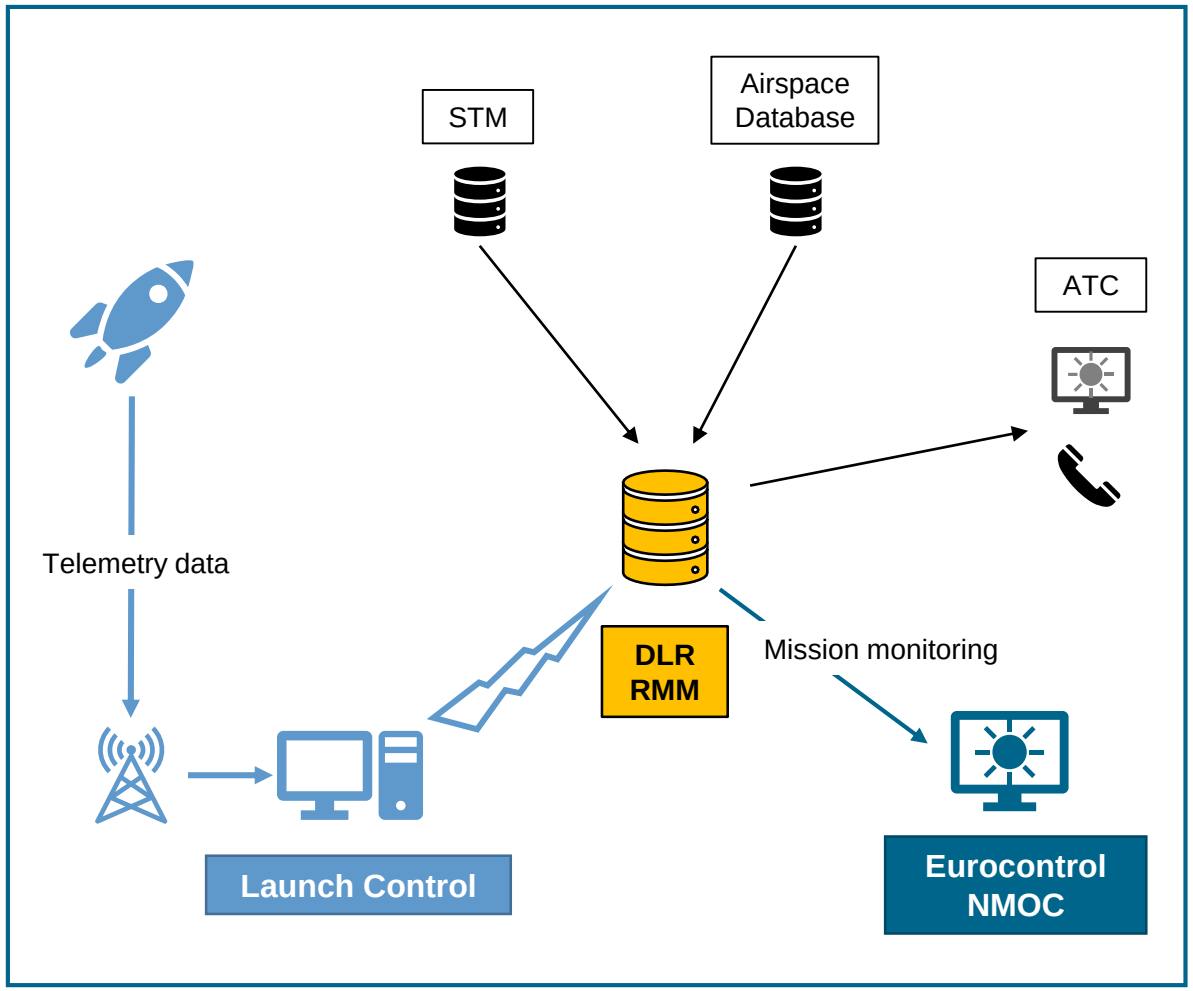
DLR Real-Time Mission Monitoring

Integration of **launch and re-entry operation within European airspace** on a network level

Space Launch Real Time Monitoring Module and working station for the European ATM Network Manager at Eurocontrol

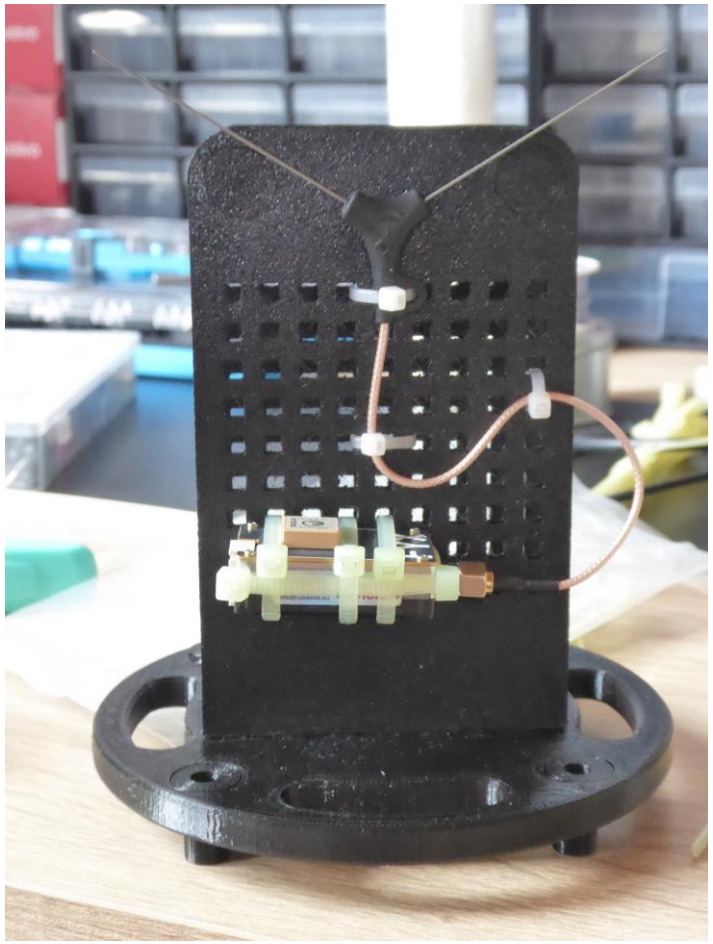
→Improve NM situational awareness

→Improve safety, enhance airspace utilization and improve contingency management for commercial space operations



Prototype

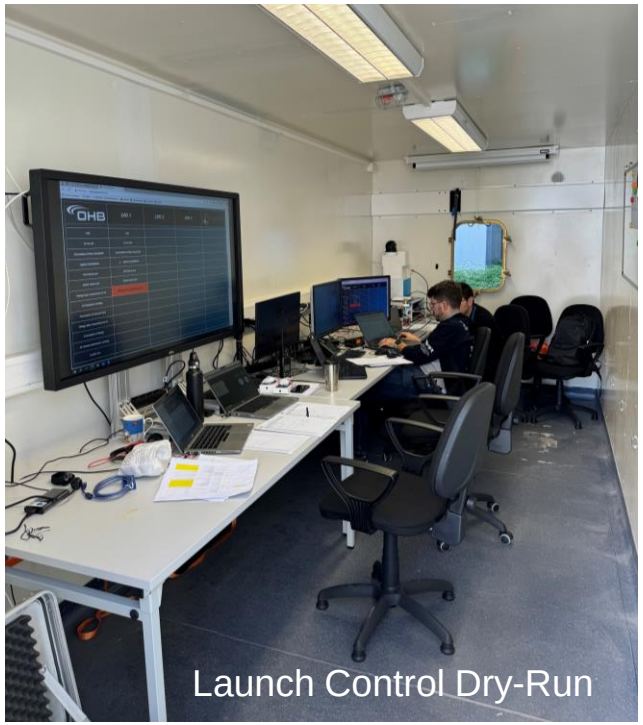
Low cost integration set-up for integration into a sounding rocket tip.



ADS-B Integration in Mobile Launch Control Center

- Demonstration Case: Mobile Launch Control Center for Offshore Spaceport @ OHB Digital Connect in Bremen
- ADS-B receiver system succesfully integrated as part of the Mobile Launch Control Center
- Operation of ADS-B transceiver has been successfully ground tested
- Planned: Use of DLR ADS-B transceiver on-board launch vehicle during offshore launch

Mobile Launch Control Center @OHB Digital Connect


Launch Control Dry-Run

ADS-B Receiver System

Summary/Outlook

- ADS-B is an interesting technology for integration of space vehicle launches seamlessly into the airspace
- Existing transponders for aviation/RPAS-domain maybe used
- CoCom ITAR limits be investigated and solved
- Hight Altitude Coding in ADS-B to be defined
- ADS-B also as means for Recovery Tracking to be investigated.
- Future jamming and spamming to be considered
- Preparation for future German/European Off-Shore Spaceport
  - Delivery/installation of receivers for integration into a VPN-secured receiver network on off-shore platforms
  - Integration in Mission Control Center