Satellite Based ADS-B for Commercial Space Flight Operations

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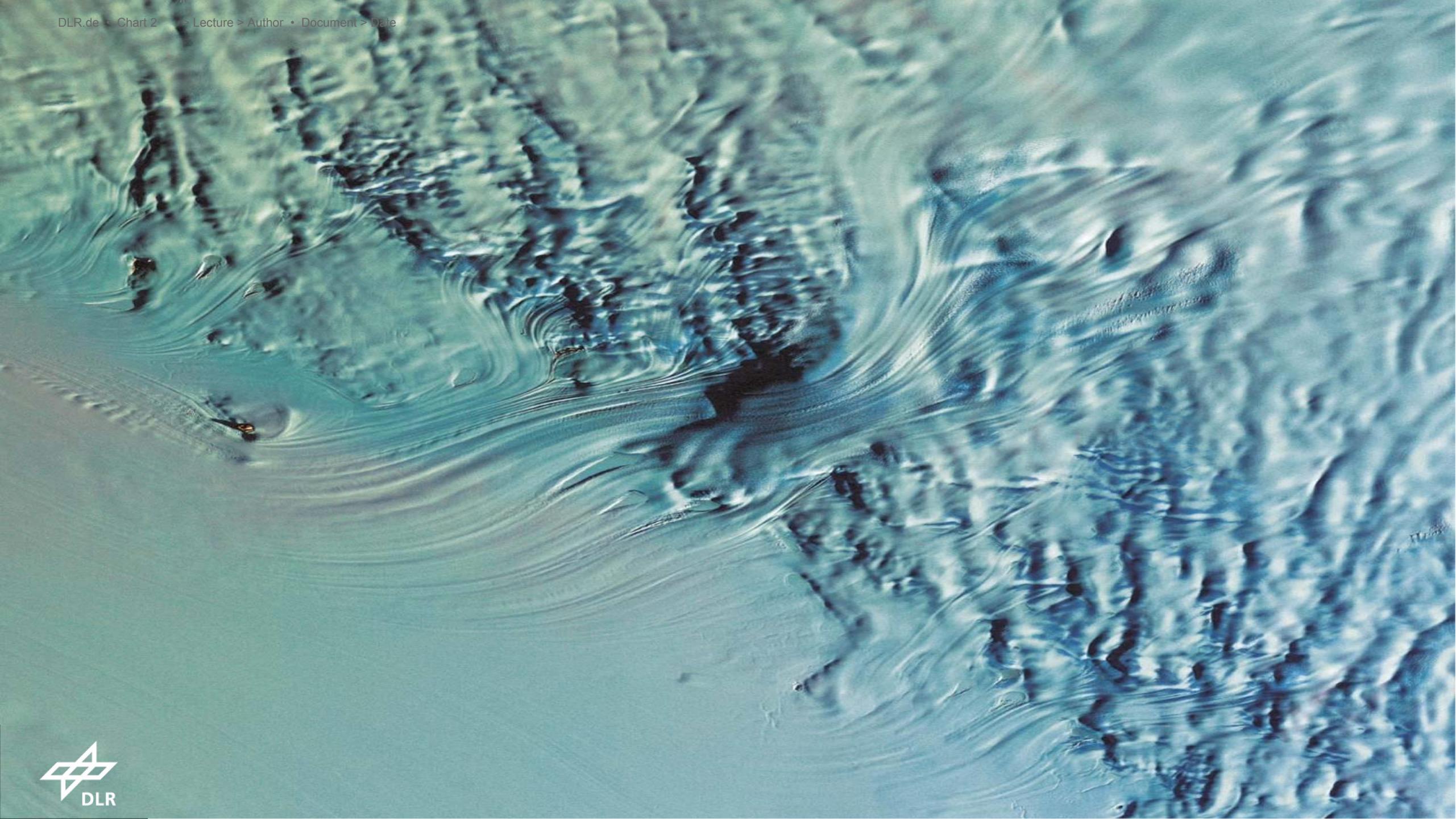
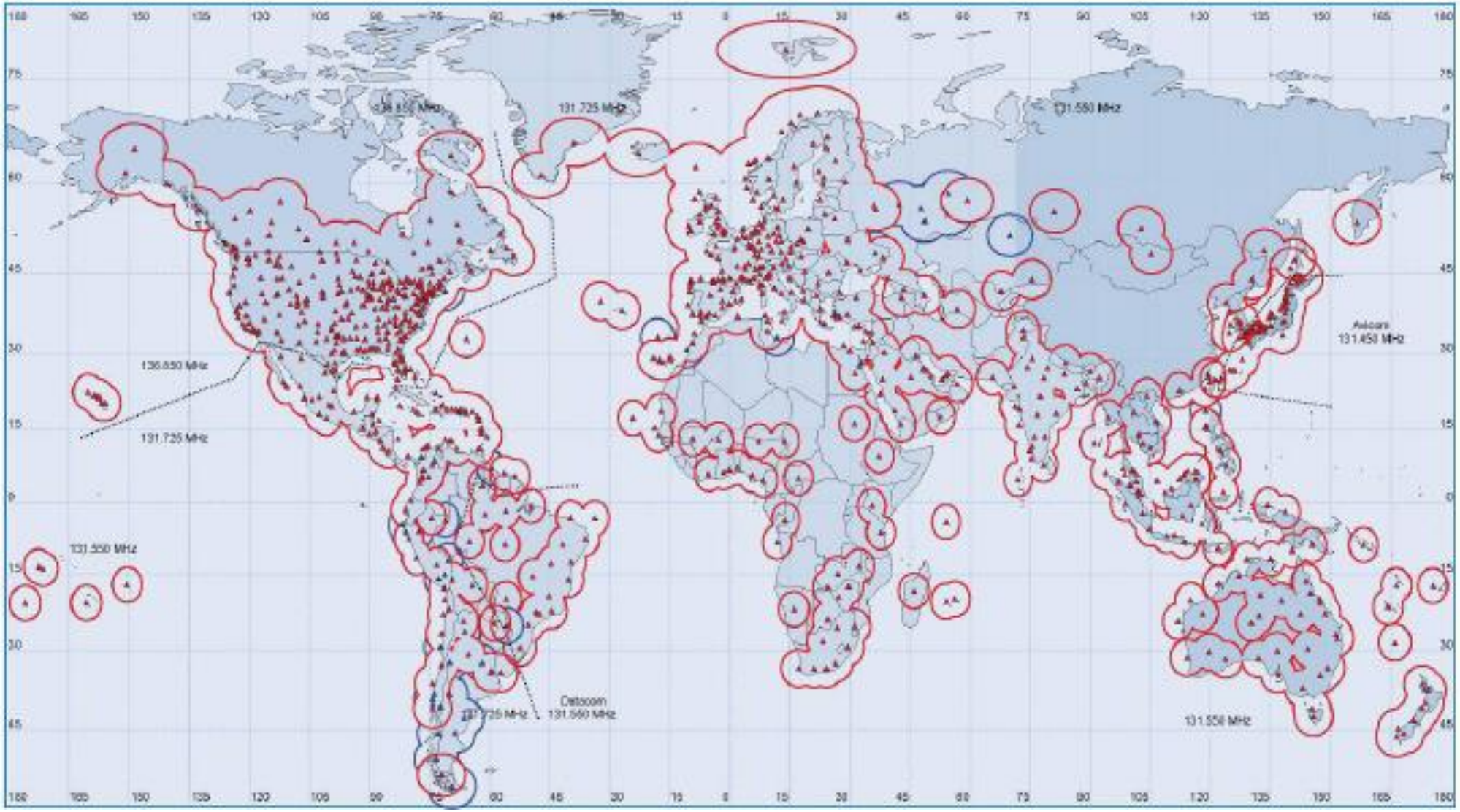
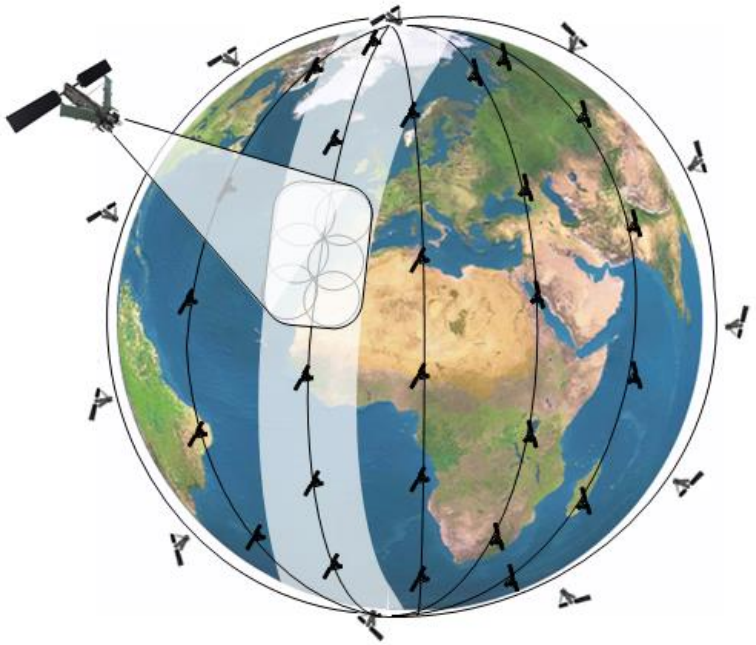


Air Traffic Surveillance today …



Satellite based Reception of 1090ES ADS-B



- Worldwide Reception of 1090ES (1090 MHz Extended Squitte
- Technical Solution:
  - ADS-B Receivers on a Fleet of LEO Satellites
  - Satellite Network for world-wide Coverage
  - Communication Network

Overview on ADS-B

Automatic **D**ependent **S**urveillance **B**roadcast

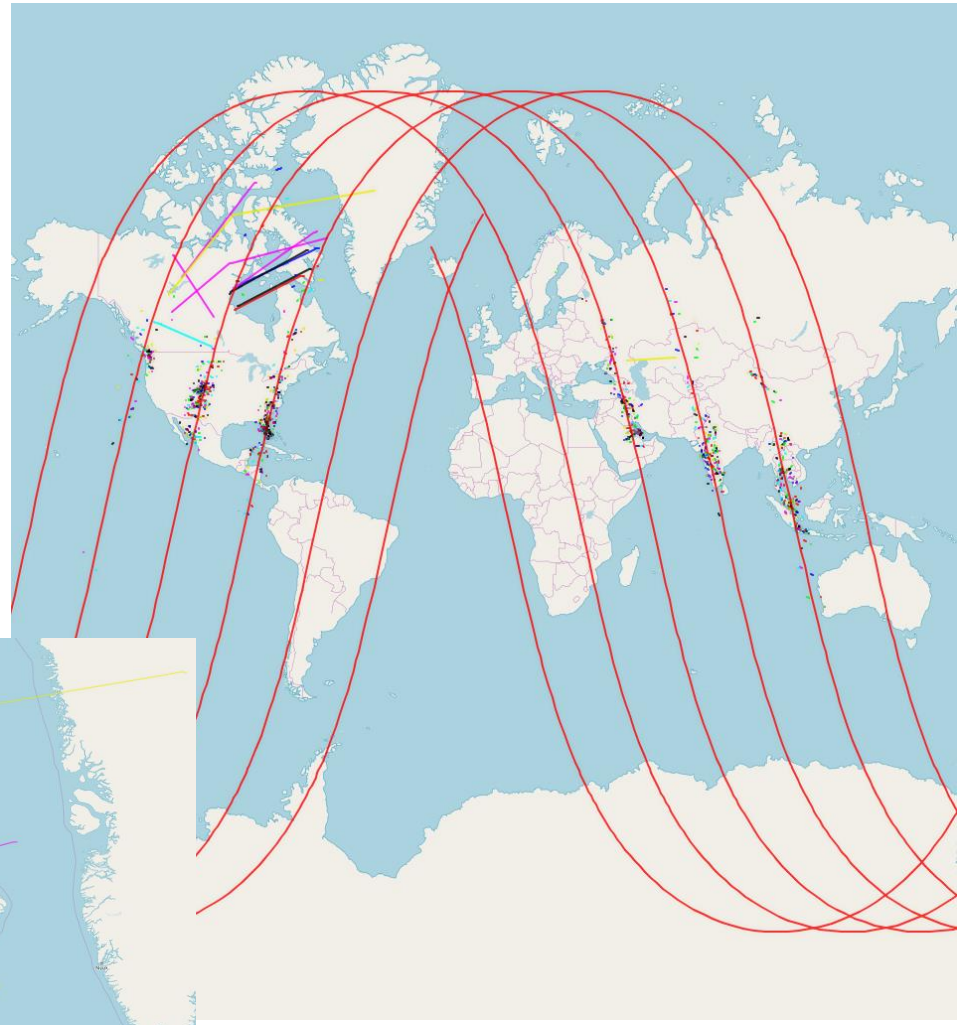
- Information transmitted:
  - Airborne Position
  - Heading and Speed
  - Identity and Category
  - Airborne Velocity
  - Barometric Altitude
  - Call Sign, …

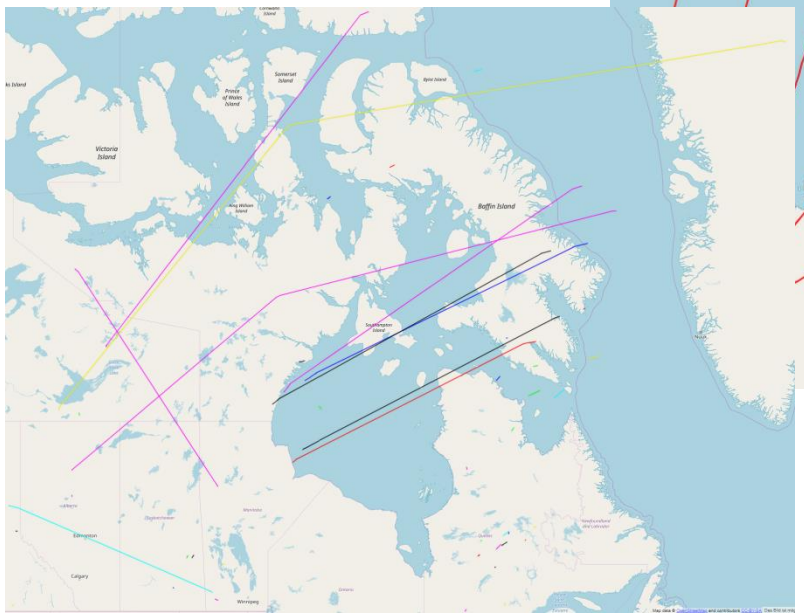
DLR's "ADS-B in space"
Receiver on ESA's Proba-V Satellite

DLR development
Operational since 2013
Operational investigations
Technology development

Global Scale Tracking of Space Vehicles

- Need of a global system
- Tracking from space shows excellent results
- Feasible globally and on the continent





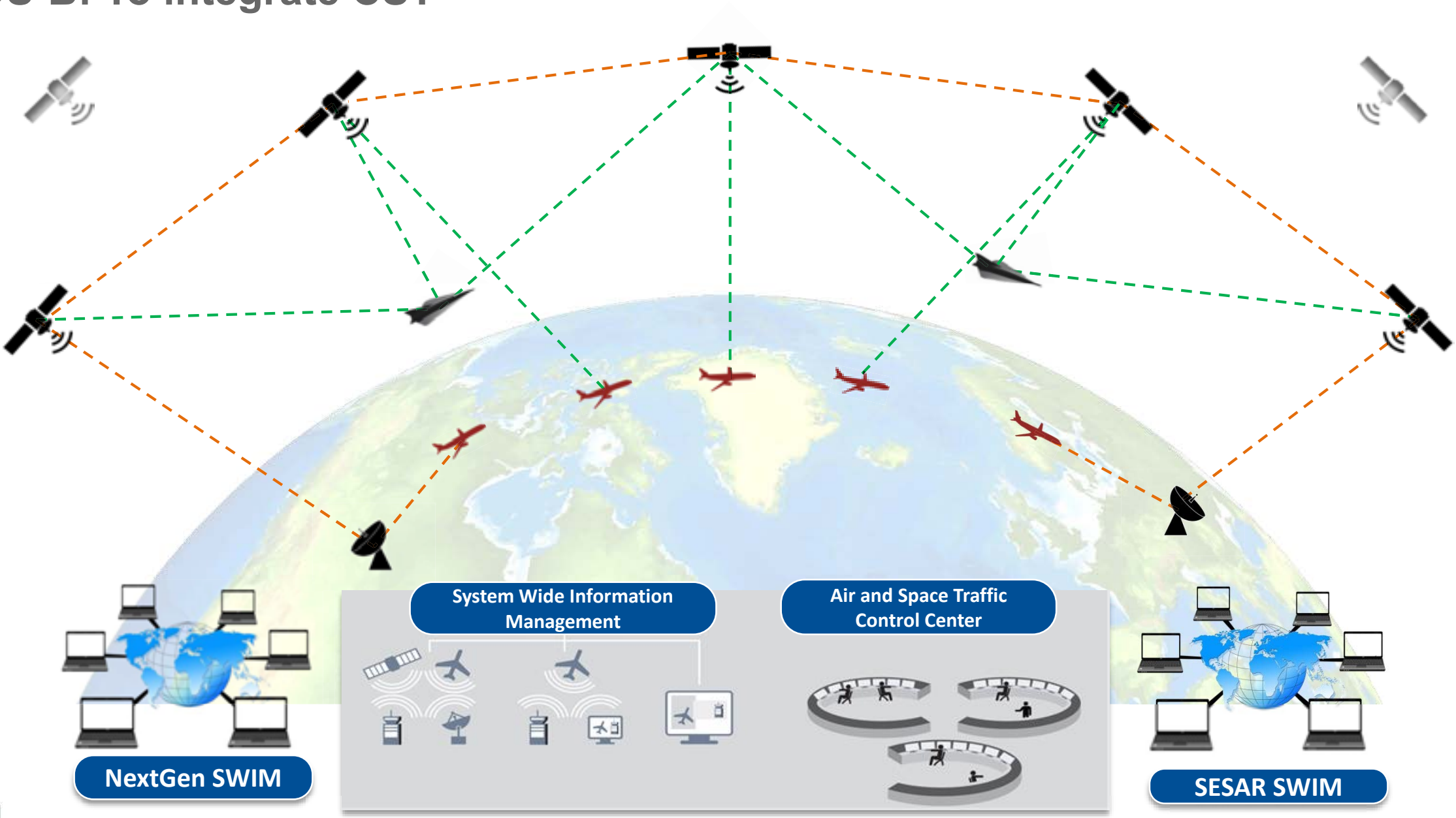
Global and North America tracks

What is about local tracking at Spaceports

- Proof of concept has been demonstrated

Final of Singapore Changi Airport
(ICAO Code WSSS

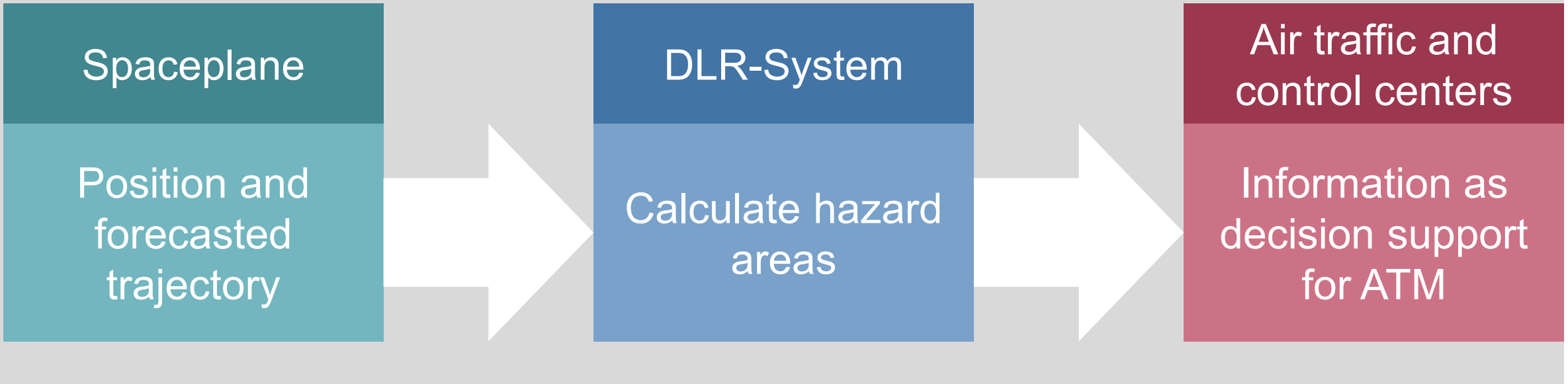
ADS-B: To integrate CST



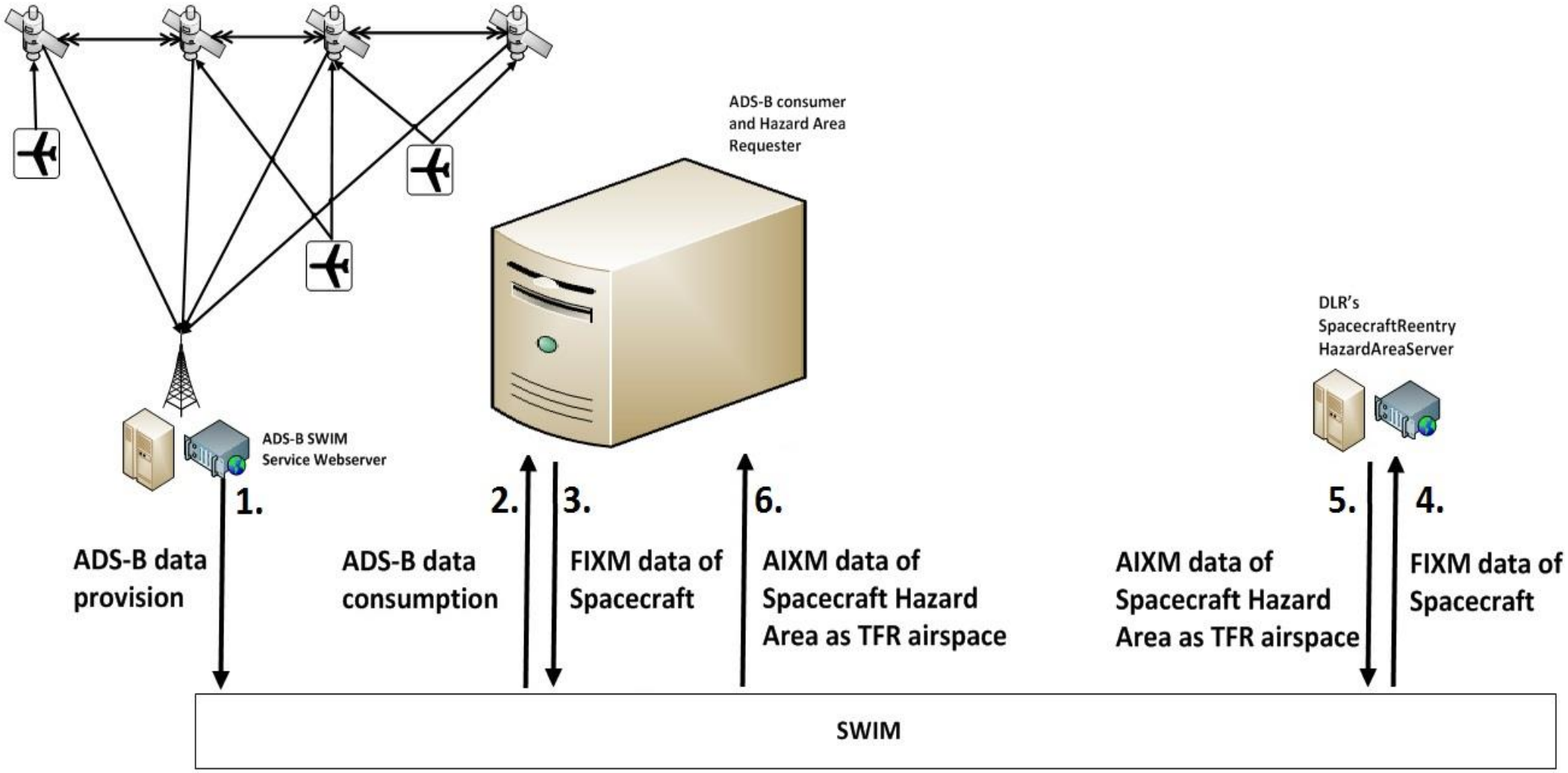
Identify Hazard Areas for Maintaining Safety

Via SWIM, all air traffic control centers and airspace users are informed online about the actual flight and status of the spaceplane

Information exchange in the SWIM system



THE SOLUTION ENHANCEMENT - Outlook



Conclusions and Limitations

Automatic **D**ependent **S**urveillance **B**roadcast

- Concurrent Technologies:
  - 1090ES (Extended Squitter),
    most common (European ADS-B-Mandate, FAA's ADS-B Final Implementation Rule)
  - UAT 978 MHz (only US, but proposed for STM by FAA)

- Limitations:
  - Barometric Altitude - limited to 101,337.5 ft (30,888 m)
    → New message encodings needed
  - COCOM limitations → ITAR limitations of GPS:
    Faster than 1,000 knots and/or
    Altitude >59,000 ft (18,000 m)

DLR is researching in worldwide operations of CST

Joint experiment using SAT data to track CST