GOMX-1:
A Nano-satellite Mission to Demonstrate Improved Situational Awareness for Air Traffic Control

Presented by:

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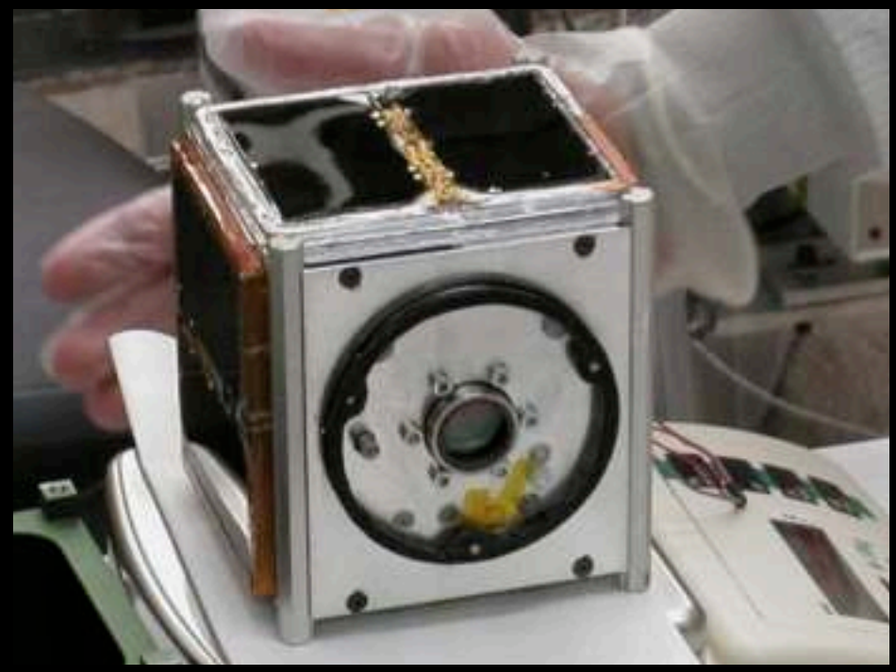
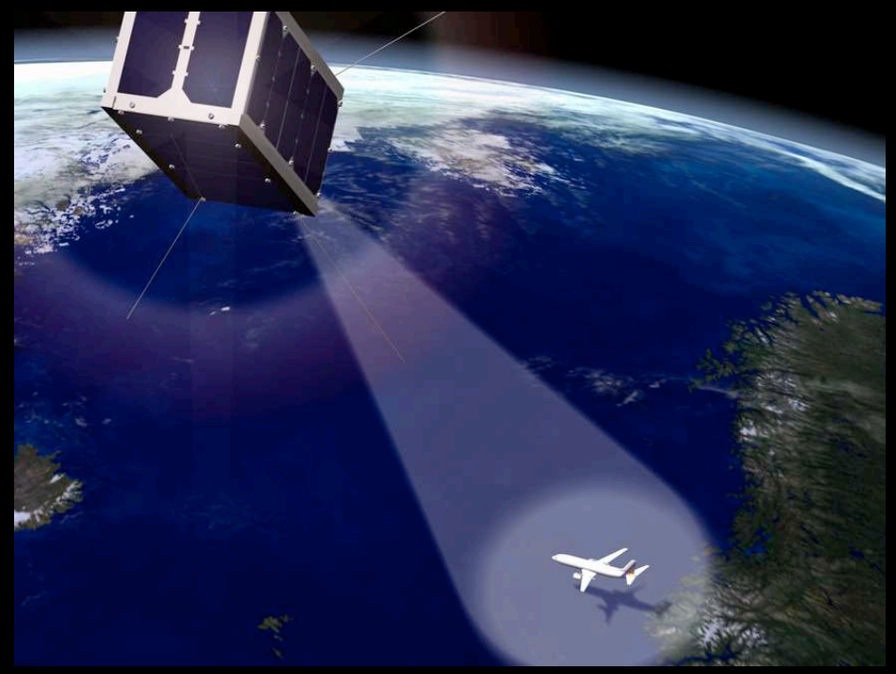
Cubesats are getting useful

- First cubesats were launched in 2003
- Was initially seen as a great tool for education, but not much more
- That view is changing rapidly due to:
  - tremendous innovation and technology development in the community
  - science applications of cubesat, e.g. RAX-1 by UMICH and SRI
  - a number of upcoming AIS missions with commercial aspirations
- No question that cubesats will find their niches within science and commercial services
- GomSpace to make first ADS-B demo from space this fall with GOMX-1!





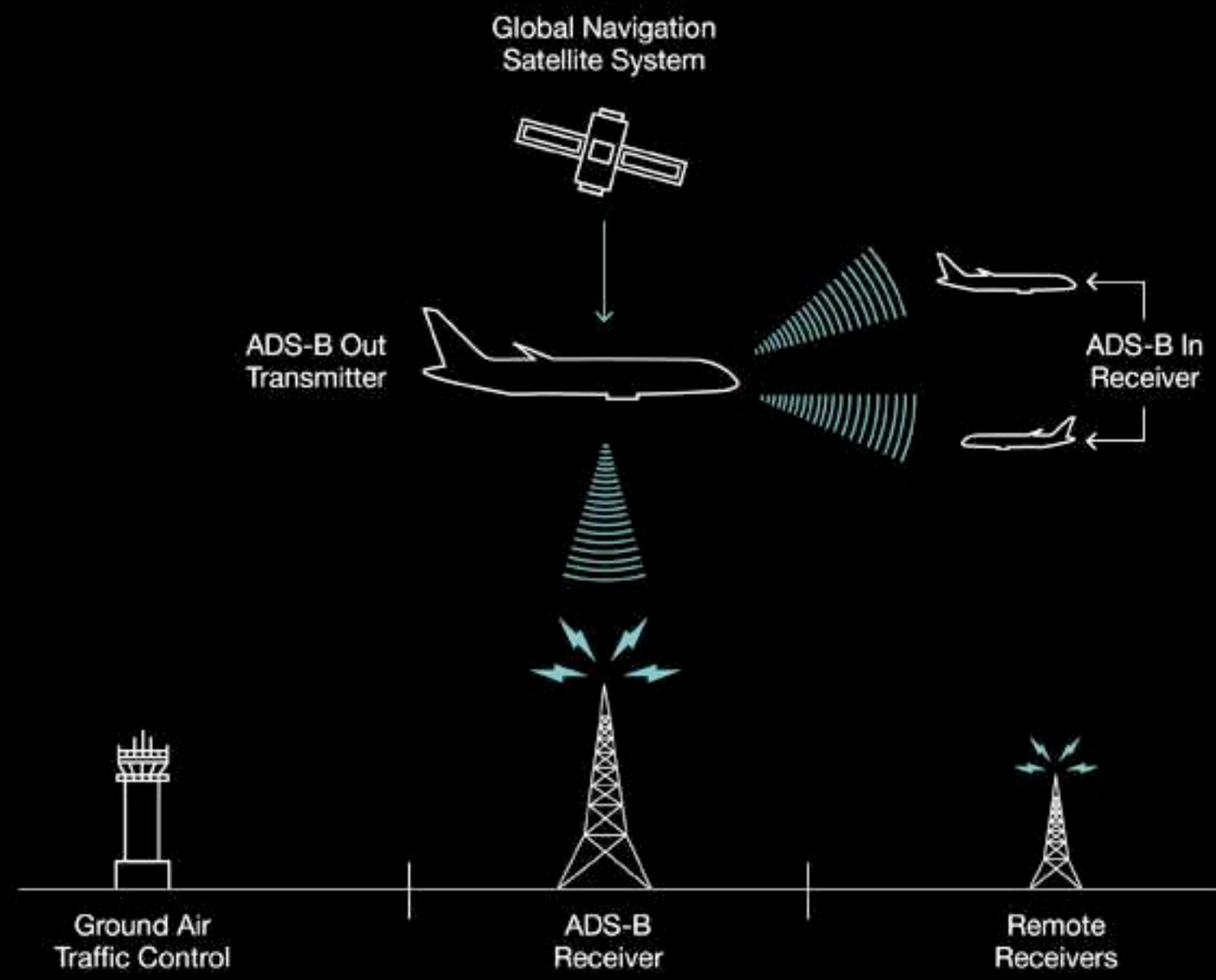
Current ADS-B System Overview

Automatic
Position and velocity information is automatically transmitted periodically (at least once every second) without flight crew or operator input. Other parameters in the transmission are preselected and static.

Dependent
The transmission is dependent on proper operation of on-board equipment that determines position and velocity and availability of a sending system.

Surveillance
Position, velocity, and other airplane information are surveillance data transmitted.

Broadcast
The information is broadcast to any airplanes or ground station with an ADS-B receiver. Current mode S ATC transponders are interrogated and then send a reply.



Why Receive ADS-B in Space

- Oceanic regions are not covered by primary or secondary radar, i.e. air traffic controllers have limited situational awareness about trans-oceanic flights.
- Significantly impacts efficiency and safety of trans-oceanic flights.
- Very difficult due to regulations and cost to introduce new equipment on the aircraft.
- The ADS-B signal is there and fits into existing tools and procedures – just need to route it to relevant stakeholders.

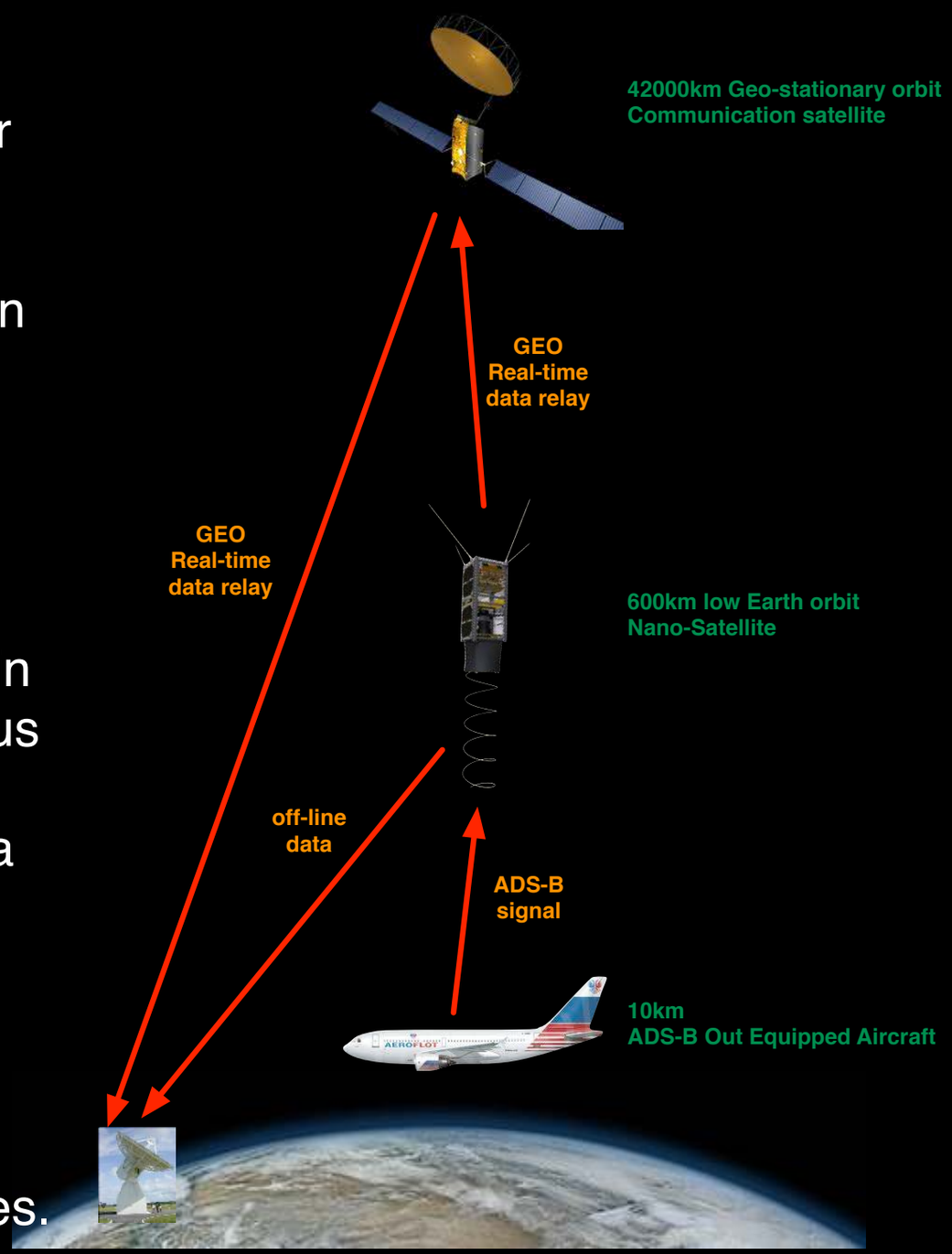
Space Based ADS-B Concepts

Off-line concept:

- A small number of nano-satellites (e.g. 4) in polar orbit pick up ADS-B signal from aircraft as the satellite pass overhead.
- Data is downlinked from each nano-satellite when a ground station is in view.
- Data is processed statistically and is used for planning & optimization.

On-line concept:

- A larger number of small satellites are deployed in a constellation providing world-wide instantaneous coverage.
- Geo-stationary satellites are used to provide data relay providing the capability to feed ATM stakeholders with real-time data over a secure network.
- Data is used operationally, e.g. to reduce separation in airspaces with no primary or secondary radar coverage. E.g. oceanic airspaces.



Mission Objectives and Partners

Mission objectives:

- Be the first to demonstrate reception of ADS-B signals in space
- Validate signal models to facilitate subsequent development of receivers with performance for commercial operation
- Demonstrate benefits from space based ADS-B with relevant ATM stake-holders

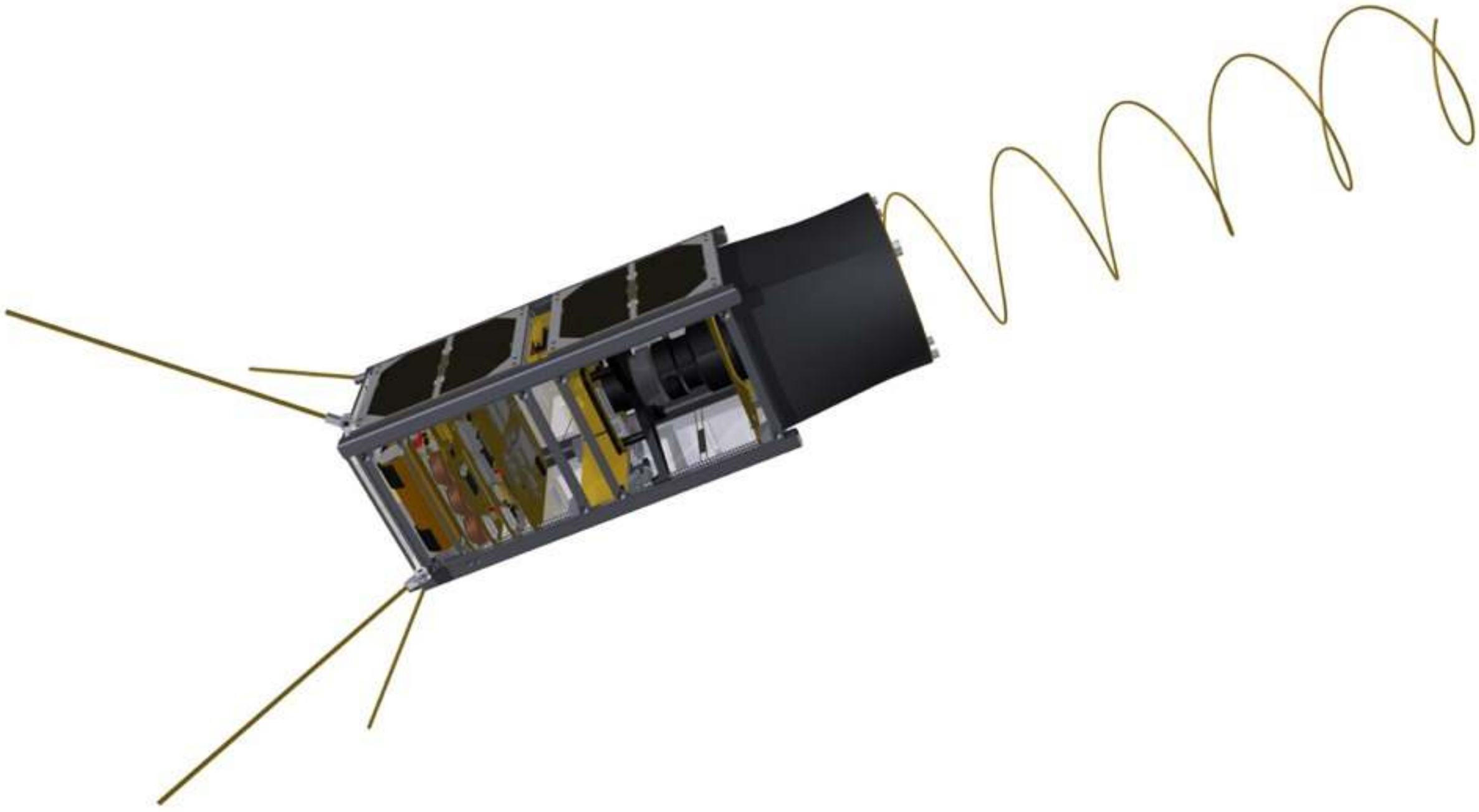
Partners:

- GomSpace
  - Project/mission management
  - Satellite design and construction
  - ADS-B receiver design and construction
- DSE Airport Solutions
  - Data validation and correlation to existing data sources
  - Pilot demonstrations with stakeholders
- Aalborg University
  - R&D in software defined radio techniques to improve reception performance

Launch:

- 20th of November 2012 into near SSO orbit

Dnepr Launch Vehicle



Build Using GomSpace COTS Components

Power

Spacelink

Computers

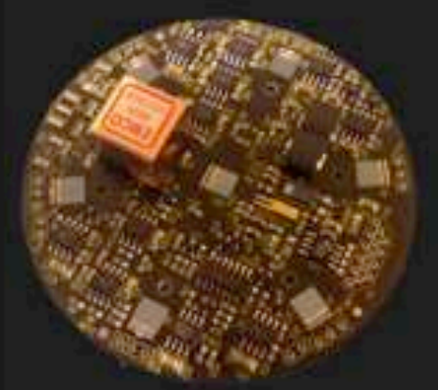
Payload

Control

Satellites

Software

Projects



The Cubesat Space Protocol (CSP)

Technical Objectives

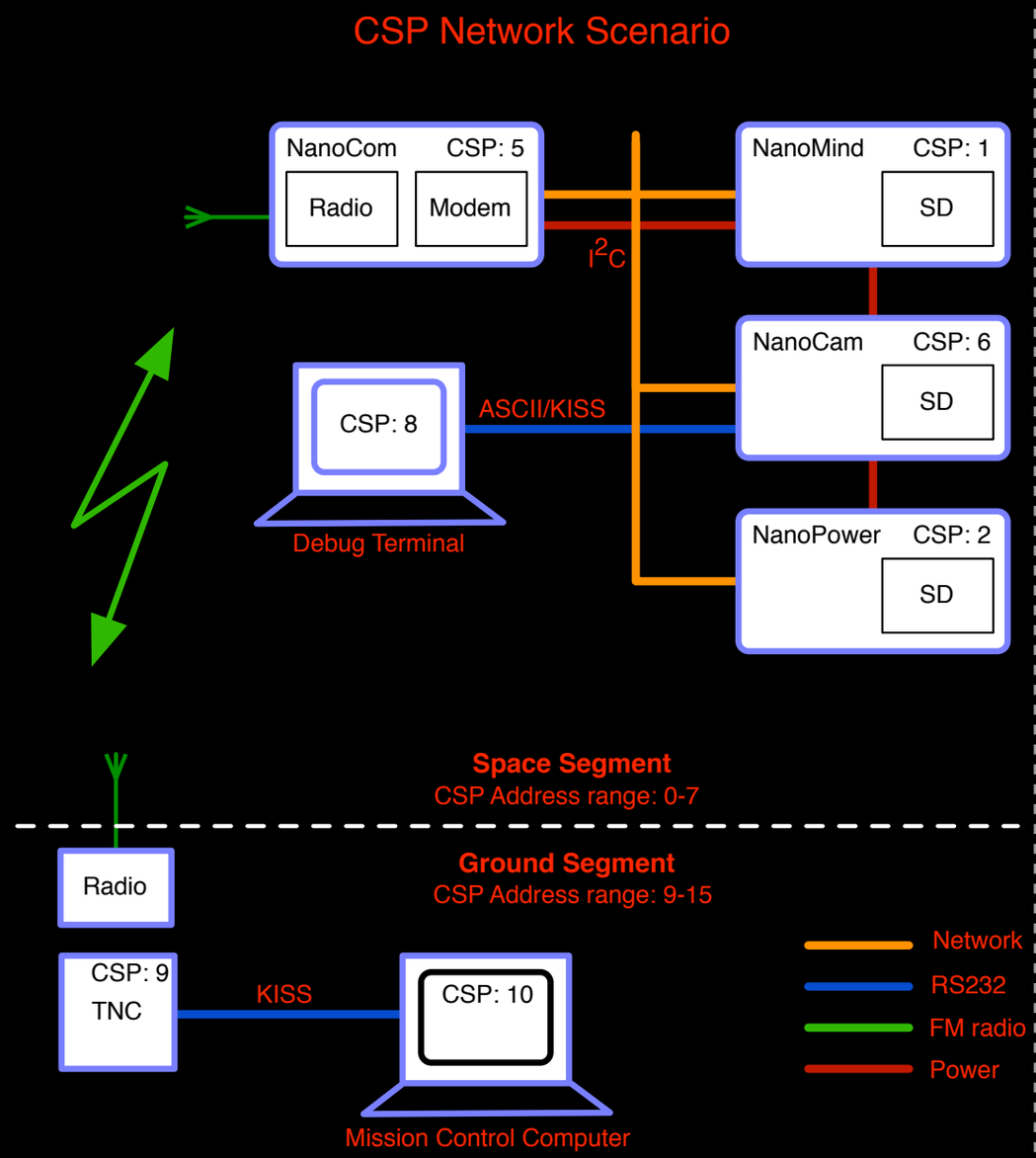
- Allow a service oriented network topology extending a network transparently across space and ground segments.
- Ease integration between subsystems - plug'n'play.

Current Compatibility

- Operating systems: FreeRTOS, POSIX
- Architectures: ARM, AVR8, AVR32, x86
- Interfaces: I2C, CAN, RS-232, CCSDS, HDLC, loop-back

Status

- Used in all GomSpace systems
- Core parts open source (Google code)
- Collaboration encouraged



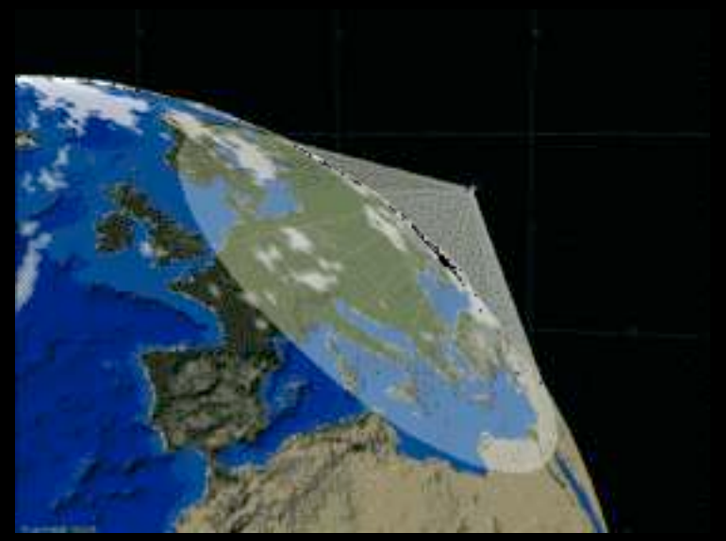
http://code.google.com/p/cubesat-space-protocol/

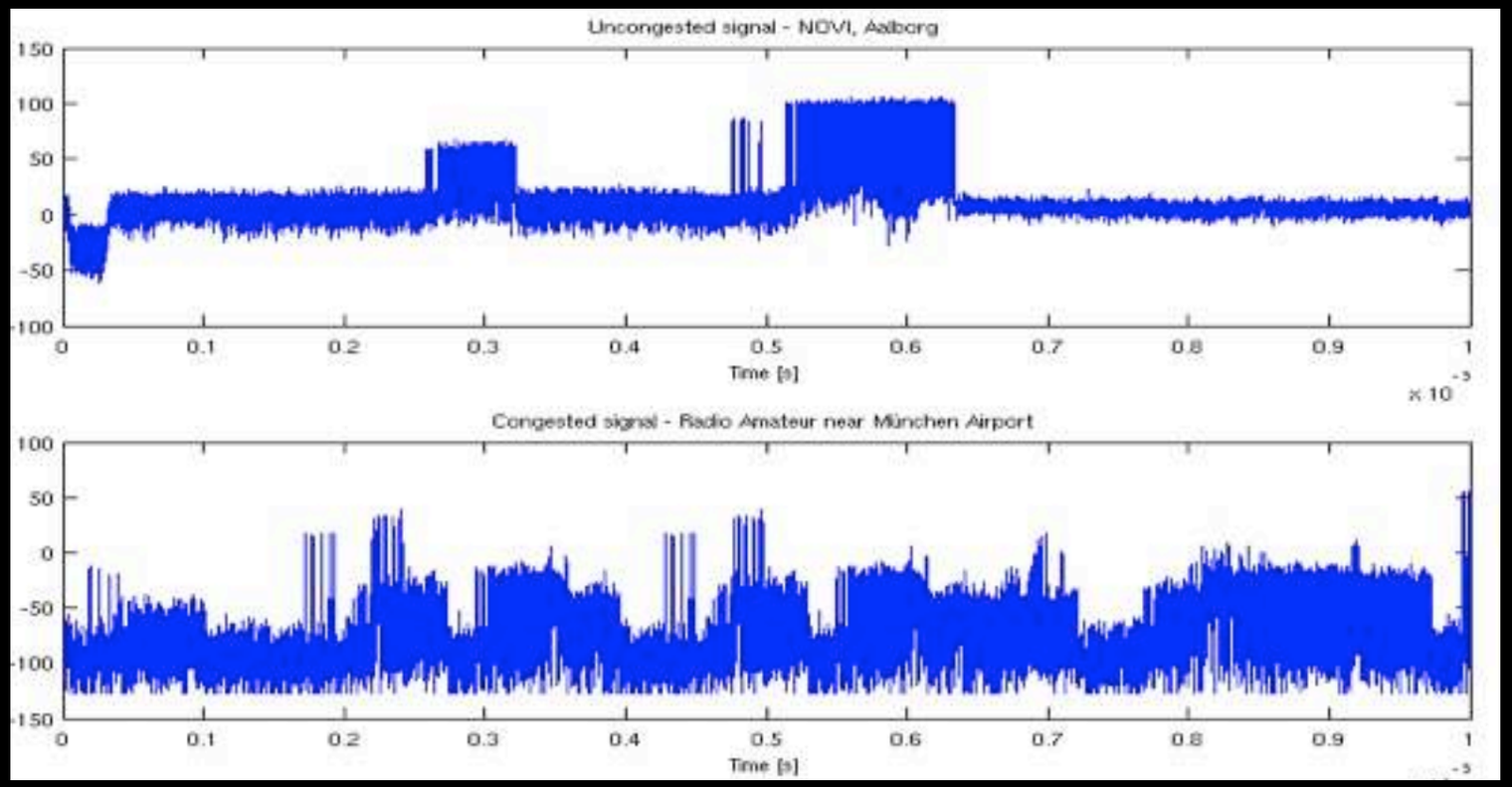
Challenge #1: Range

Challenge #2: Data Collisions

- Satellite will see a large area resulting in ADS-B signals interfering over crowded airspaces.
- Operation is not expected to be feasible in congested airspaces such as e.g. over central Europe, but adequate performance to cover oceanic regions is expected.

- The GOMX-1 mission will characterize exactly where operational service is possible and where not.



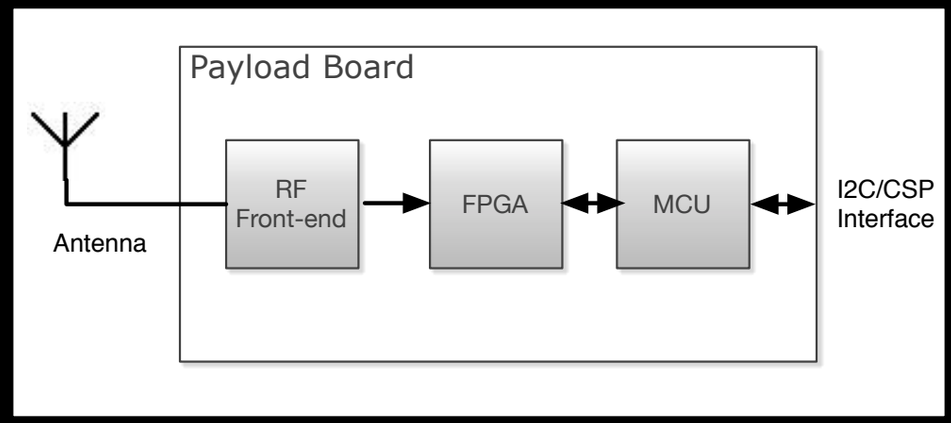


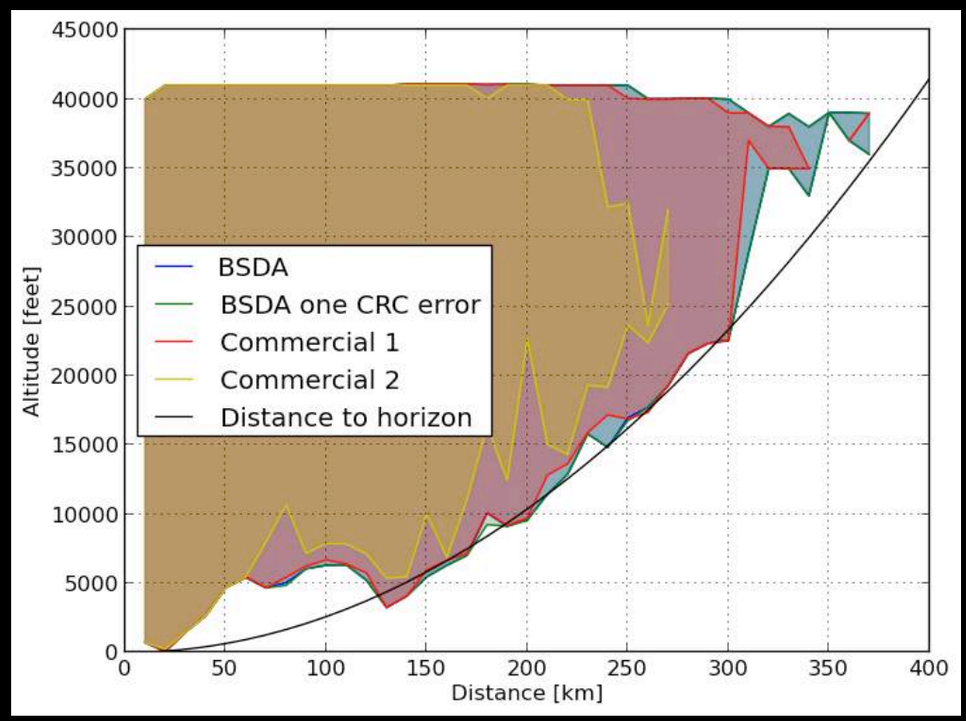
Mode-S in un-congested airspace

Mode-S in **congested** airspace

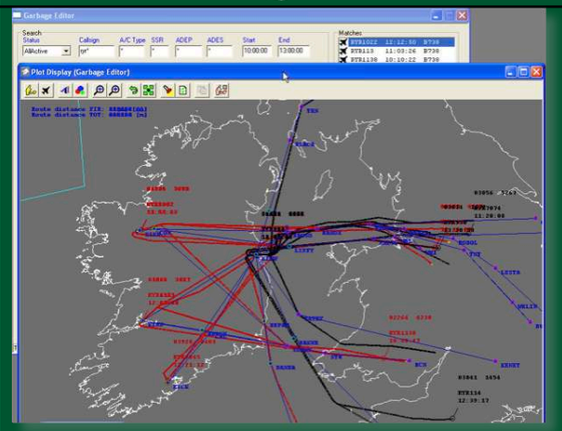
The ADS-B Receiver Payload

- Deployable Helical Antenna
  - 1090 MHz
  - stowed stacking height <2 cm
  - deploys to ~42 cm length
- Sensitive RF front-end
  - optimized for in-space reception
- Commercial FPGA
  - decoding and analysis algorithms
  - new bit code can be uploaded in flight
  - SEU monitoring and other features
- MCU with 2GB solid storage
  - data storage and filtering
  - statistical data analysis





Roadmap Ahead

Year	System	Goals	Main Challenge	
2012	Demonstration Satellite (GOMX-1)	• Validate link models • Pilot demonstrations with ATM stakeholders	Develop ADS-B receiver and antenna for in-space operation	
2015	3-5 payloads in operation	• Provide unique data material on air traffic • Improve en-route charging • Improve air space management	Developing software and analysis models that directly transform the data into benefits for the users	
2018	e.g. 60 satellites in 5 orbital planes with real-time link	• Provide services for operational air traffic control	Generating sufficient trust in the system for operational use	

Contact Information

Come see the GomSpace booth at SmallSat!

www.gomspace.com

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