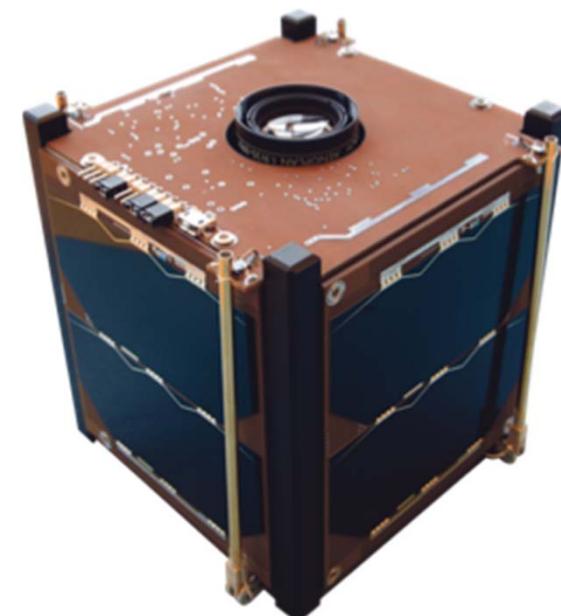


GomSpace Presentation

GomSpace at a Glance

- A space company situated in Denmark
 - Nano-satellite products & platforms
 - Micro-satellites (tailored products)
 - Re-entry systems & micro-gravity R&D
- Established in 2007
- Has export of space hardware to customers in more than 40 countries spanning the globe
- Design and integration done in-house by GomSpace





GOMX-1: Air Traffic Control from Space using Nano- Satellites

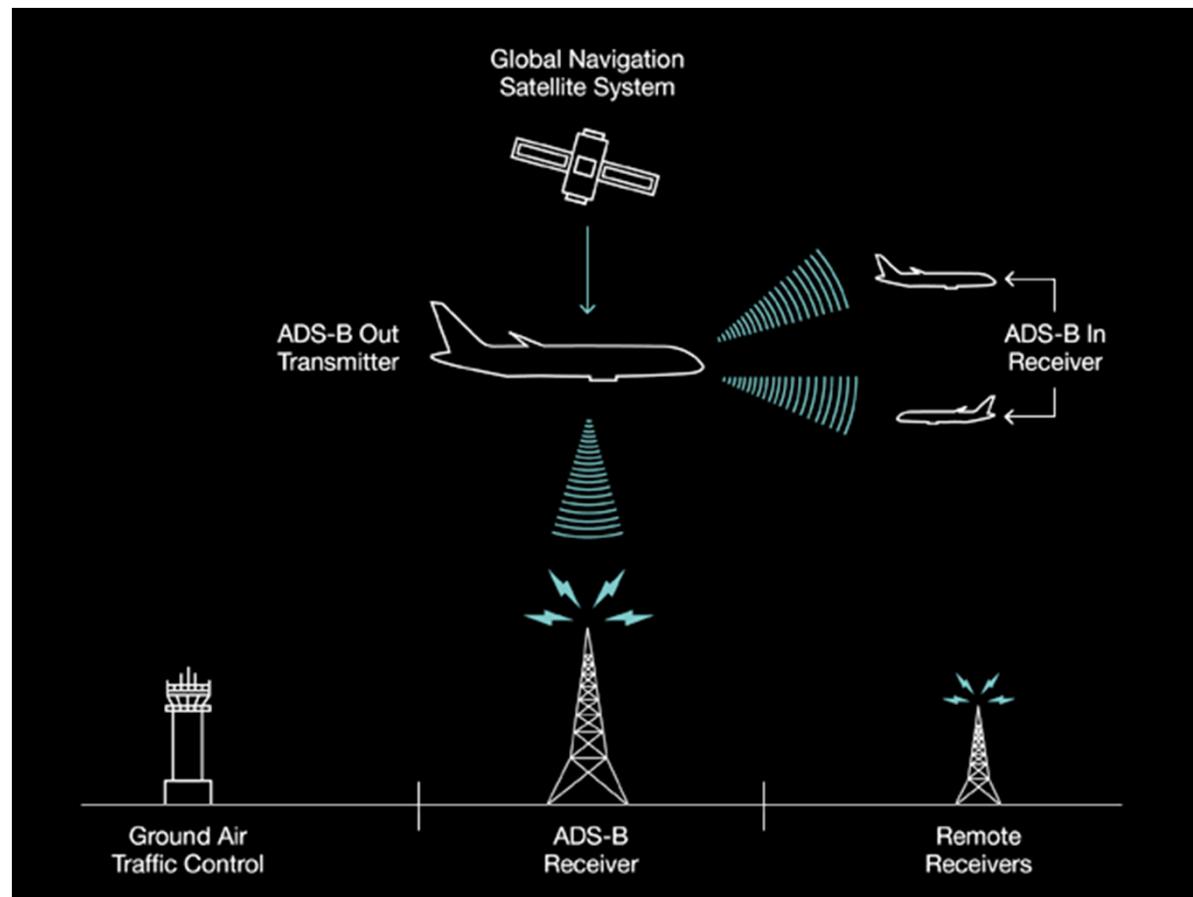
Current ADS-B system Overview

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 Space Based ADS-B?

- Important problems addressed
 - Oceanic regions not covered by ground-stations
 - Expensive to deploy & maintain groundst. in sparsely populated areas (e.g. Greenland)
 - Cannot deployed in some countries due to political and economical conditions.
- Roll-out
 - Approx. 30000 commercial aircraft in operation
 - 70-85% of aircraft are equipped today
 - Mandated use of ADS-B from:
- Value Generation
 - More efficient air space regulation
 - Leading to potential 16x flight in most fuel efficient corridors between the continents



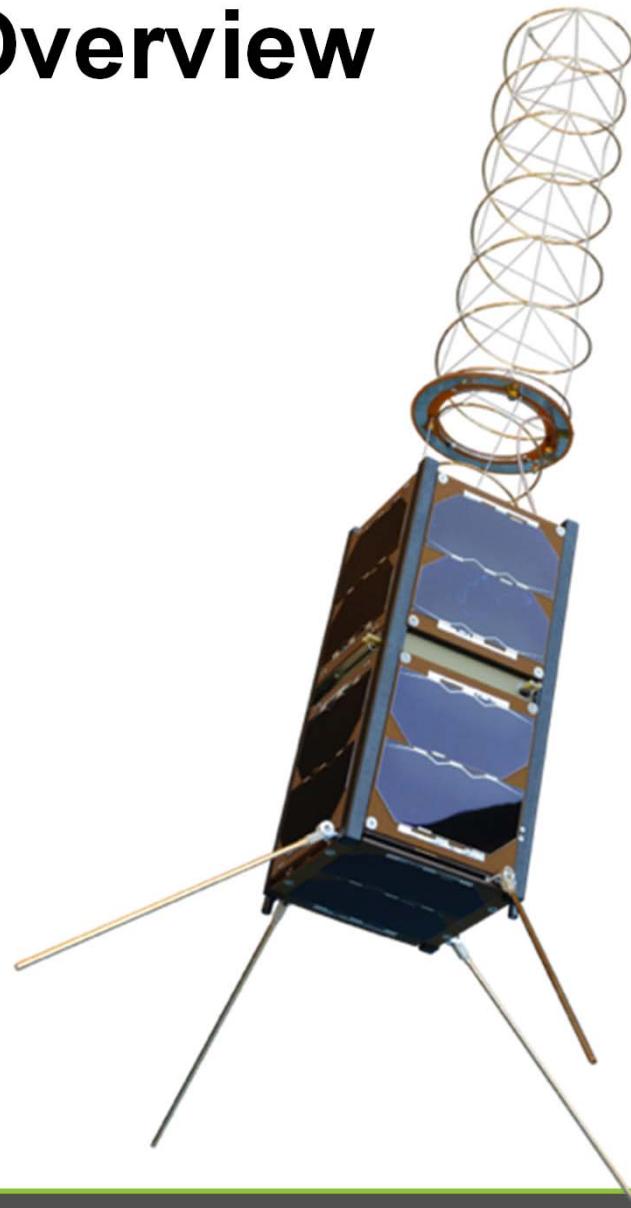
The GOMX-1 Mission

- Goals
 - Be among the first to demonstrate reception of ADS-B signals in space
 - Validate signal models for access QoS
 - Demonstrate benefits to ATM stake-holders
- Project Partners
 - *GomSpace (prime)*
 - Project/mission management
 - Satellite design and construction
 - ADS-B receiver design and construction
 - *DSE Airport Solutions*
 - Data validation and correlation to existing data sources
 - *Aalborg University*
 - R&D support for software defined radio techniques
 - Contribute to development of business models
- Launch: 21st of November 2013



Space Segment Overview

- **Platform**
 - Based on GomSpace's COTS port-folio
 - 20x10x10 cm in stowed config. 2 kg
 - 9k6 downlink in UHF
- **Payload**
 - Deployable helical antenna, ~10dBi
 - Discrete front-end, FPGA based baseband processing
 - On board database in uC of raw and decoded ADS-B
 - FPGA and uC in orbit reconfigurable
- **Orbit**
 - Near SSO
 - Perigee: 598km, apogee 835km



Launch & Early Operations

21st of November:

- Launch by Dnepr from Yazny
- Signal acquisition
- Two-way com and large scale telemetry retrieval



22nd of November:

- Active detumble of satellite
- ADS-B antenna release and confirm
- First ADS-B data retrieved

23rd of November:

- First filebased operations
- TLE object identified

25th of November:

- Switch to autonomous operations outside office hours

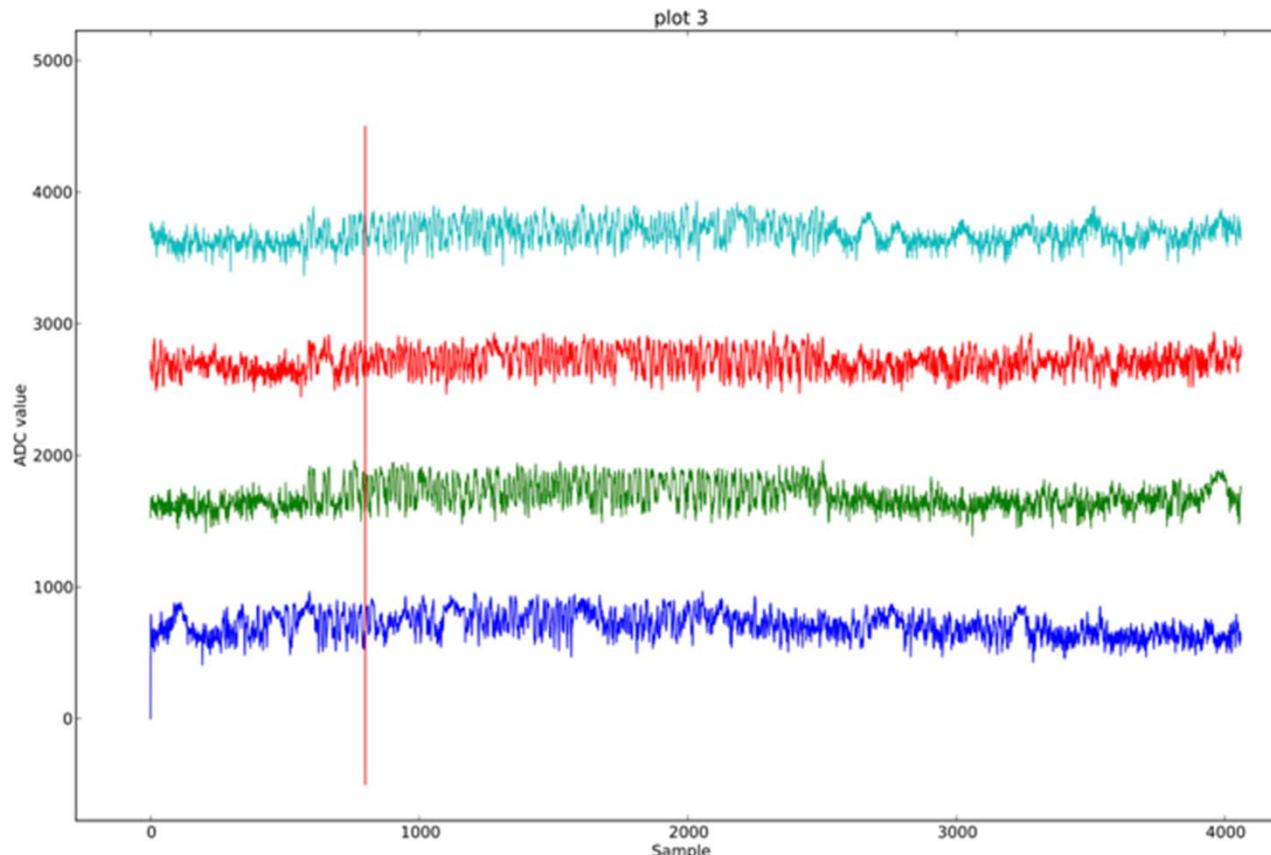
Space Based ADS-B Overview Data



Plot of plane positions on Northern Hemisphere (one dot per plane per orbit max).

Note: ADS-B payload receives many more plane positions (up to 150/s) than can be downlinked on the data-link.

Raw Samples (synchronized)

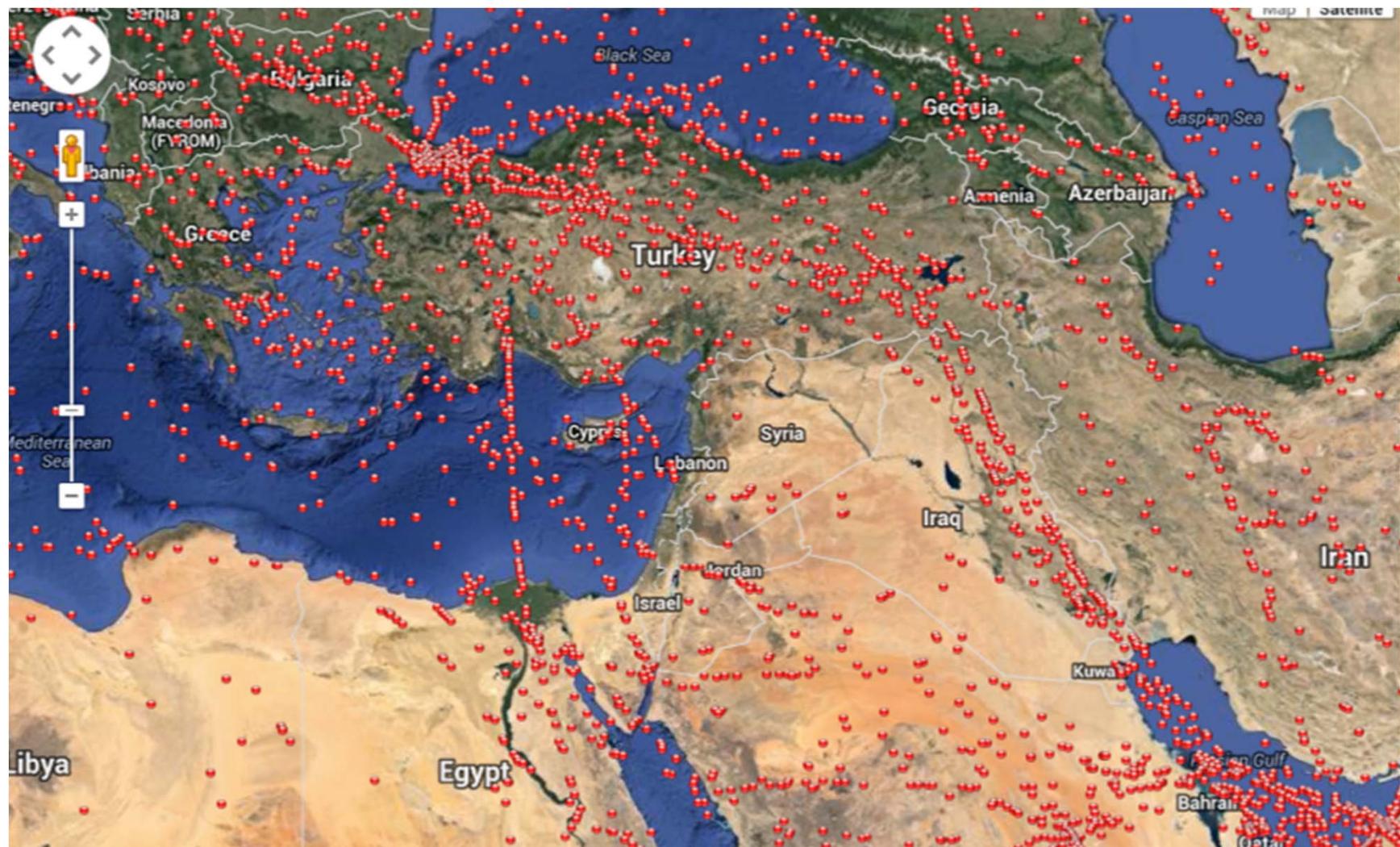


Four samples after log-amp detector acquired over Europe. Note disturbance from DME pulses. Red line indicated start of frame data. Preamble used for synchronization. Blue sample is false detection / garbled signal.

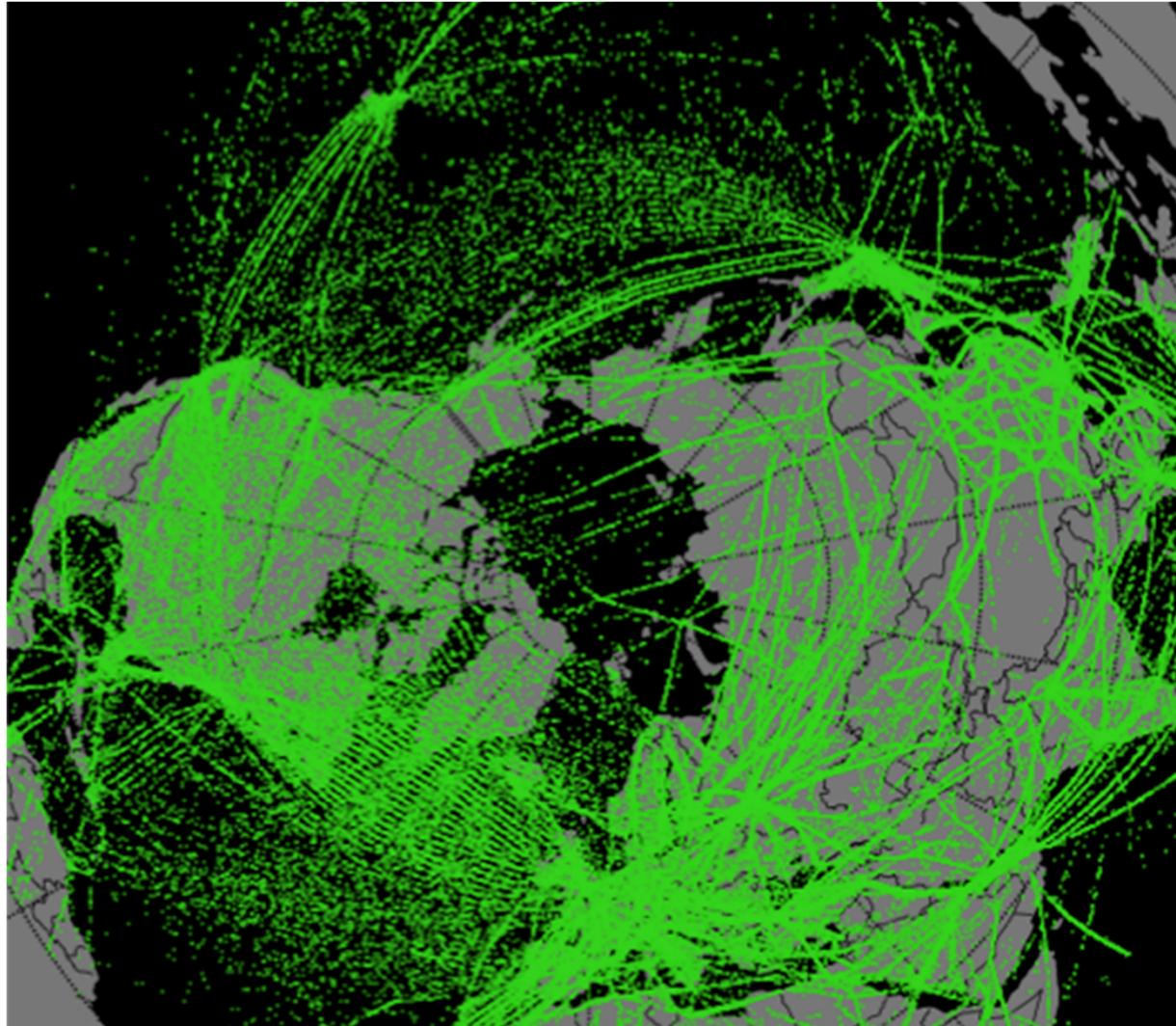
Not all Airspaces are Equally Attractive...



The Middle East

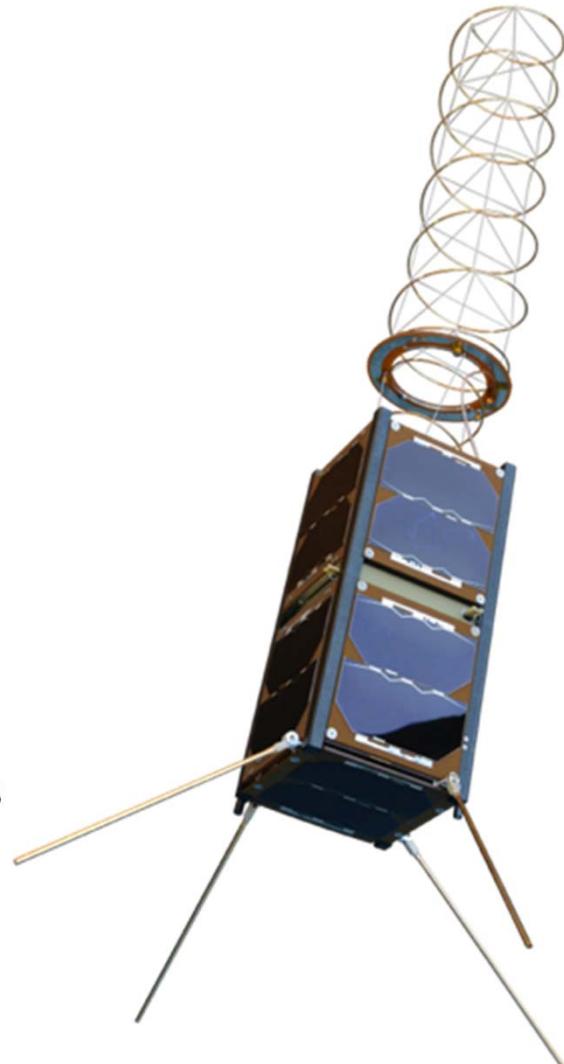


Polar View



Current Spacecraft Operational Status

- Platform systems continue to be in excellent health
- Attitude control:
 - Larger than expected residual magnetic dipole moment.
 - Source isolated to ADS-B antenna.
 - Cannot be handled by nominal controller for Nadir tracking
 - Spacecraft stable and with X-axis aligned to local magnetic field with slow rotation around X. ADS-B antenna scanning Earth regularly.
- Payload Operations:
 - Radiation event FPGA bootstrapping circuit on ADS-B payload 9/5-2014 – rectified from ground.
 - Database with 6 months of unique data



GOMX-1 Conclusions

- **GOMX-1 Mission Conclusions**
 - Very successful demonstration mission
 - Important lesson learned on magnetic cleanliness
 - Perfect and accurate data reception
- **Next steps with Space Base ADS-B**
 - Updated ADS-B receiver design to fly in 2015 on GOMX-3
 - Looking at regional solution for niche business cases
 - R&D in comms technology for fast data dissemination

