

**ICAO MID
Surveillance/ MICA Workshop**

Space Based ADS-B

February 27th, 2019



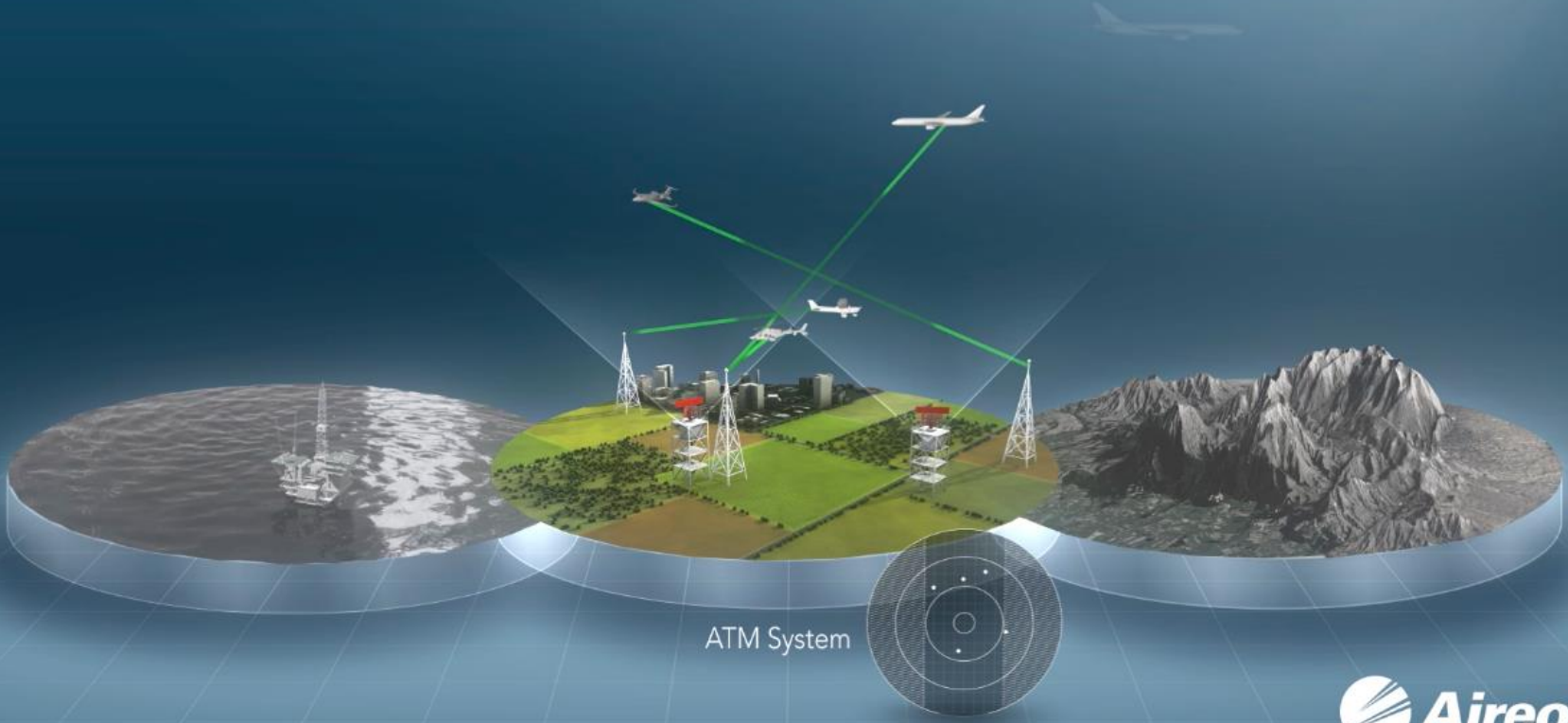
AIREON LLC PROPRIETARY INFORMATION

Space Based ADS-B Solution

Worldwide layer of ATS Surveillance



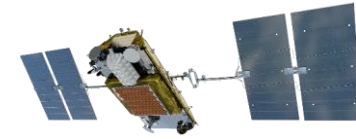
Current Surveillance is Limited to Line of Sight



Over 70% of the world is not covered by ATS Surveillance

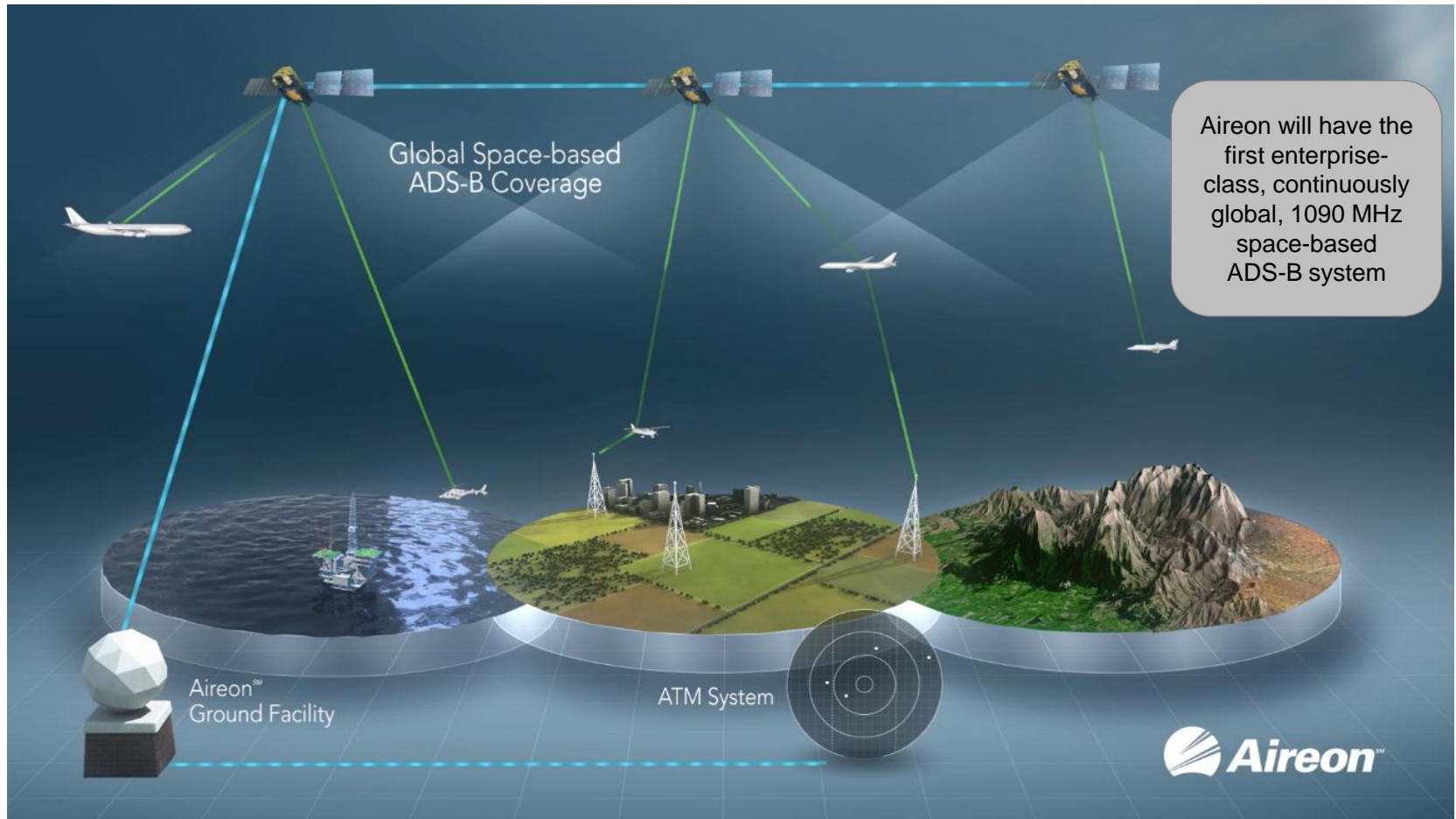


As today...100% Global Air Traffic Surveillance

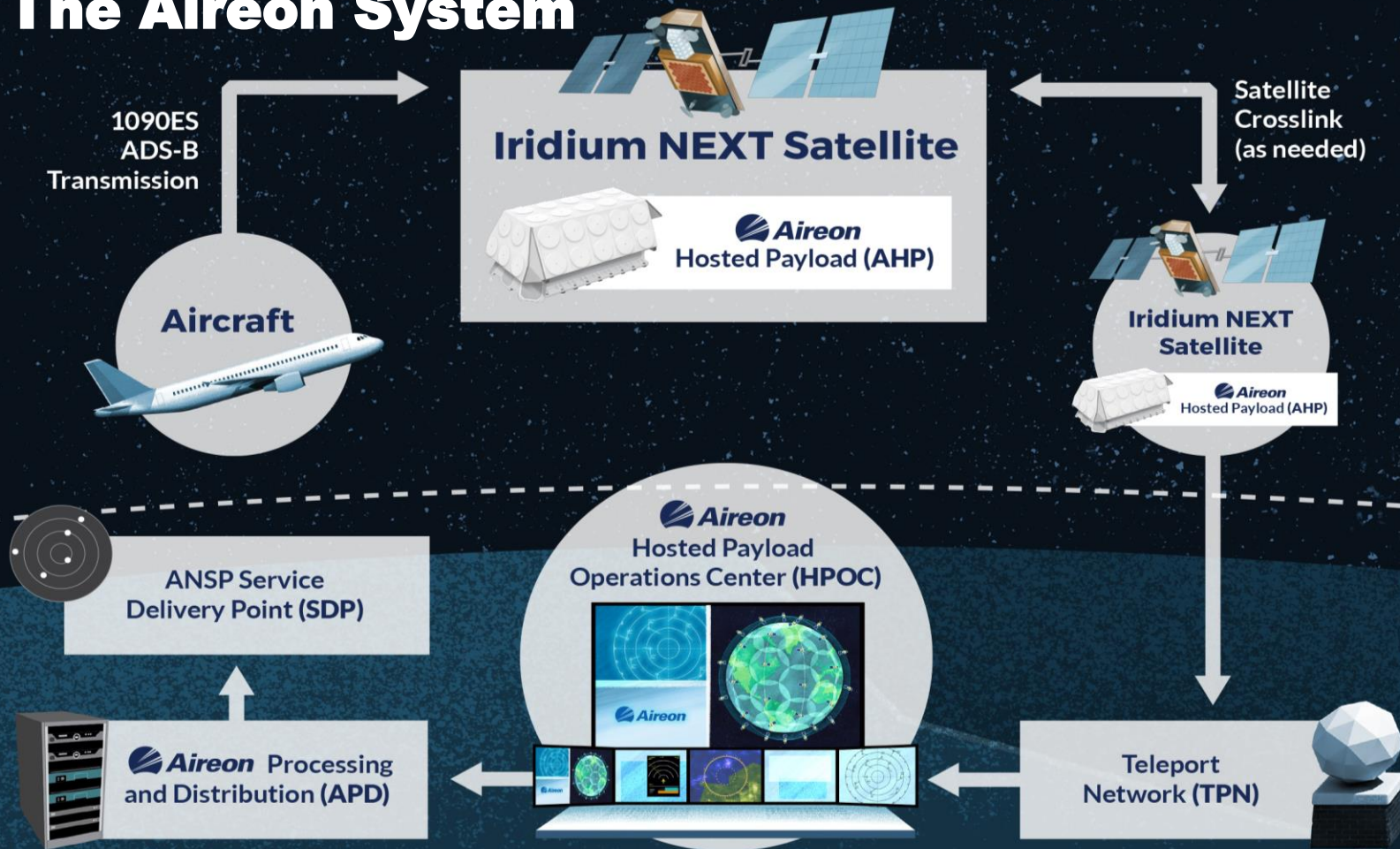


**AIREON
GLOBAL
COVERAGE**

Aireon System Overview, a space based ADS-B surveillance solution

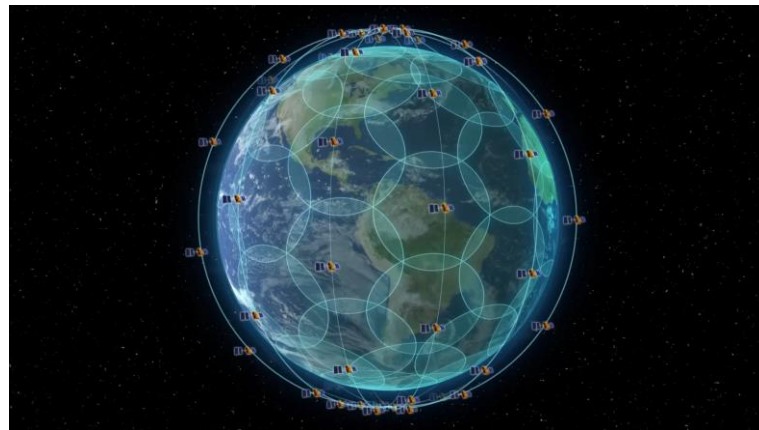
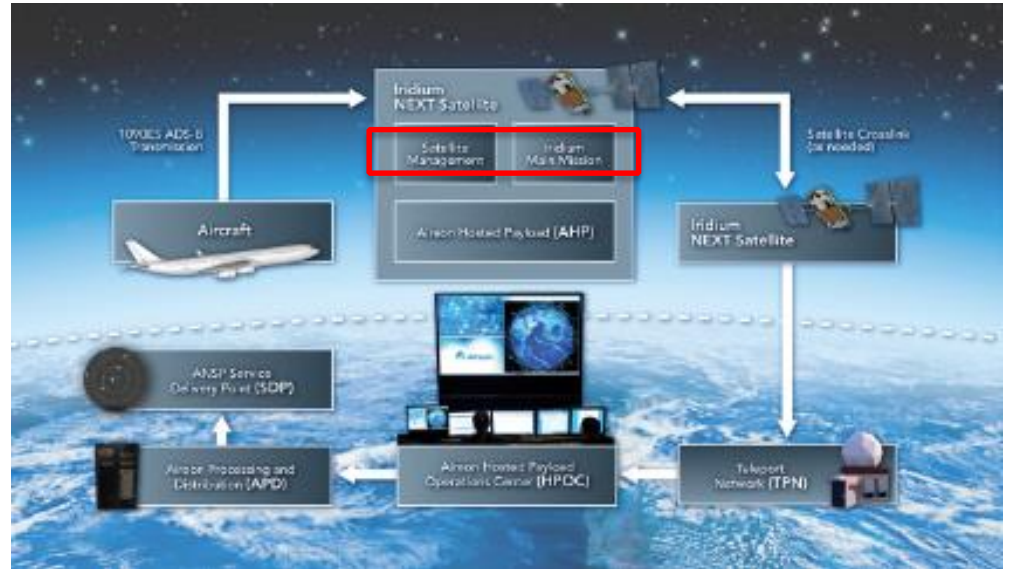


The Aireon System

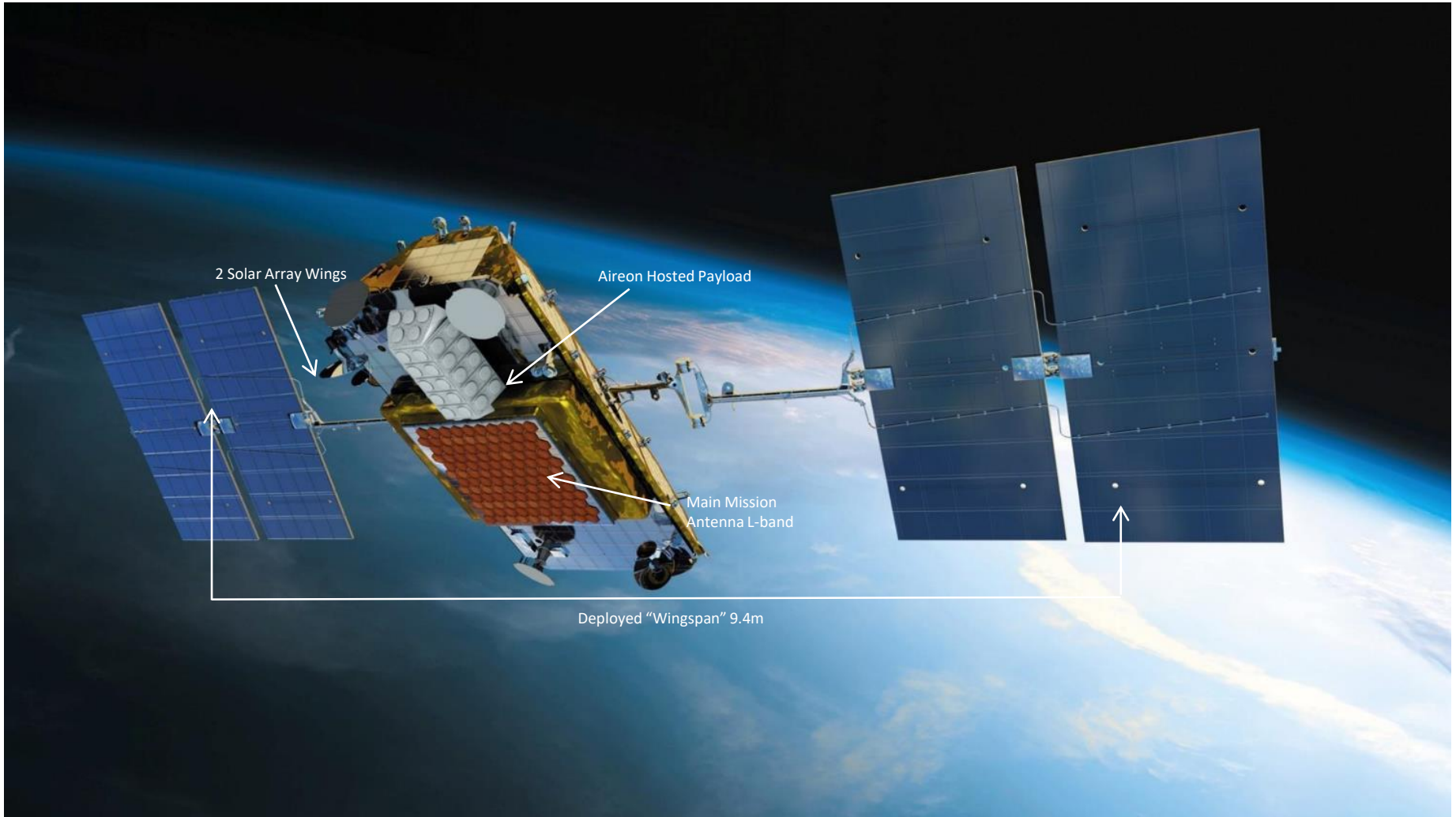


Iridium NEXT Constellation

- Satellites in orbit: 66
 - 11 satellites per plane
 - Plus 9 in-orbit spare satellites
 - 6 ground spare satellites
- Orbital Planes: 6
- Availability: ≥ 0.999
- Typical Lifecycle: 14 years
- Operational altitude:
 - 485 miles (780 km)
- Final launch is slated for end first week of January 2018 to complete the whole constellation



Iridium NEXT Satellite



Strong mix of partners for design build test and OPS

DESIGN & BUILD



OWNERSHIP



Space-Based ADS-B as ATS Surveillance

Position Accuracy / Update Interval



Voice
Position
Reporting



ADS-C
Position
Reporting



Radar
Surveillance /
MLAT



Space Based
ADS-B
Surveillance



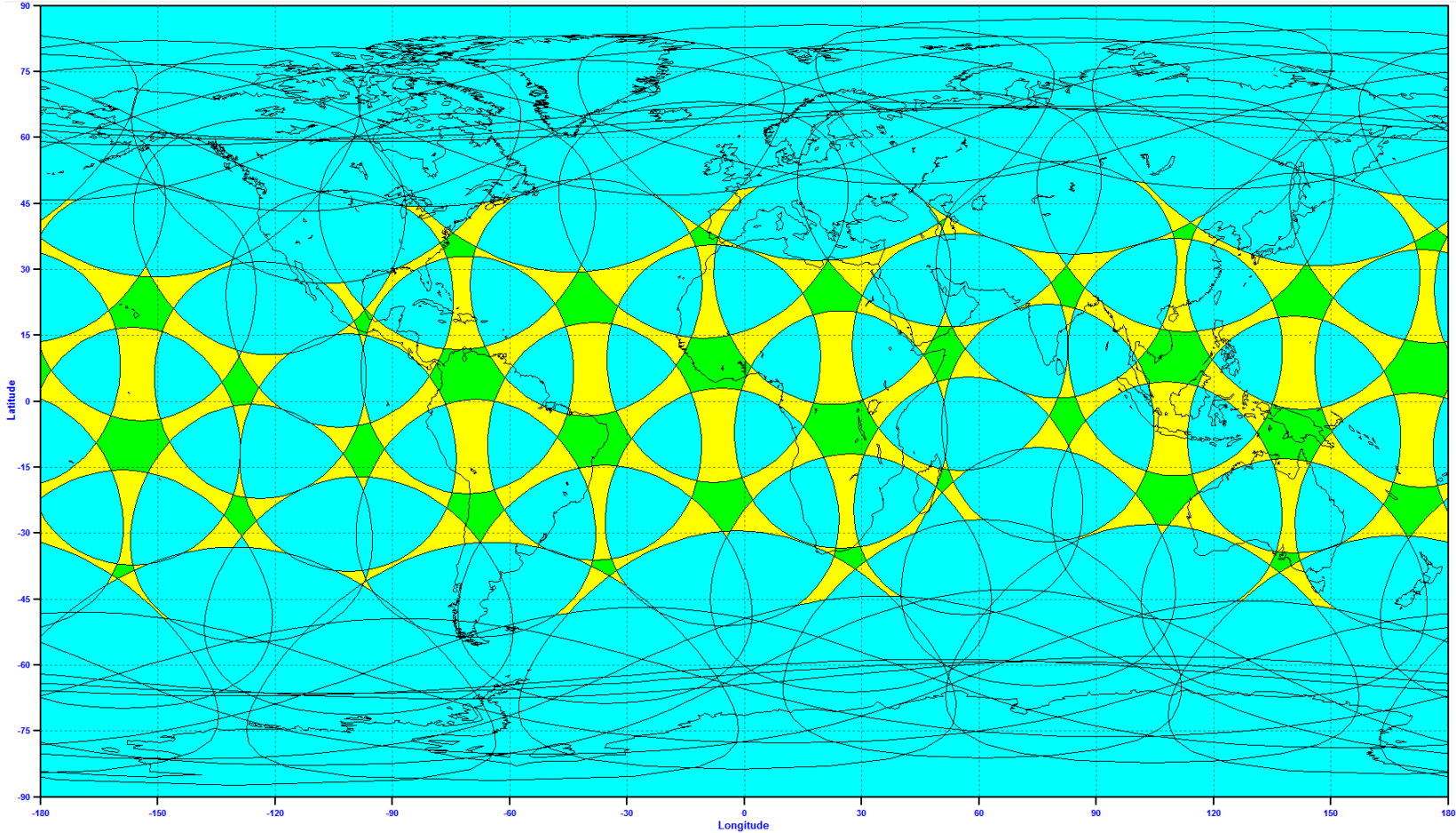
ADS-B
Surveillance

ADS-B, like radar, is a backbone technology that helps Air Traffic Controllers efficiently separate aircraft and move them from airport-to-airport

Overlapping Satellite Coverage – End State

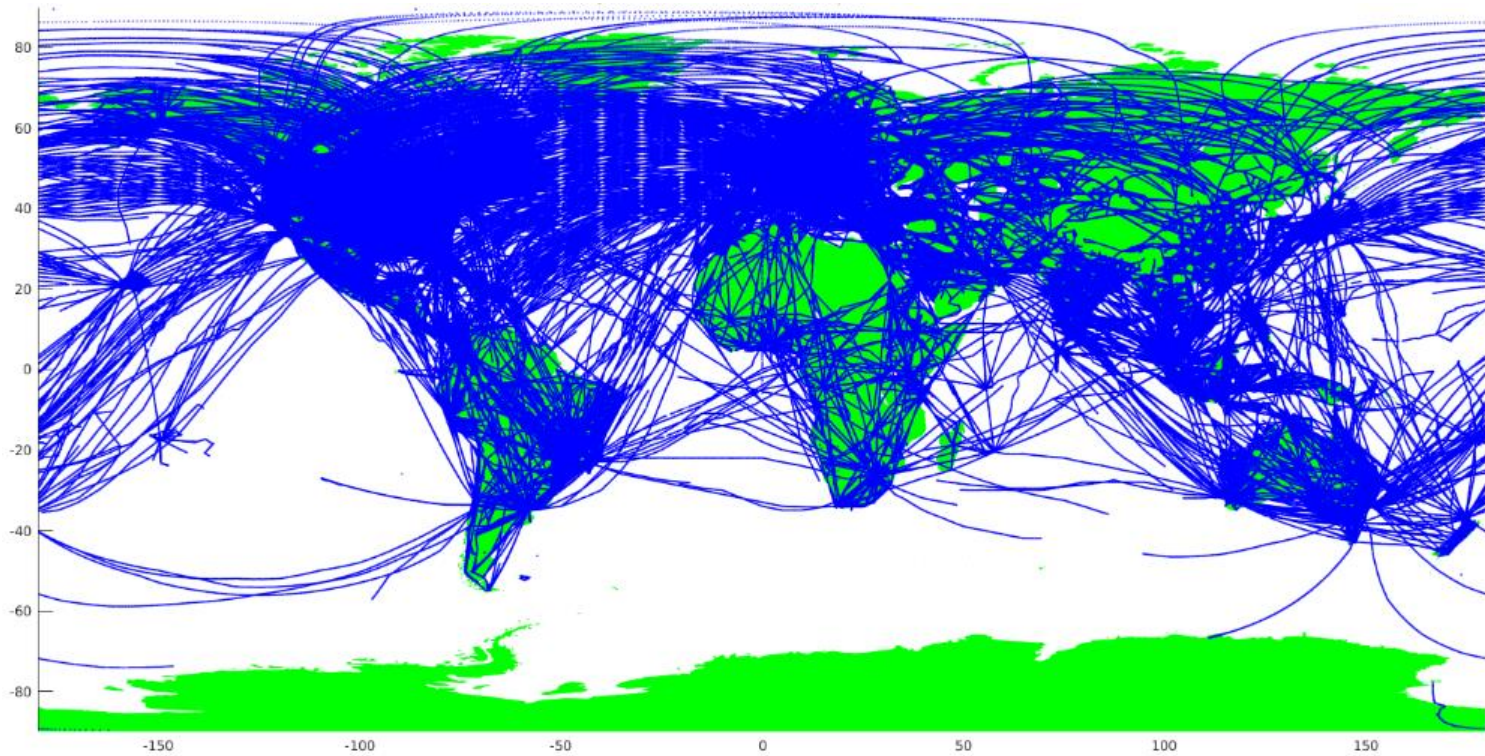
Satellite Dynamics Made Easy
Session View Setup Scenes Tools BIT

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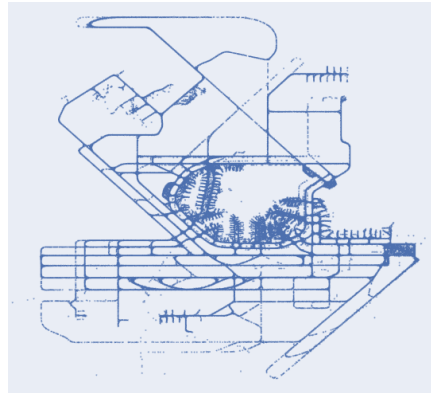
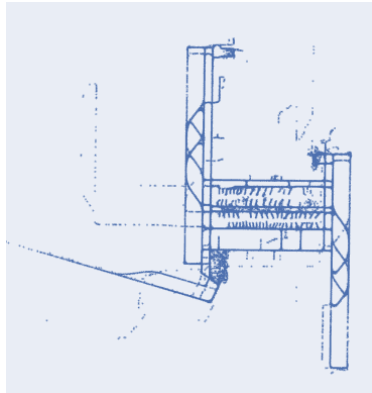
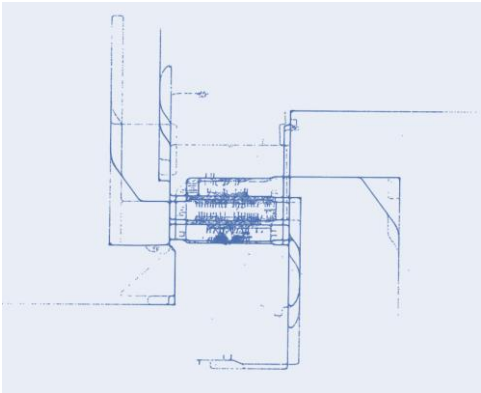
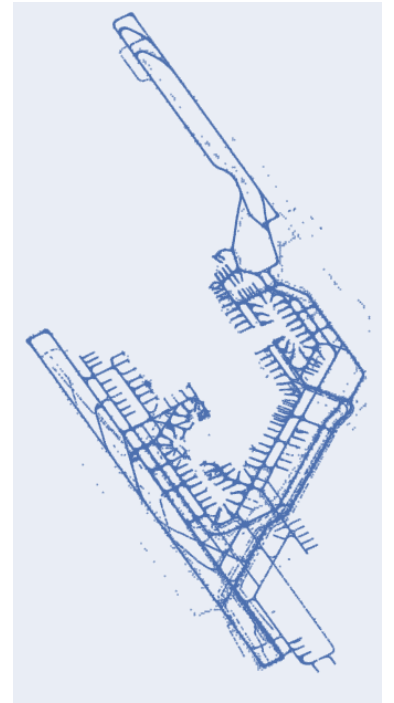
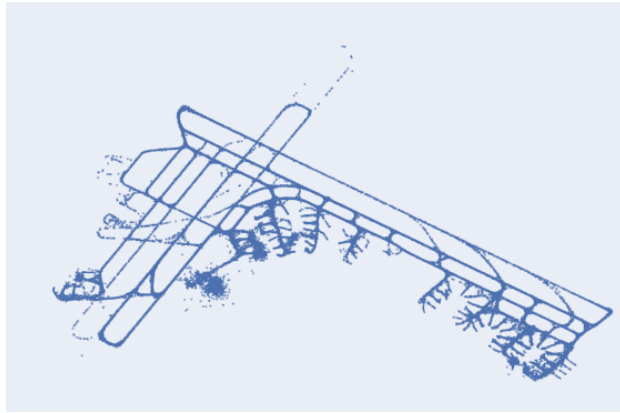
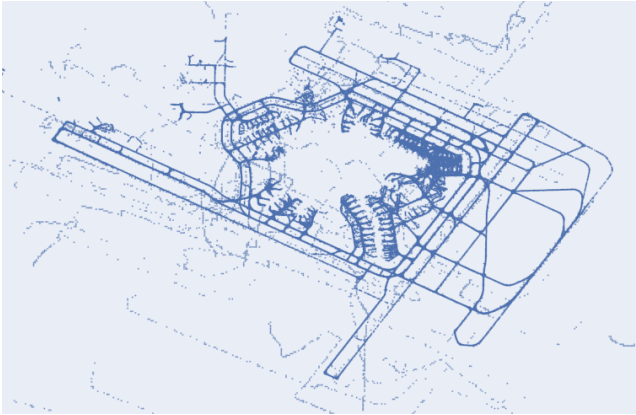
Green = Single
Yellow = Double
Blue = Triple+

Worldwide coverage



As of February 2019, Aireon receives over 25 billion ADS-B position messages received per month!

Visibility at surface level



New Service = New Approach

Part ANSP Ops Center



Part Global Customer Service Center



ATM / ANSP Service Provider Organizational Approval

Safety Certification Process



Together with our partners rigid testing is being completed

Flight testing / targets of opportunity

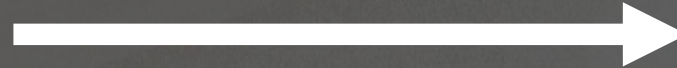
- High density environment
- Low density environment
- Various transponder output
- Bottom mount antenna
- Low altitude

2018-2019:

- Aireon System Acceptance Test
- Customer Acceptance Test
- Completion of Safety Case
- EASA Certification as SSP

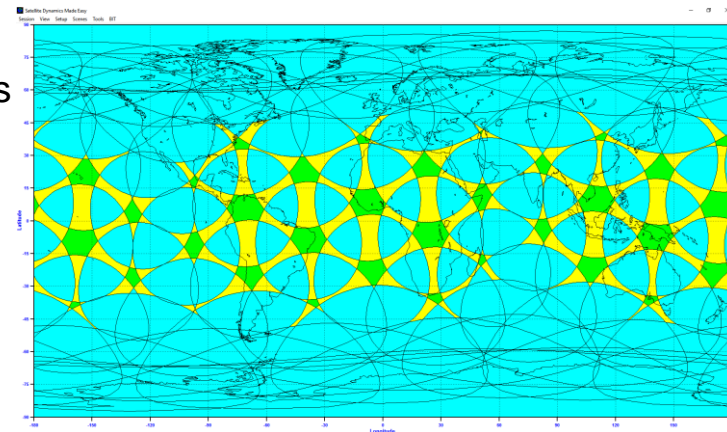
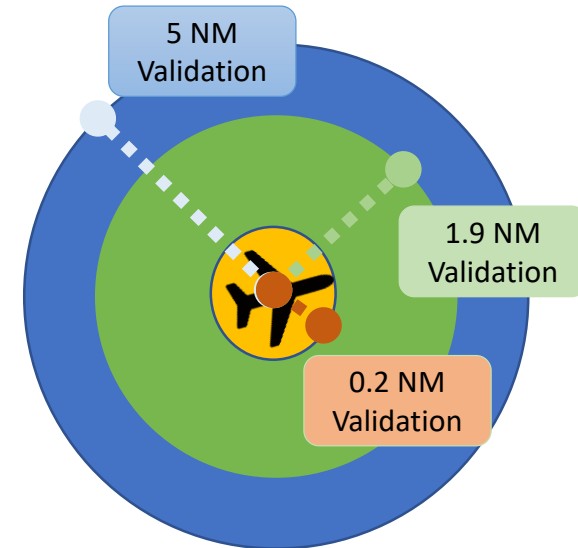
Operational readiness

- System fallback & contingency
- Disaster recovery
- Safety & security
- Policy & procedures



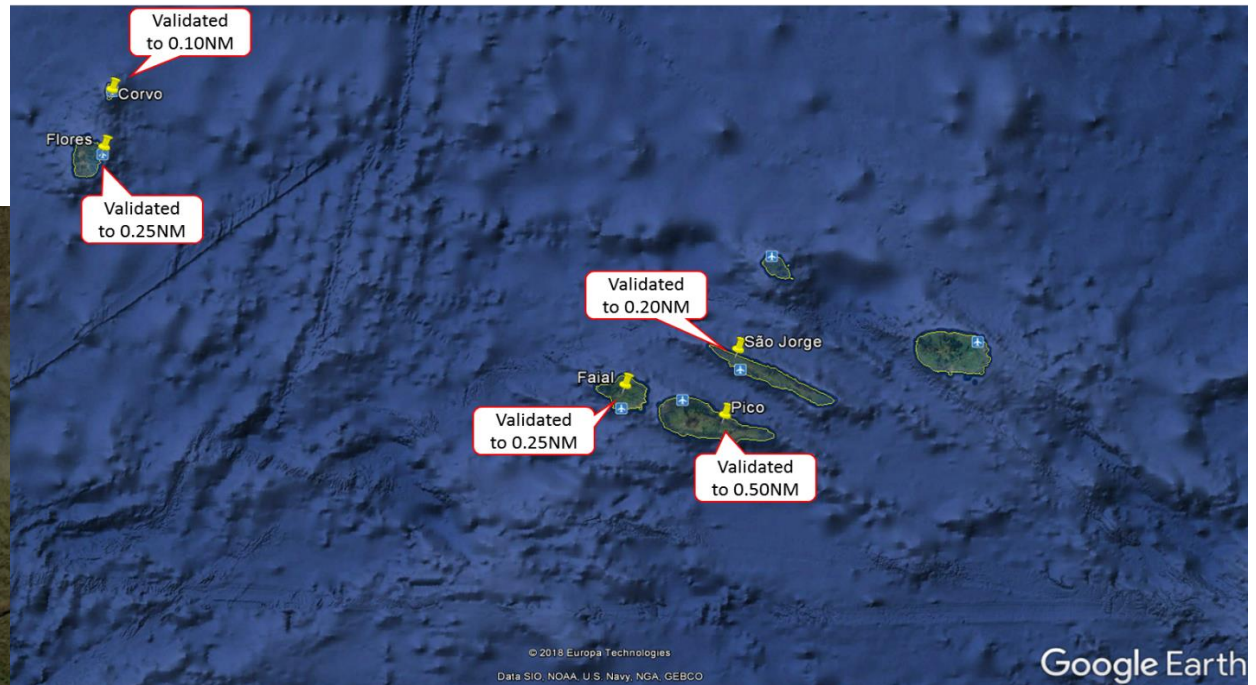
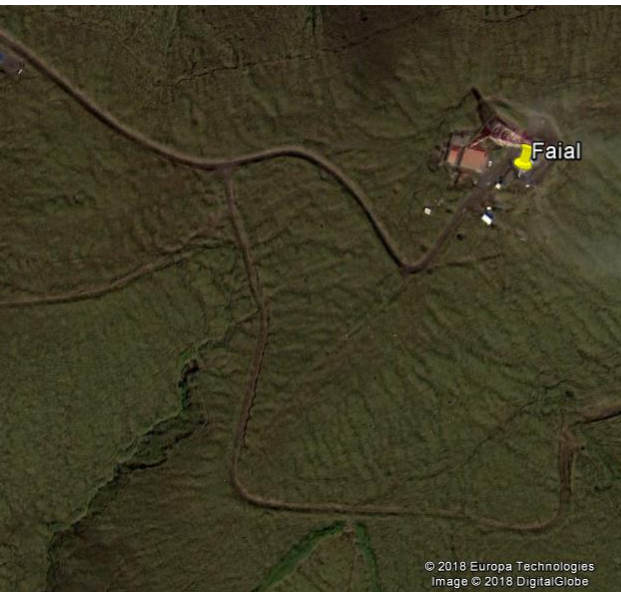
Aireon's Independent Position Validation Solution

- There are three possible validation states, each of which can be broken down into further levels of granularity: Valid, Invalid, and Unknown
- The algorithm relies on the fact that the beam footprints are much larger than anticipated allowing for many TDOA opportunities
- The initial target validation state is determined via TDOA and then maintained using the target kinematics when TDOA is not available
 - ADS-B velocity does not use GPS position but instead utilizes doppler shift calculations
- This kinematic portion propagates TDOA validated positions, using reported velocity, to reported positions and compares the two values
- Single source ADS-B has its limitations. The industry is starting to recognize these limitations.



Azores Test Targets

Using a source of ADS-B data that is completely independent of Aireon



Google Earth

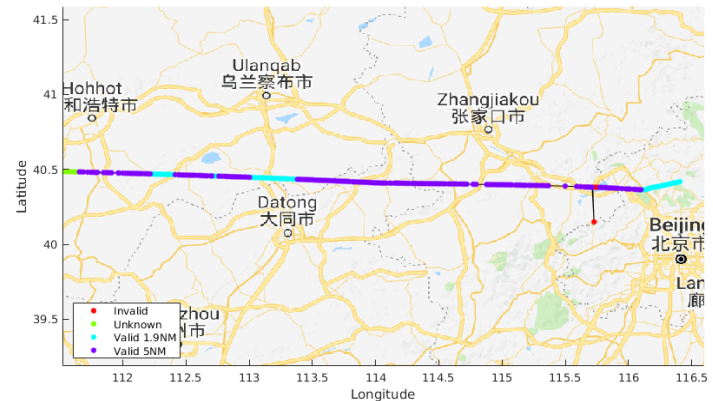
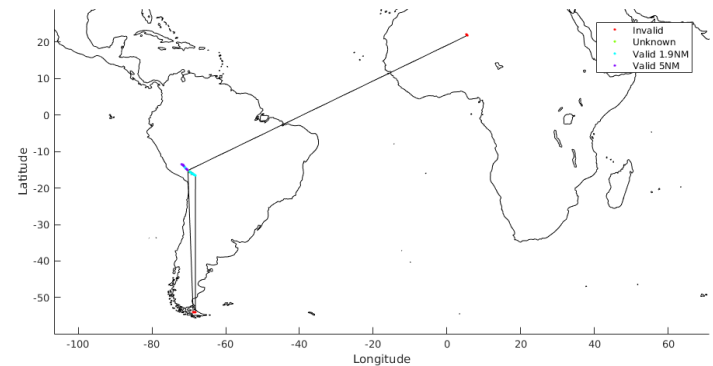
Google Earth



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Examples of Invalid Targets

- The intent of the validation algorithm is to not only provide confidence in good ADS-B data but to flag bad data
- Many examples have been found of targets that report incorrect positions (small and large)
- The large outliers are easily identified via the coarse range check
- Smaller deviations are more difficult to detect and do require a more complicated validation algorithm



Example Outliers

43 702039

- Many of the targets perform well most of the time but occasionally report repeated bad data that causes a jump to some random location

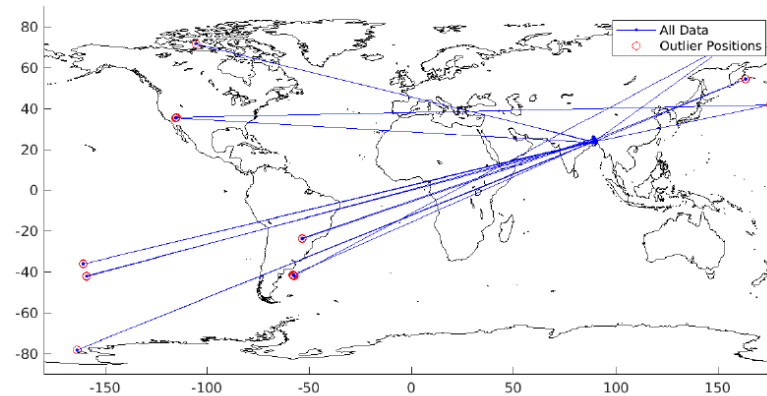


Figure 43: 702039 Outlier Positions

Total Position Messages: 53151

Number of Outlier Positions: 343

Largest Outlier: 13468km observed 30-Jul-2018 10:26:07Z by SV114

Example Outliers

25 406B88

- This target appears to have a valid ICAO but is part of a group of targets that just fly up and down the prime meridian

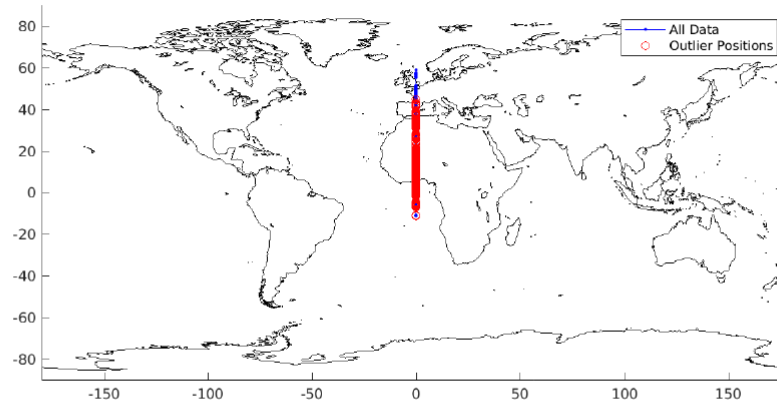


Figure 25: 406B88 Outlier Positions

Total Position Messages: 9141

Number of Outlier Positions: 4793

Largest Outlier: 8933km observed 30-Jul-2018 22:31:04Z by SV126

Surveillance as a Service

- Advanced automation platforms and trackers can prioritize targets and present the best and most reliable target to the controller.
- Aireon will manage the data delivery (including security) to the SDP. After the SDP, the data distribution, use and verification would be under ANSP responsibility.
- Aireon will deliver the data to the ANSP in Data Format ASTERIX CAT021, CAT023, CAT025, CAT238 and FAA CAT033 and CAT023, so it can be fused at the (automation system) platform.
- For ANSP to process the data from the APD and use it in its automation platform, (automation system), an SDP must be installed and establish two telecommunication lines (telco), 2 lines for redundancy purposes.

Meeting or exceeding EUROCAE ED 129 Standards

Surveillance Datalink	1090ES ADS-B (DO-260 versions 0,1,2)
Aircraft Transmitter Classes Supported	A1 or higher with a top-mount antenna
Data Format to ANSP	ASTERIX CAT021, CAT023, CAT025, CAT238 and FAA CAT033 and CAT023
System Coverage	Continuously Global
Availability	≥ 99.9% (ICAO GOLD Standard for surveillance)
Latency	≤ 2s to a ATC Surveillance Tracker
Update Interval	96% of reports ≤ 8s (worst case)

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Questions?

-End

