

Technology in support of ASBU – Aireon perspective

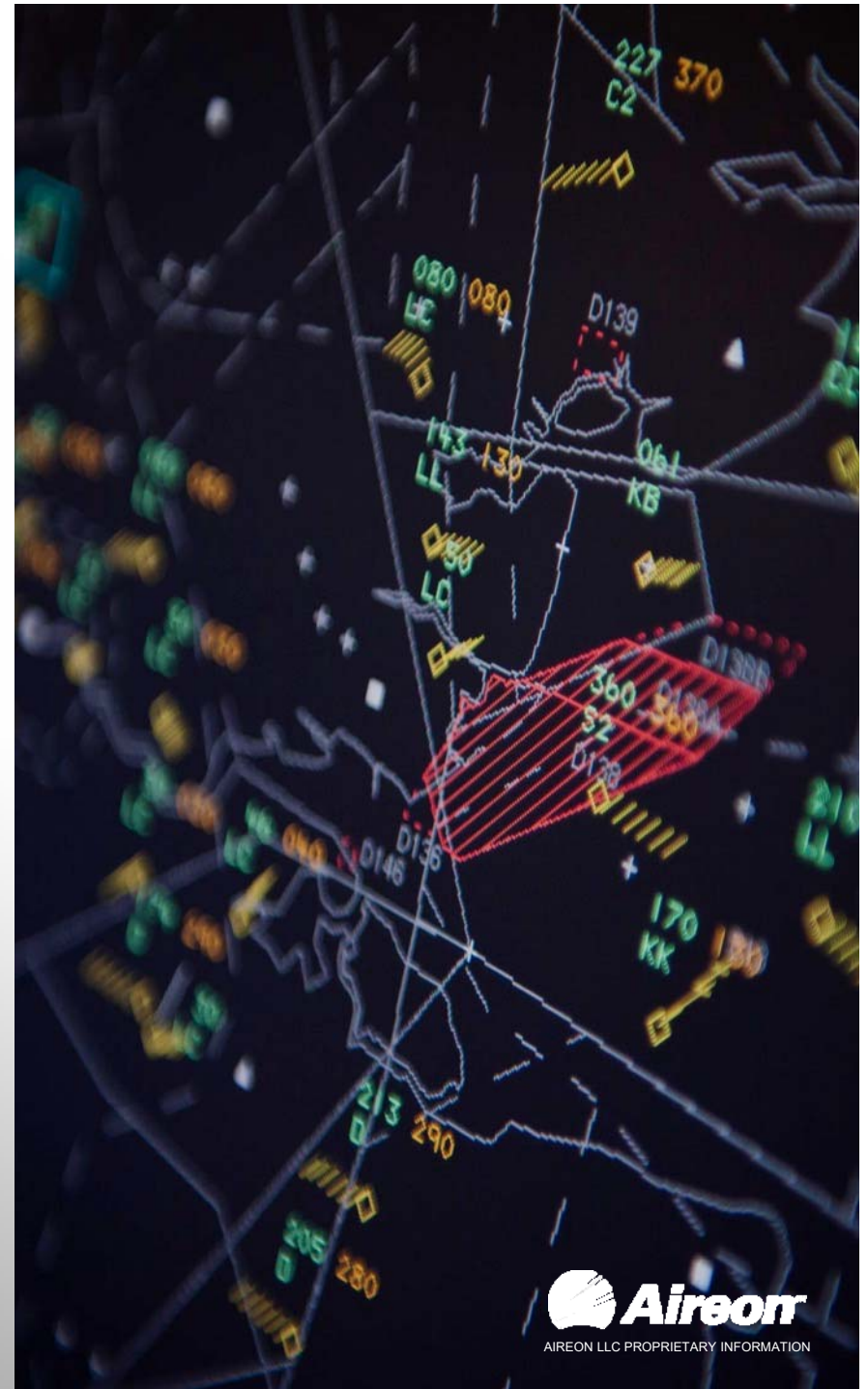
Marrakech

December 11th, 2018



Space Based ADS-B Solution

Worldwide layer of ATS Surveillance



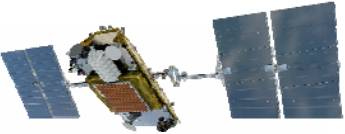
Current Surveillance is Limited to Line of Sight



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

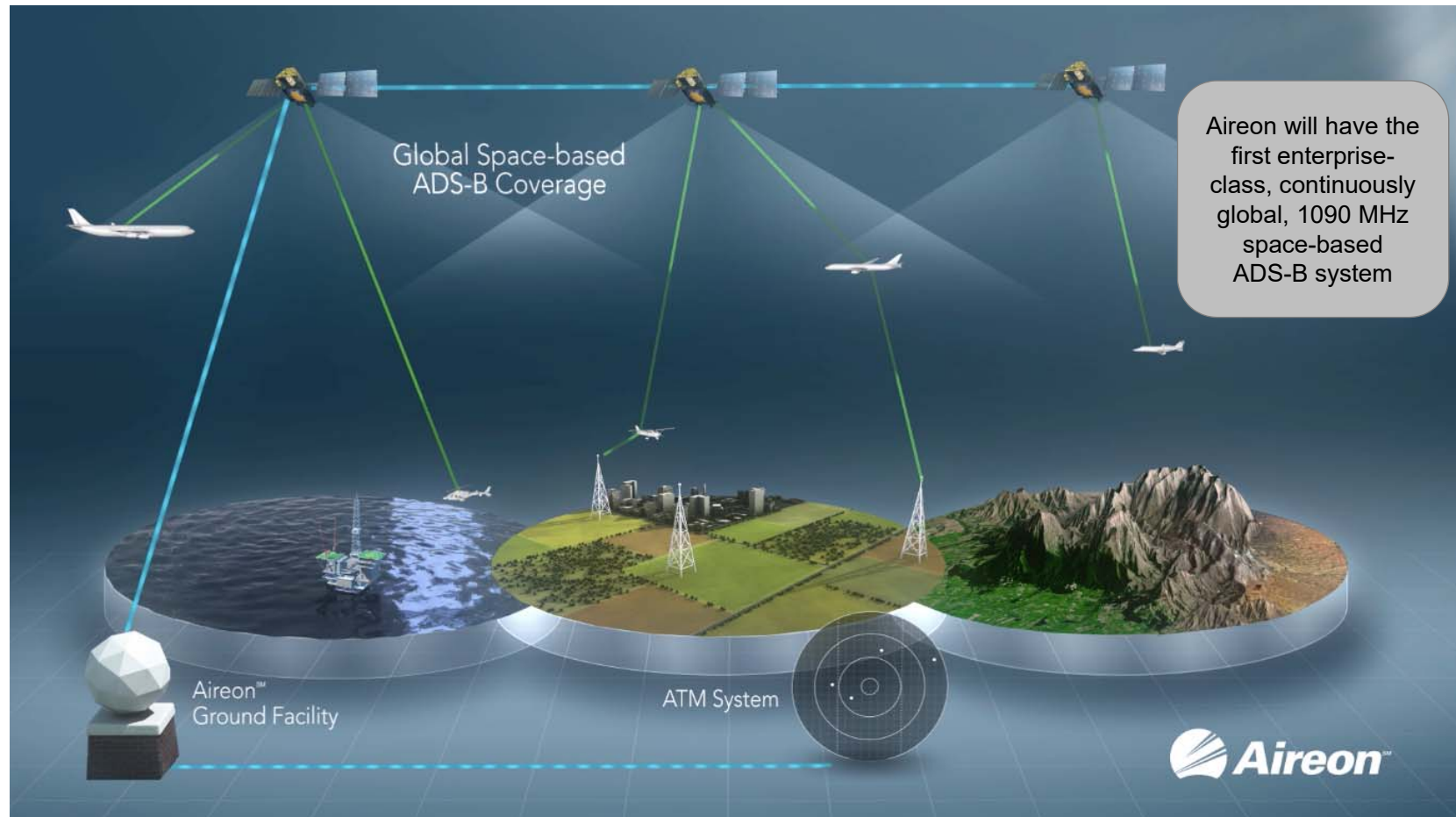


In Jan 2019...100% Global Air Traffic Surveillance

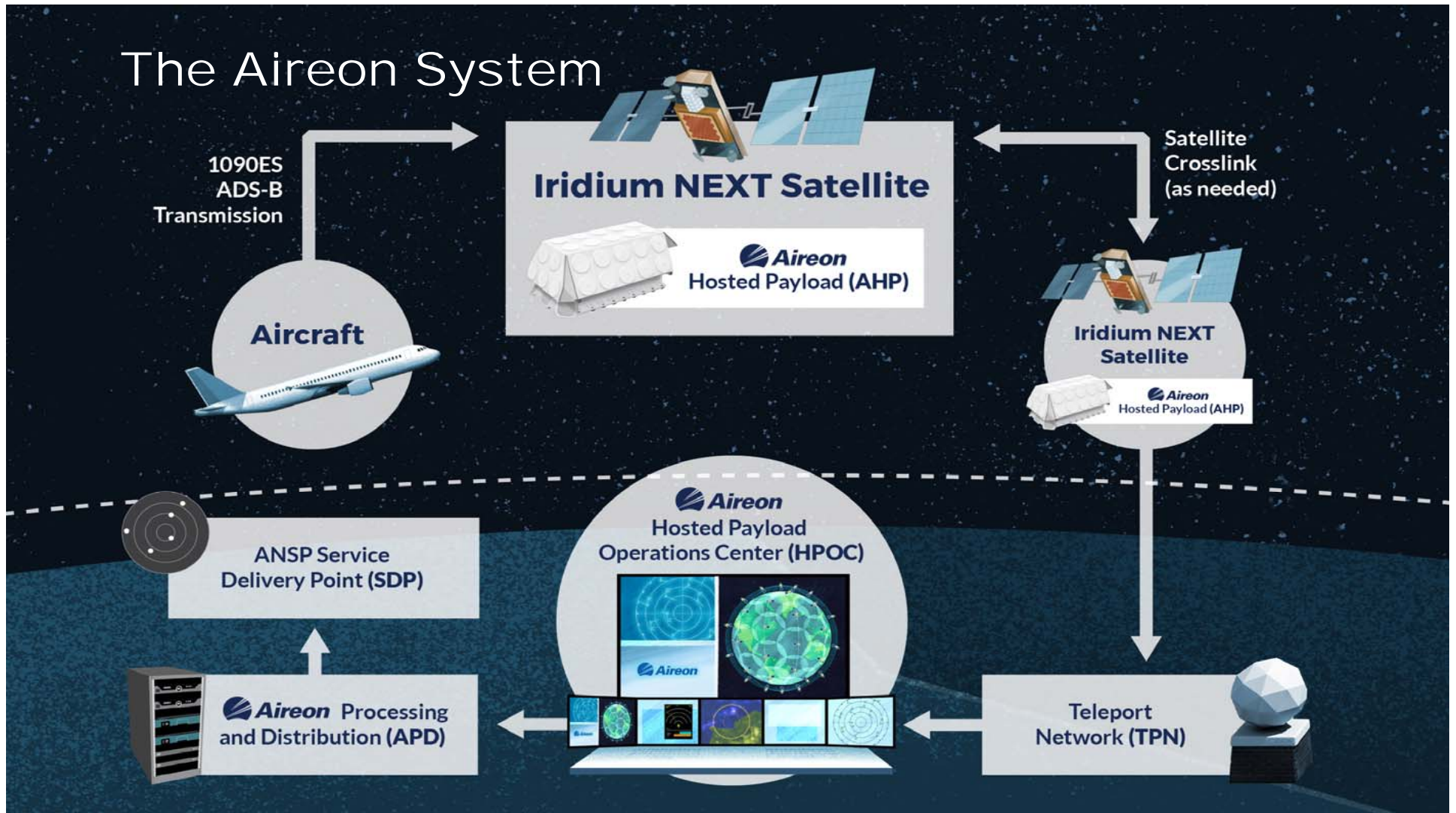


AIREON
GLOBAL
COVERAGE

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

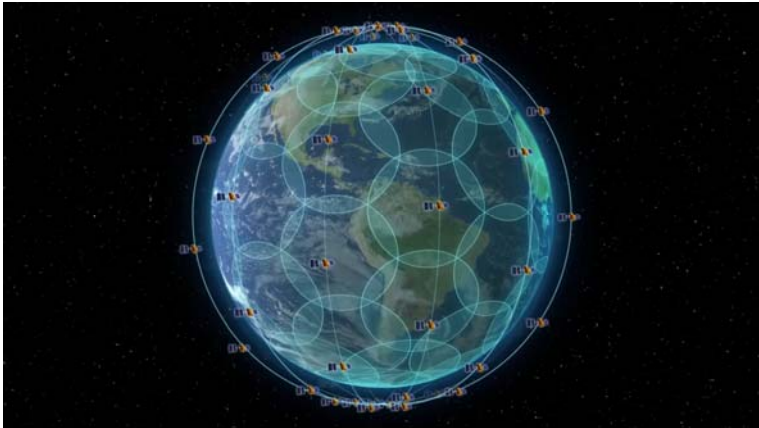
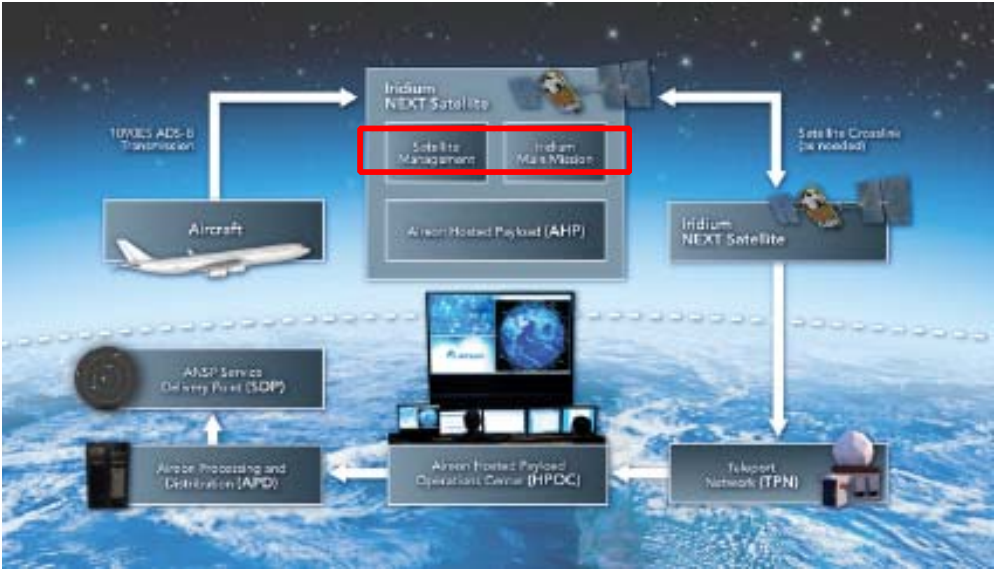


The Aireon System

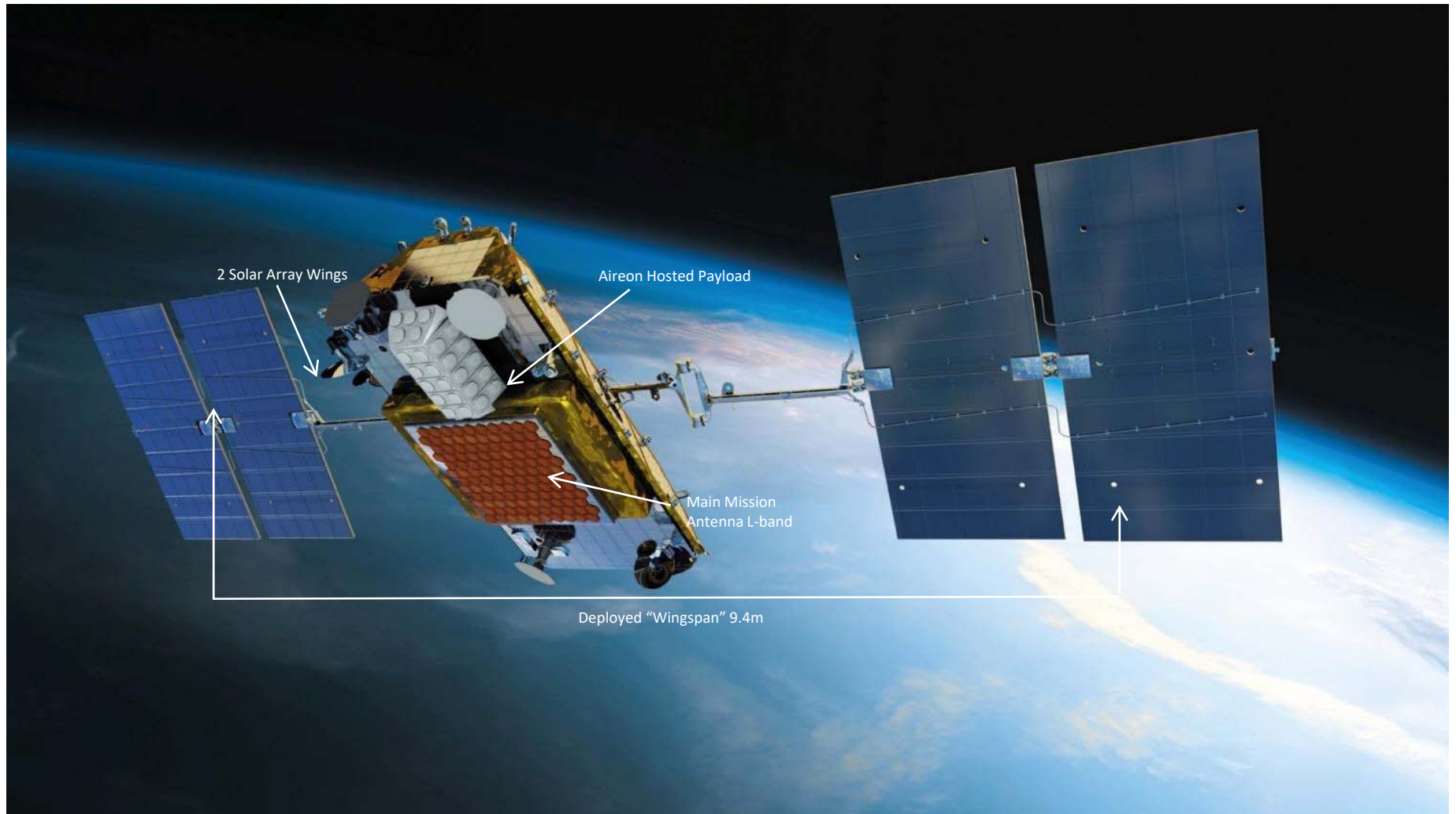


Iridium NEXT Constellation

- 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



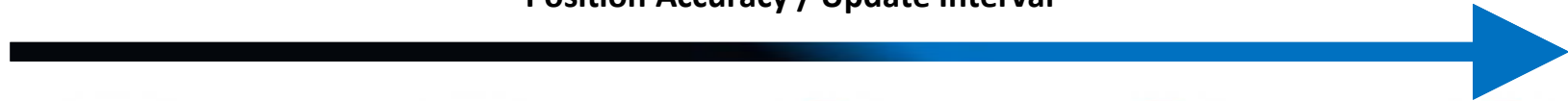
OWNERSHIP



AIREON LLC PROPRIETARY INFORMATION

Space-Based ADS-B as ATS Surveillance

Position Accuracy / Update Interval



Voice
Position
Reporting



ADS-C
Position
Reporting



Radar
Surveillance /
MLAT



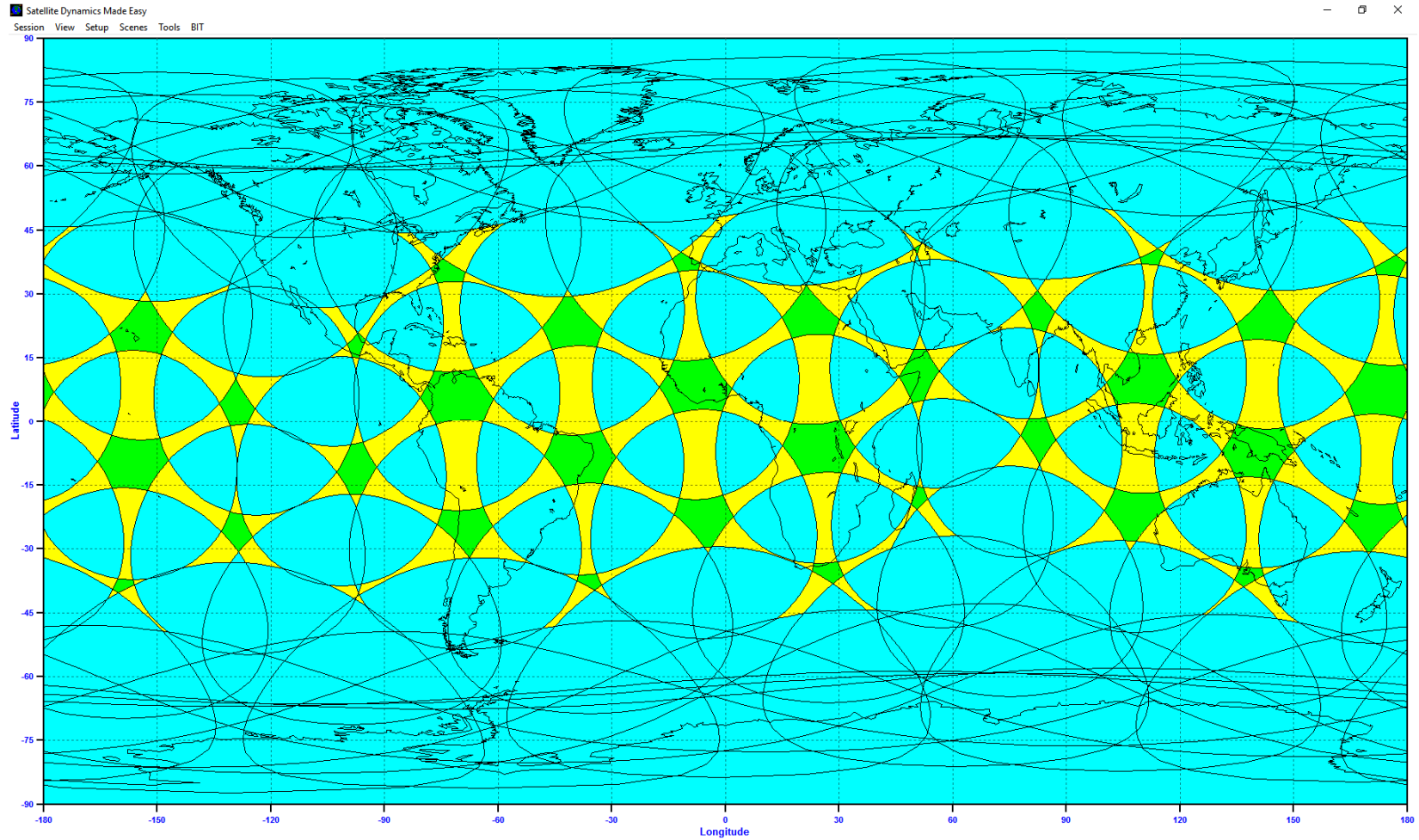
Space Based
ADS-B
Surveillance



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

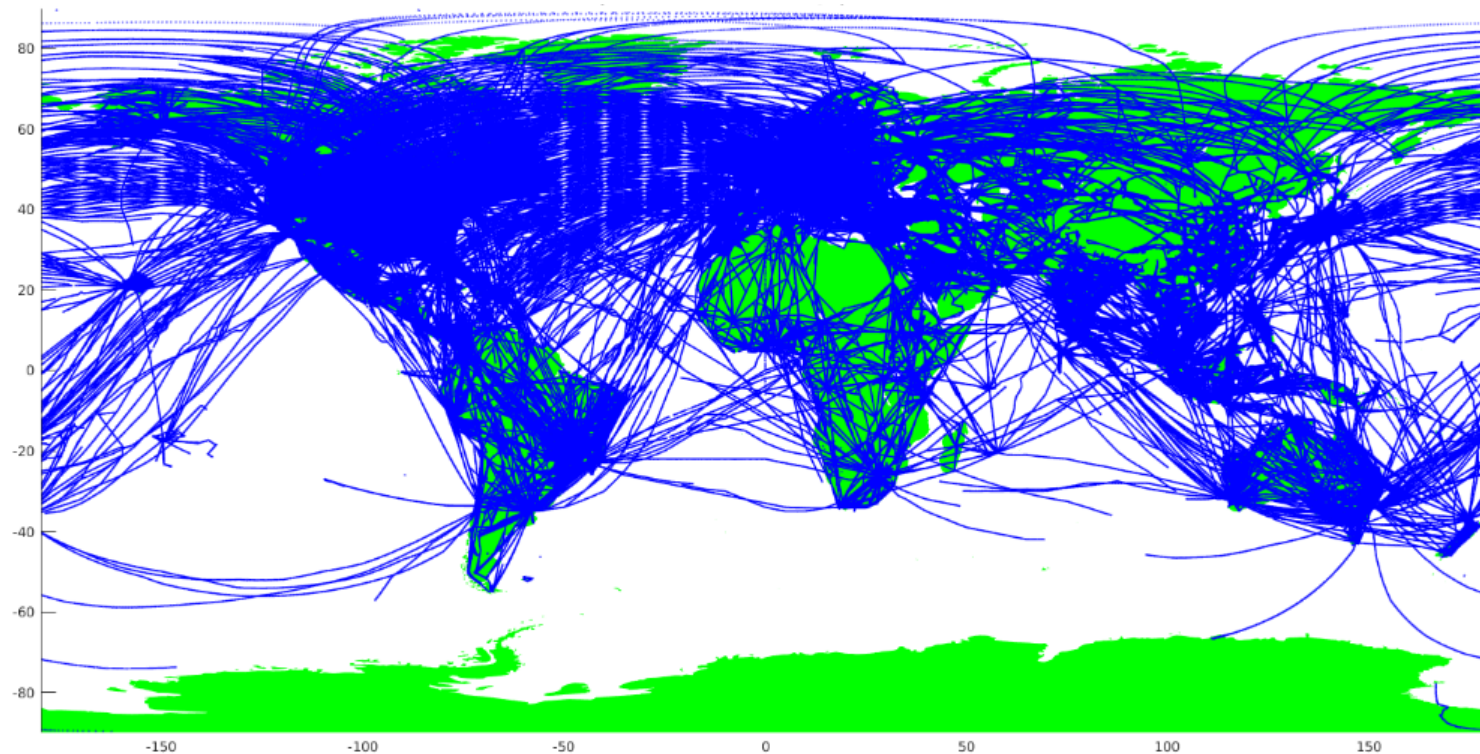
Overlapping Satellite Coverage – End State



Green = Single
Yellow = Double
Blue = Triple+

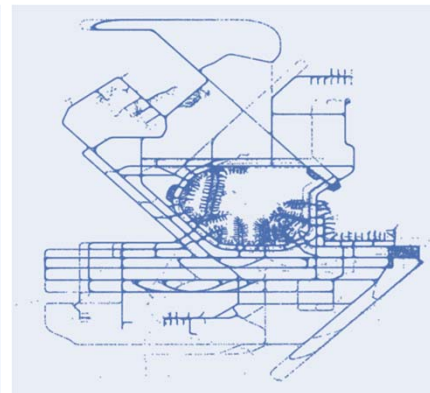
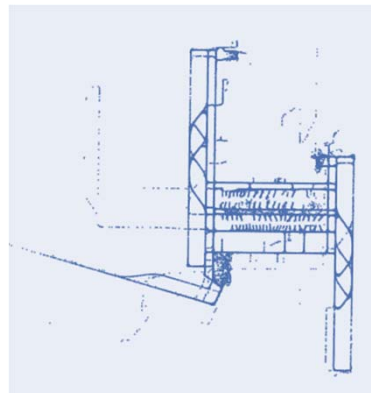
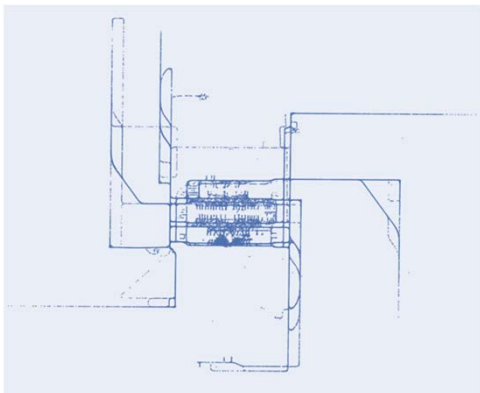
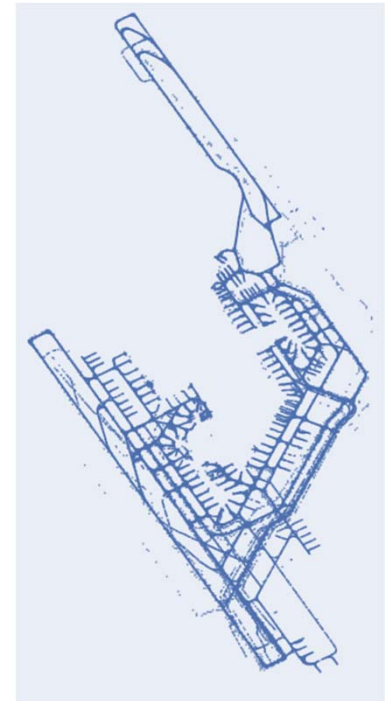
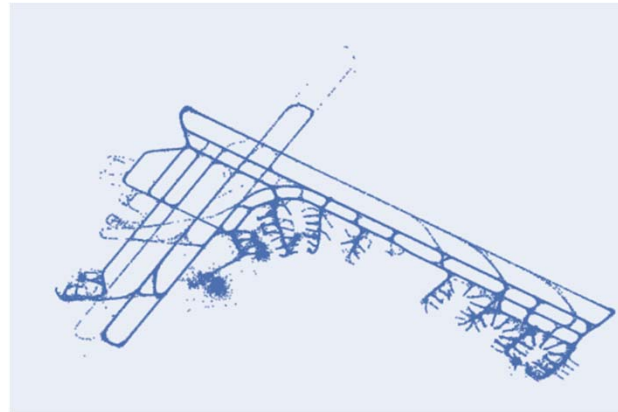
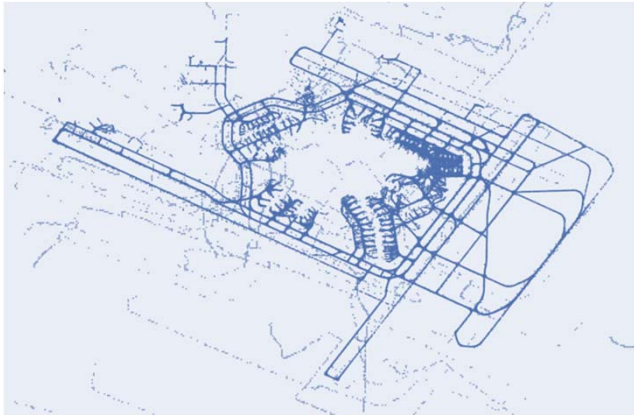
Coverage Plot from 2018-10-24

Active Payload Count = 60



As of Oct 2018, Aireon receives over 13 billion ADS-B position messages received per month!

Visibility at surface level

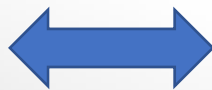


New Service = New Approach

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

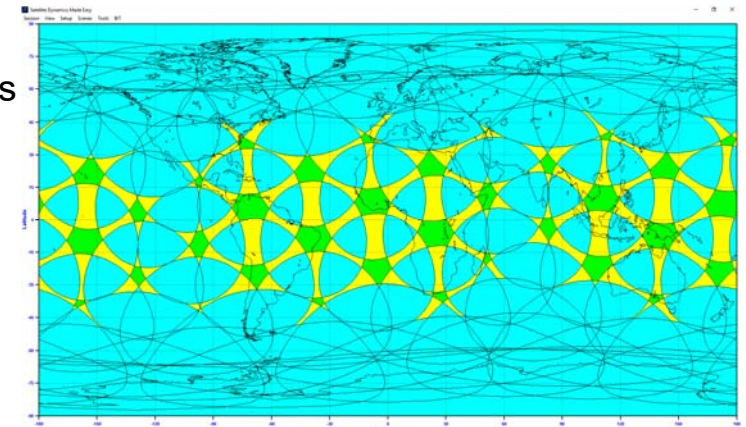
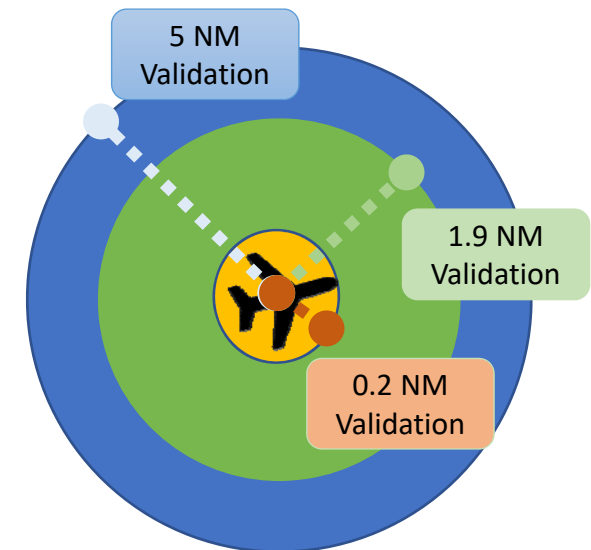
Operational readiness

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



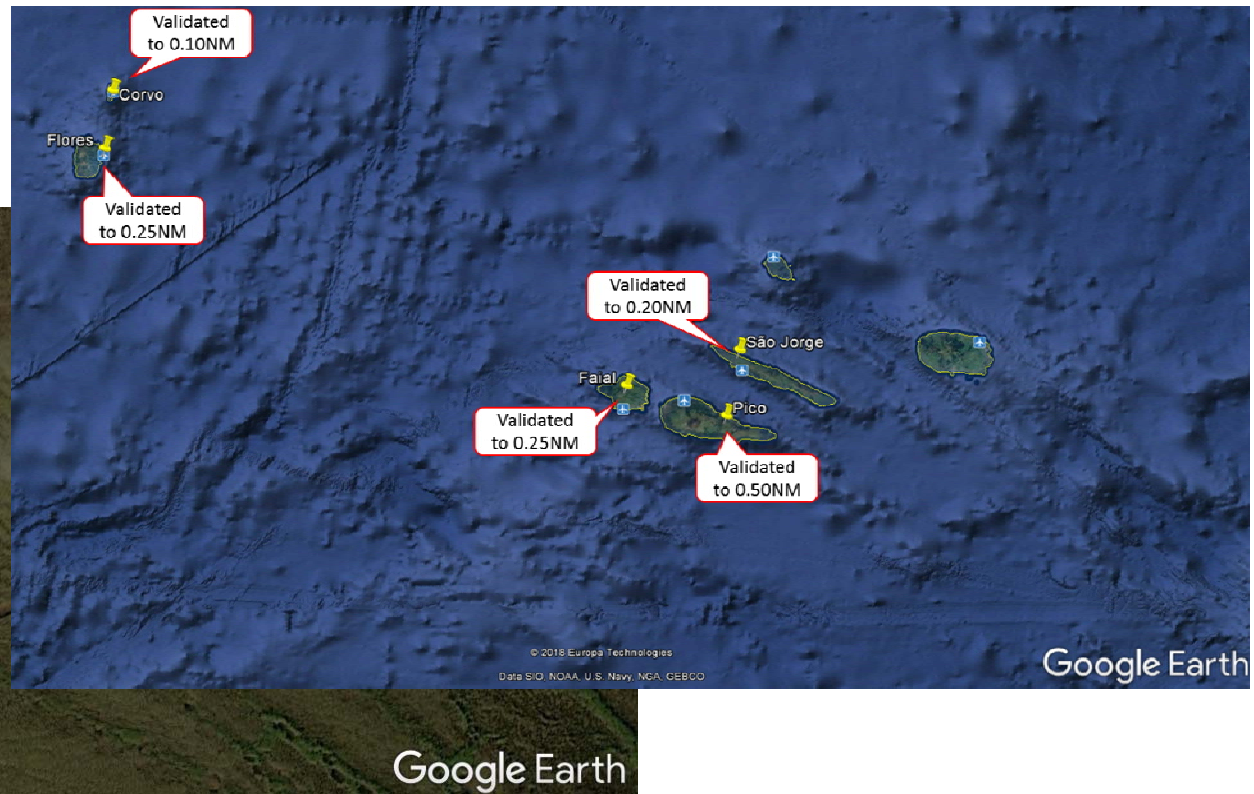
Aireon's Independent Position Validation Solution

- 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.



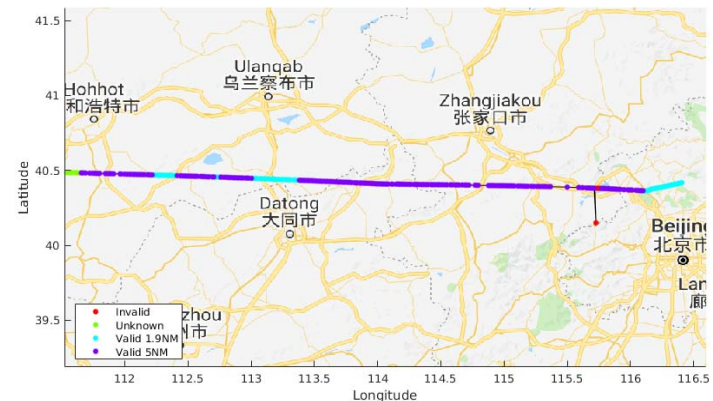
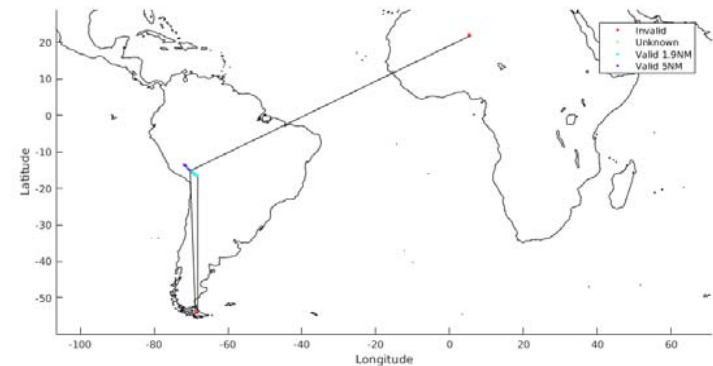
Azores Test Targets

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



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

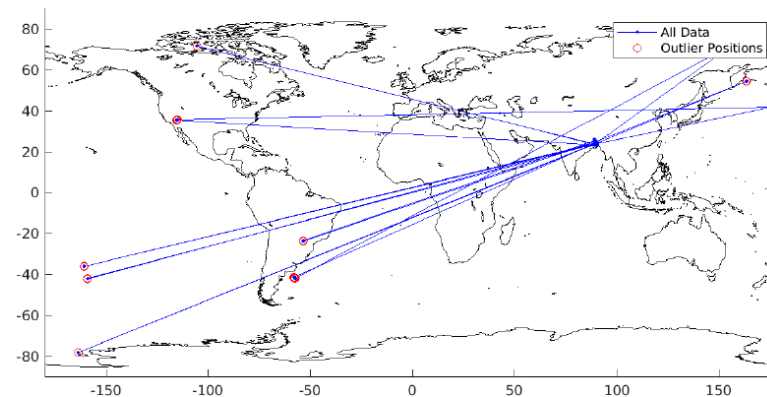


Figure 43: 702039 Outlier Positions

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

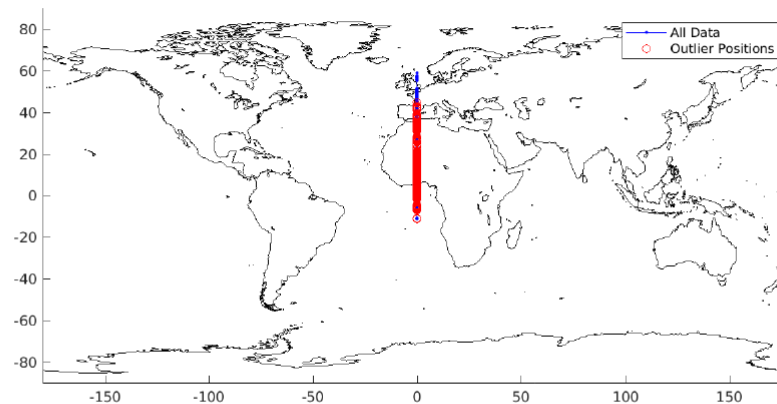


Figure 25: 406B88 Outlier Positions

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

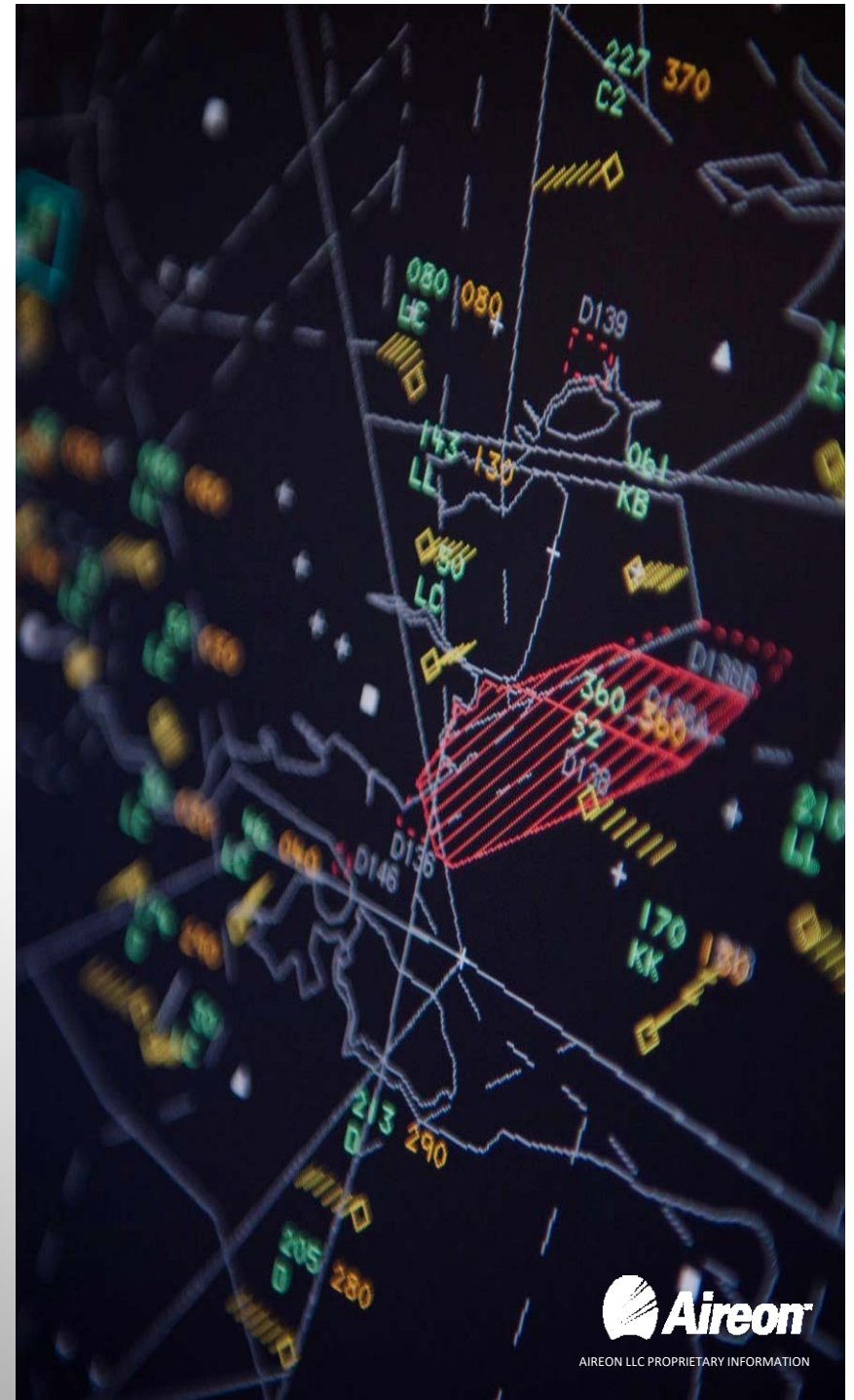
- Advanced automation platforms and trackers can prioritize targets and present the best and most reliable target to the controller.
- Aireon will manage the data delivery (including security) to the SDP. After the SDP, the data distribution, use and verification would be under SANS responsibility.
- 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 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

Aireon and ASBU

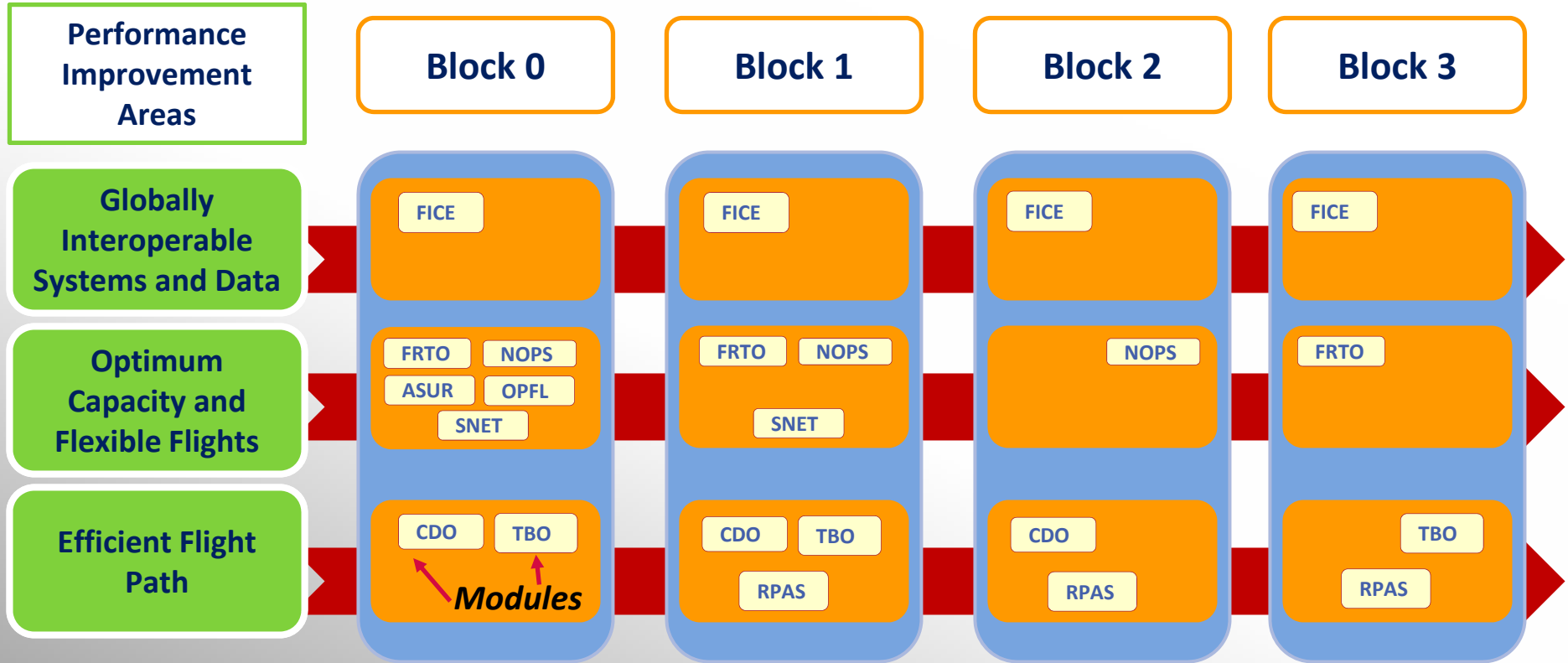
the correlation between Aireon's space-based ADS-B system and the ICAO Aviation System Block Upgrades (ASBU)



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Space Based ADS-B will be a key enabler to several ASBU block upgrades

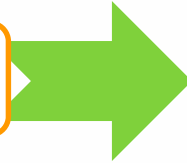


Threads

FICE: Flight and flow Information for Collaborative Environments;
 FRTO: Free-Route Operations; NOPS: Network Operations; ASUR: Alternate Surveillance;
 OPFL: Optimum Flight Levels; SNET: Safety Nets; CDO: Continuous Descent Operations;
 TBO: Trajectory-Based Operations; RPAS: Remotely Piloted Aircraft Systems



Threads



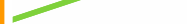
Relation to Aireon and Space-Based ADS-B

Flight and Flow Information for Collaborative Environments (FICE)



Consistent surveillance information that can be provided to all

Network Operations (NOPS)

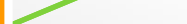


Optimum Flight Levels (OPFL)



Reduced separation for ADS-B Out equipped aircraft in oceanic/remote airspace

Free-Route Operations (FRTO)



Surveillance source for conflict alerting and minimum safe altitude warnings in remote airspace and filling in gaps caused by line of sight issues in ground based systems

Safety Nets (SNET)



Alternative Surveillance (ASUR)



Remotely Piloted Aircraft Systems (RPAS)



Surveillance to allow for additional procedures where allowed

Continuous Descent Operations (CDO)



Trajectory-Based Operations (TBO)



Increased monitoring in oceanic/remote airspace

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Questions?

-End

