

Space Based ADS-B

“Status of Deployment and Innovative Safety Developments”

Cyriel Kronenburg

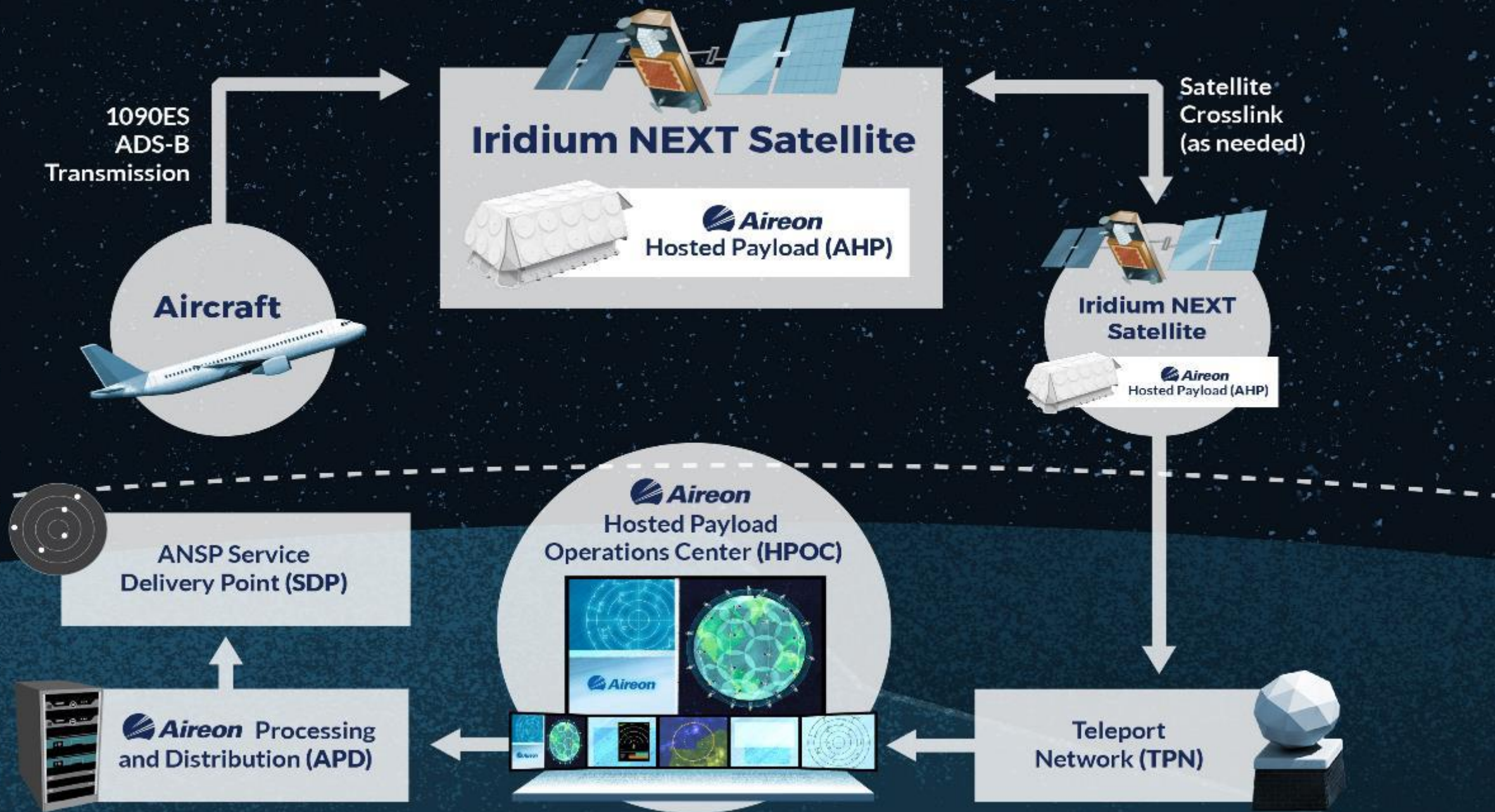
Vice President, Aviation Services



The Concept in 2014



The Design



System Now Used for ATC Separation Services

| Environment | Type of services | Horizontal Separation Minima |
|-------------------------------|--|------------------------------|
| Oceanic - Advanced | AREA control service in Oceanic sector | 15 NM |
| En-Route Non-Radar (NRA) | AREA control service in En-Route sector | 5 NM |
| En-Route Radar (RAD) | | |
| Terminal Area Non-Radar (NRA) | | 3 NM |
| Terminal Radar (RAD) | APPROACH control service in a TMA sector | |



Safety Certified



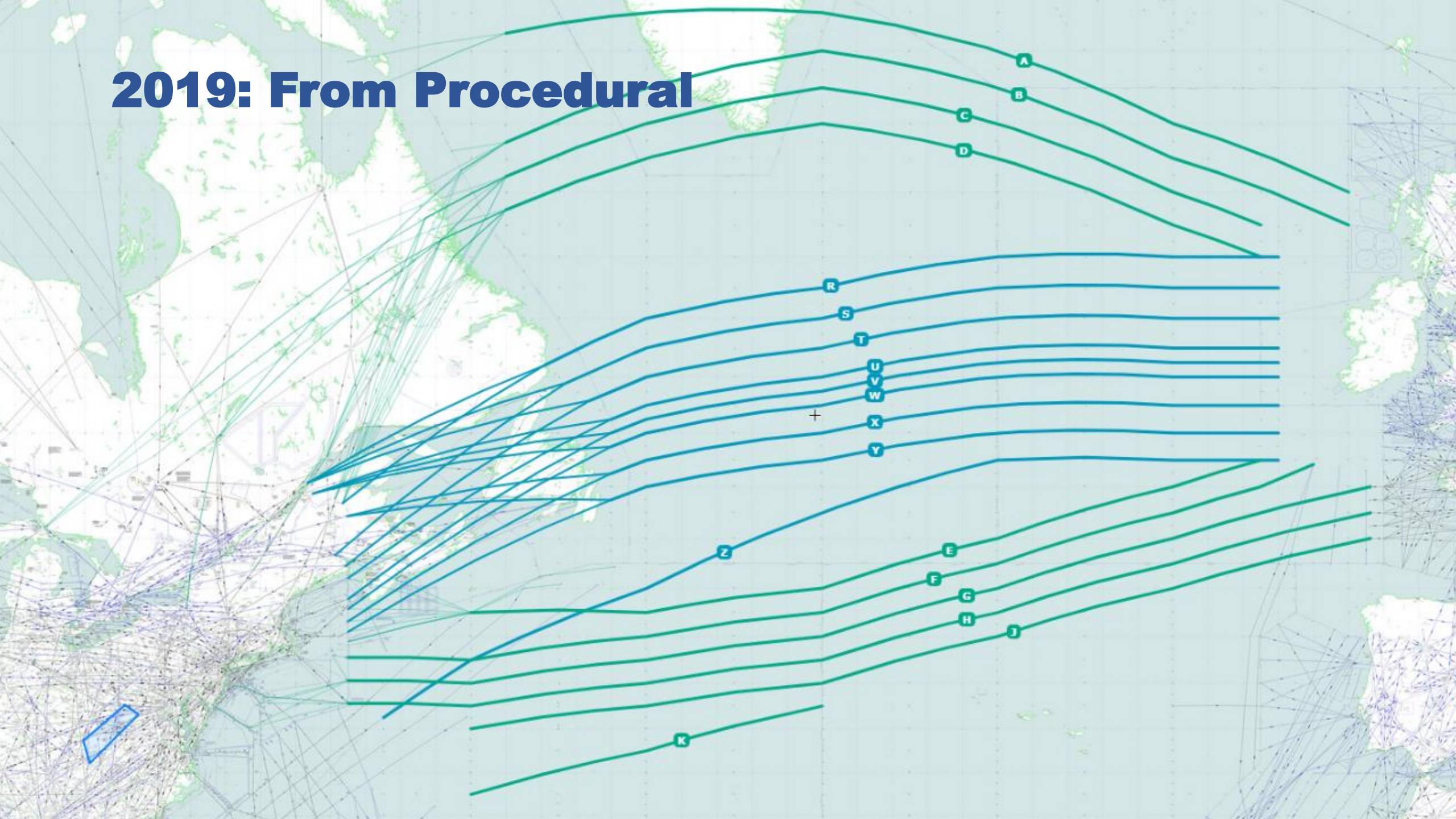
Designed to meet tough cyber security requirements
Developed to deliver Air Traffic Separation
Company wide SMS policy & procedures
ATSEP Staff Certification

First ATC surveillance service provider in the world to obtain an EASA Certification



AIREON LLC PROPRIETARY INFORMATION

2019: From Procedural

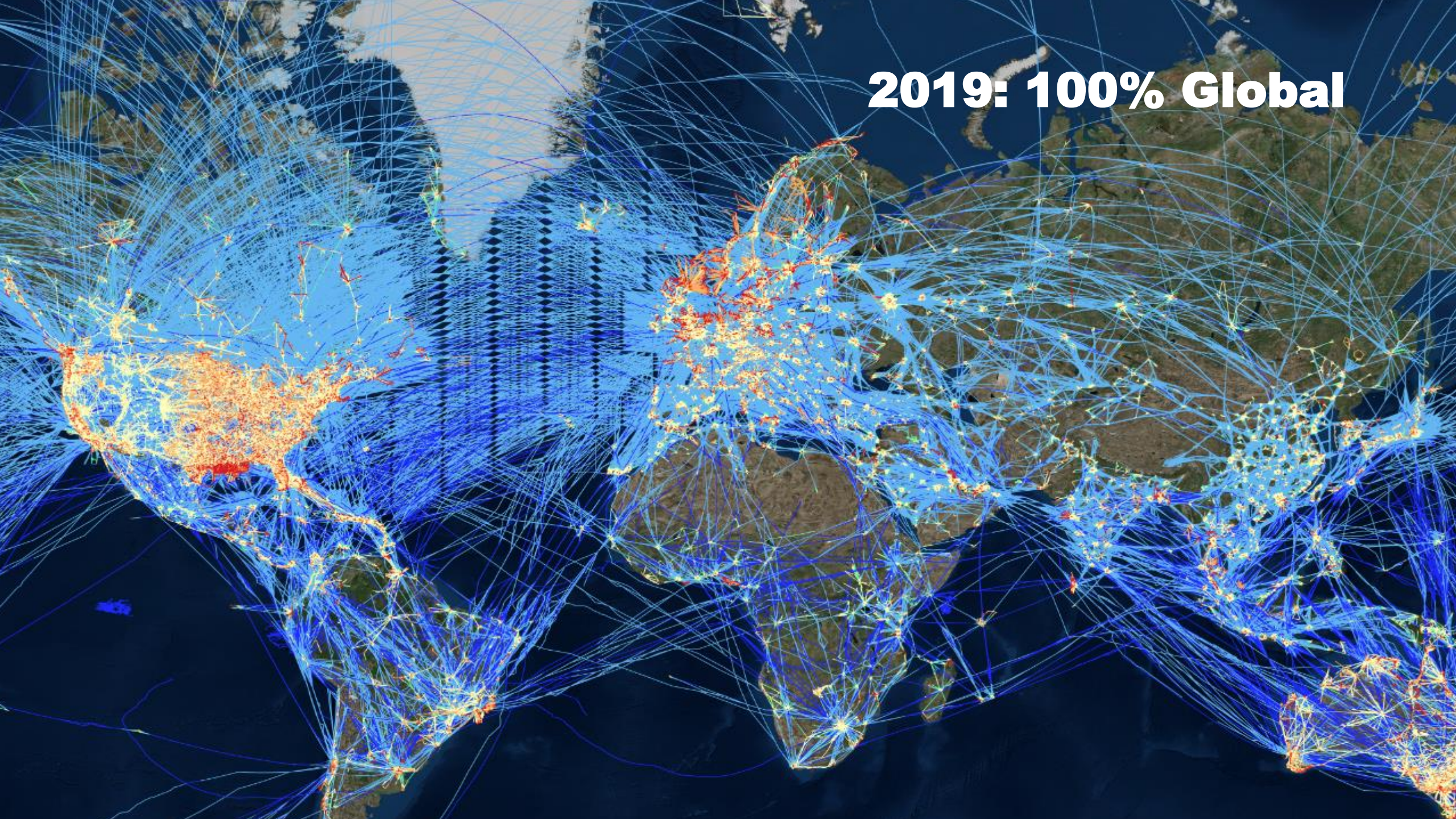


2019: To 100% ATS Surveilled

| Action Window | | | | |
|---------------|-------|-----|----------|--|
| ACID | State | FL | OEP/Time | |
| DAL35 | P | 360 | 65N50W/1 | |
| DJT100 | P | 340 | 53N20W/1 | |
| QTR727 | P | 400 | 66N50W/1 | |
| NRS75151 | P | 380 | 57N20W/1 | |
| QTR727 | P | 400 | 65N50W/1 | |
| DAL445 | P | 320 | 53N20W/1 | |
| DLH410 | P | 360 | 5430N20W | |
| AAL151 | P | 380 | 56N20W/1 | |
| DAL137 | P | 300 | 57N20W/1 | |
| DLA231 | P | 330 | 58N20W/1 | |
| BAW295 | P | 360 | 56N20W/1 | |
| DLH418 | P | 340 | 55N20W/1 | |

Message List

2019: 100% Global



Since March go-live 13 ANSPs



OBSERVATIONS IN THE NORTH ATLANTIC

**134 million
reports**

Performance exceeds specifications of ATS surveillance on U/I and latency

>72%

Of traffic eligible for reduced longitudinal separation

~13 daily

Conformance safety alerts through flight level and route adherence monitoring

11,776

Additional flights offered Variable Mach in 42 days, representing 37% of traffic

Significant Improvements in Collision Risk

NAV CANADA

SAFETY OCA

The presence of space-based ADS-B in the NAT would have reduced the collision risk estimate:

- 2016 – from 19.8×10^{-9} to 4.6×10^{-9} , a 77% improvement
- 2017 – from 10.5×10^{-9} to 5.9×10^{-9} , a 44% improvement
- 2018 – from 17.3×10^{-9} to 7.0×10^{-9} , a 59% improvement

Source: PRISM (OPMR)



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GlobalBeacon Live as of 5 November 2018

- Qatar Airways became the GlobalBeacon launch customer, since launch joined by an estimated 4000 commercial aircraft using Aireon data as of Q1 2019 as part of their GADSS tracking
- Additional resellers such as SITA, Rockwell Collins (ARINC), IBM, The Weather Company and NavBlue signed reseller agreements with FlightAware and Airbus for integration of the Aireon data into flight tracking solutions

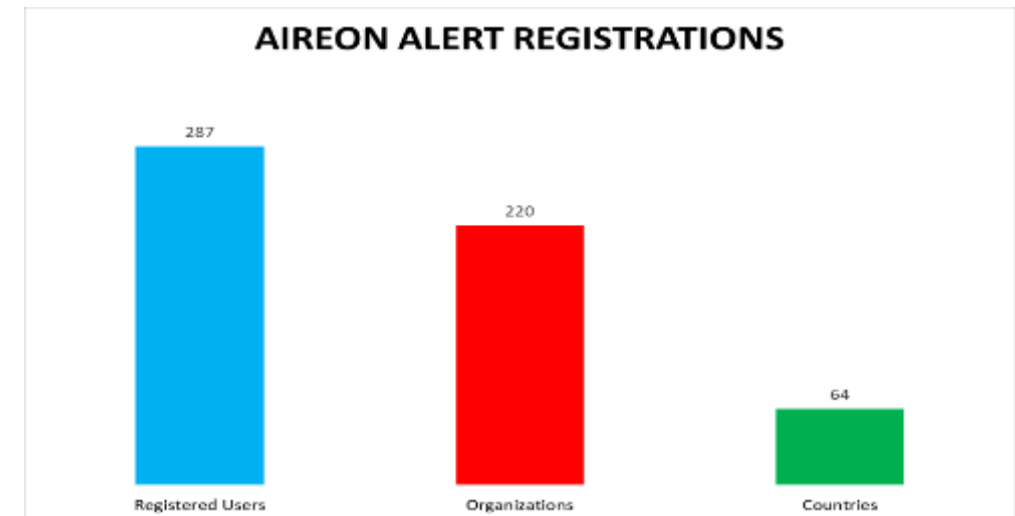


The screenshot shows the GlobalBeacon web interface. On the left, a map of Europe displays several aircraft tracks. A 'Configure Settings' dialog box is open in the center, allowing users to adjust alert thresholds. The dialog includes sliders for 'Number of seconds since last position report' (set to 300 for WARNING, 600 for EMERGENCY), 'Emergency transponder codes' (7500, 7600, 7700), 'Turbulence encounter >X feet' (set to 200 for WARNING, 300 for EMERGENCY), 'Altitude below X more than Y miles from origin/destination' (WARNING: 25000, 150; EMERGENCY: 12000, 100), and 'Groundspeed below X more than Y miles from origin/destination' (WARNING: 250, 150; EMERGENCY: 200, 100). At the bottom of the dialog are options for 'Reset Defaults', 'Set All to Emergency', and a 'SAVE' button. The background interface includes a 'Global Beacon Space-Based' browser tab, the URL 'www.flightaware.com/aireon', and a table with columns for 'Alert Trigger', 'Ident', 'Tail', 'Departure', and 'ETA'.

ATS Surveillance is a Critical component in Annex 13 Responses

- Dozens of Accident Investigation requests were received since Aireon went live (13 this month)
- ATSB Australia recently concluded ADS-B coverage in remote terrain could have prevented CFIT (VMC into IMC)
- Immediate response to Alerting and Distress phases possible, with high fidelity data

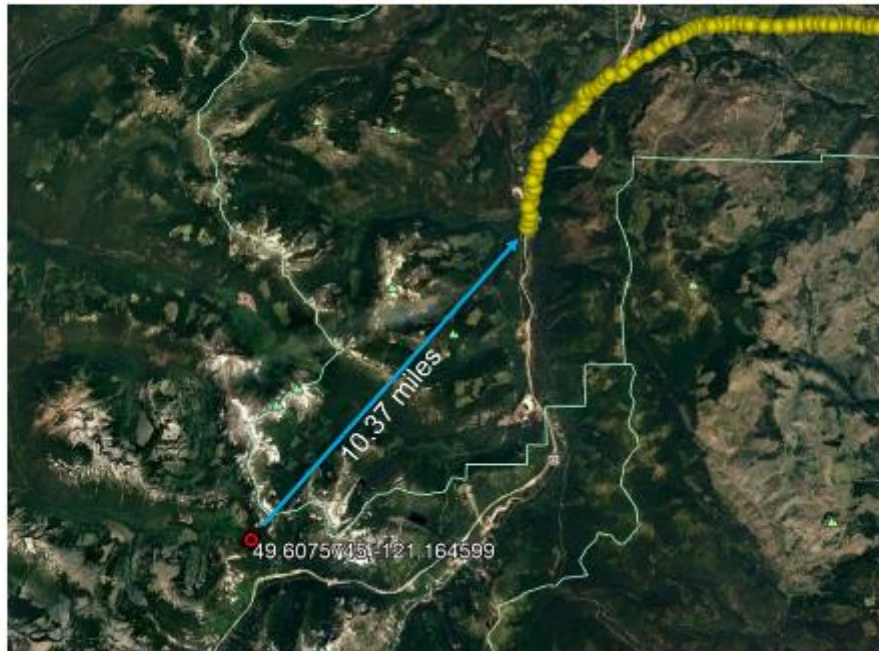
“our investigators were able to pinpoint, with a very high degree of accuracy, as possible splash down location of the missing helicopter. While the search is currently on going, we are preparing a media statement in readiness of a successful outcome”. ATSB Australia



Real Example: Accuracy

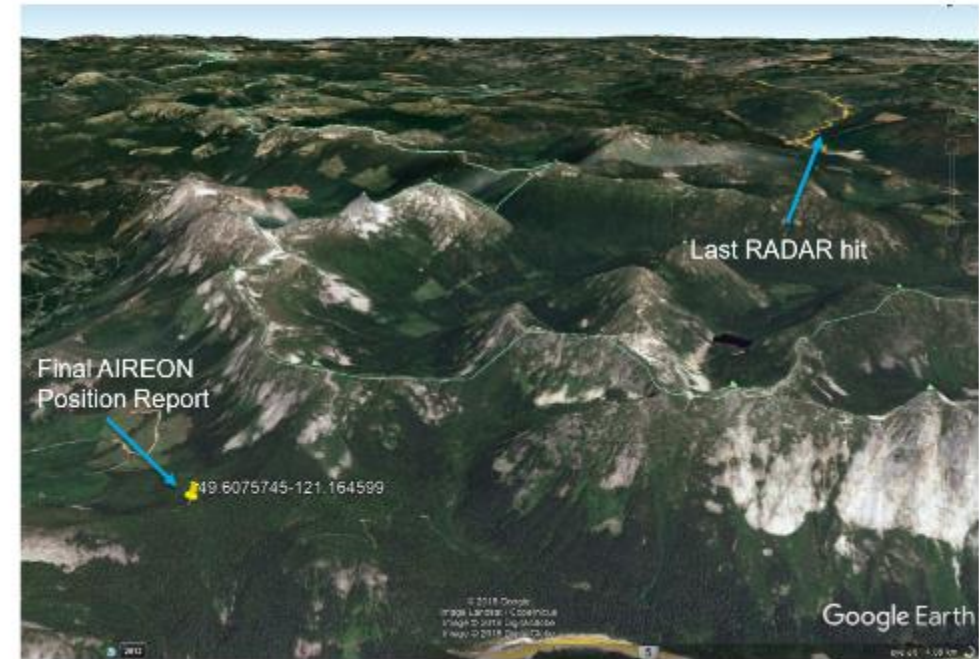
NAV CANADA

RADAR VS AIREON COMPARISON



NAV CANADA

RADAR VS AIREON COMPARISON

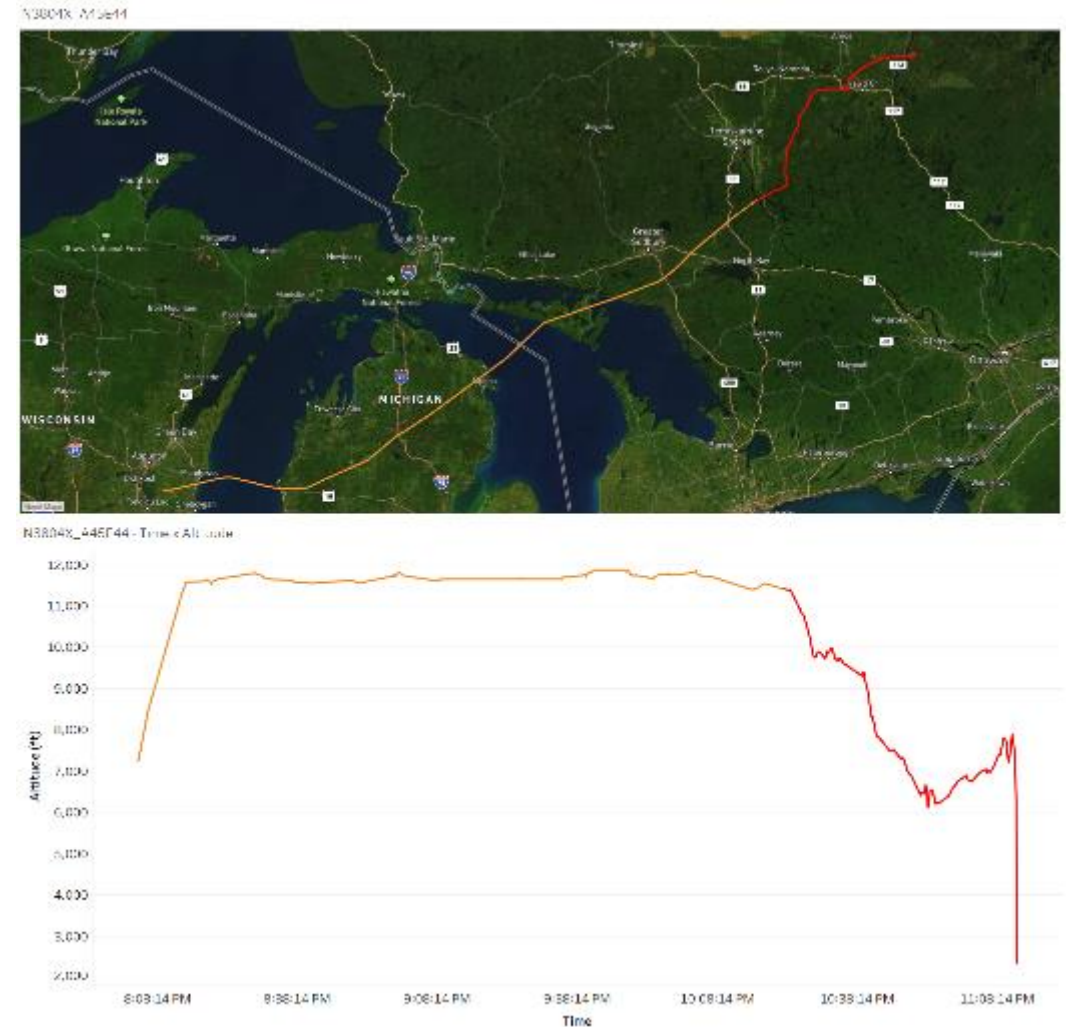


Real Example: SAR Response Timing

- Beechcraft V35 Bonanza was flying from Oshkosh and went missing
- Eight planes and helicopters and about 100 personnel participated in SAR for two days until Civil Air Patrol requested SBA data
- The search area was narrowed to a couple of hundred meters
- The crash site was located quickly (in Canada) and it brought closure for the family

Civil Air Patrol Search Lead:

“This is excellent! We have passed the data to Canada. This narrows the search area to a couple hundred meters, it will bring closure to this search and for the family.”



ELT versus Accurate Position Reports

NAV CANADA

CEASAR

CANADIAN ENHANCED ALERTING FOR SEARCH AND RESCUE

- When an aircraft has an accident, an on-board Emergency Locator Transmitter (ELT) should automatically emit a signal
- High rate of failure
- Many false alerts
- **80%** of reported aircraft accidents in Canada over 10 years didn't send automated alert from ELT to SAR (no ELT on board or missed signal)
- **75** Minute Detect & Alert Time to SAR with 406 MHz ELT vs. **5** minute with CEASAR

Innovative Safety Improvements at Global Level

Commercial space
integration



GPS interference
monitoring

No additional
avionics
requirements,
uses all ADS-B
out versions



Immediate global
contingency of ATS
surveillance data in case
of unforeseen outages,
weather , natural or
geopolitical events



Real Time
Conformance
Monitoring



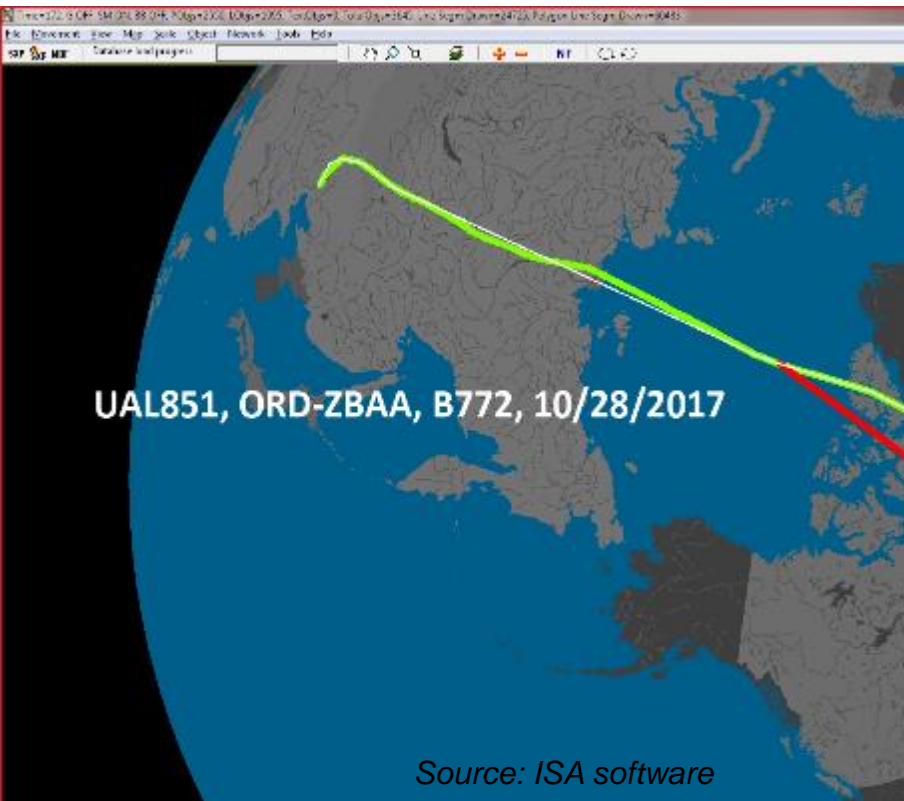
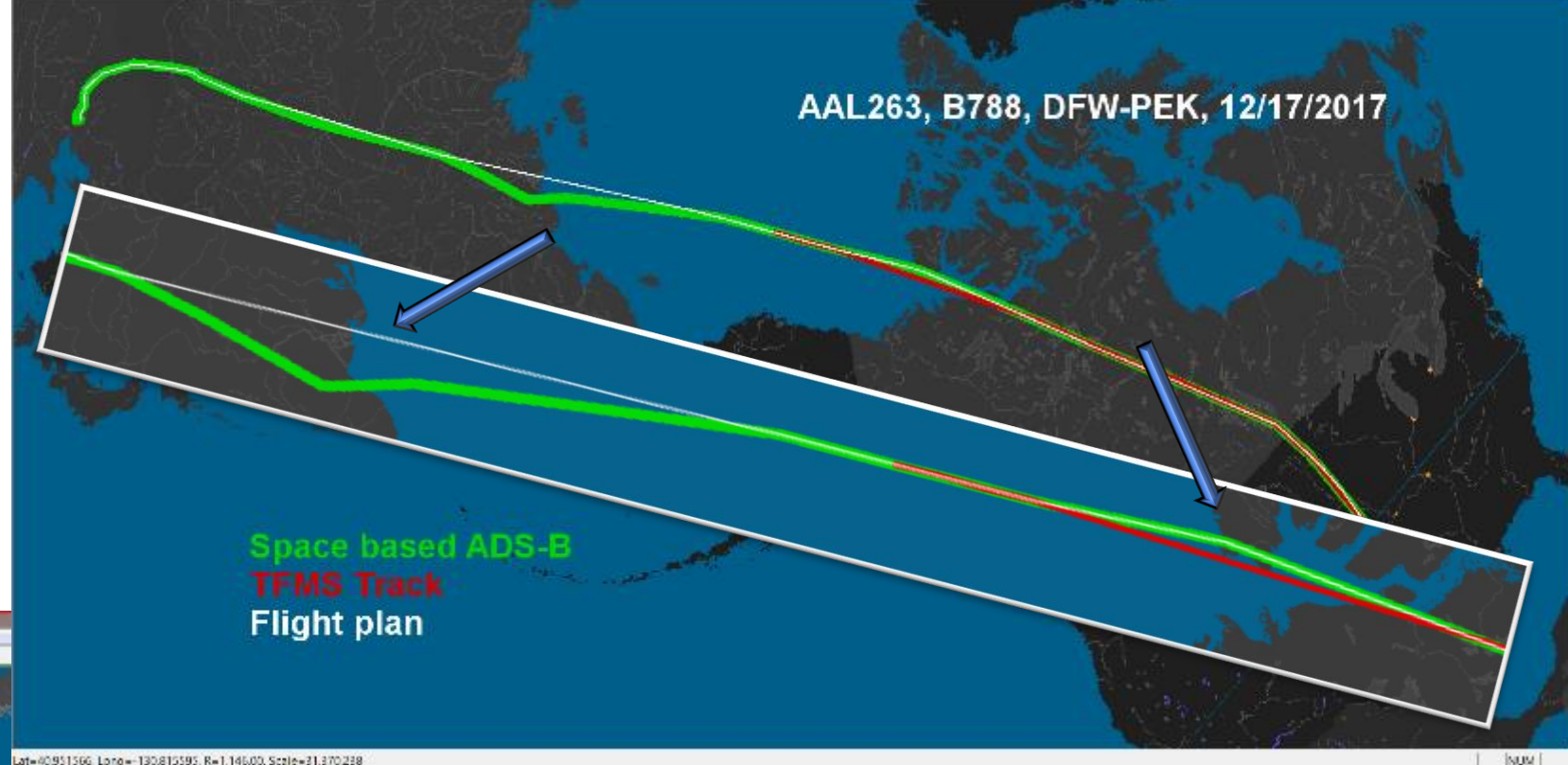
Global
Transponder
Conformance
Analysis

Enhances incident and
accident investigations with
time-critical flight data



Near real time safety net
for hazards such as CFIT
and Uncleared Deviations

**We don't
know what
we don't
know**

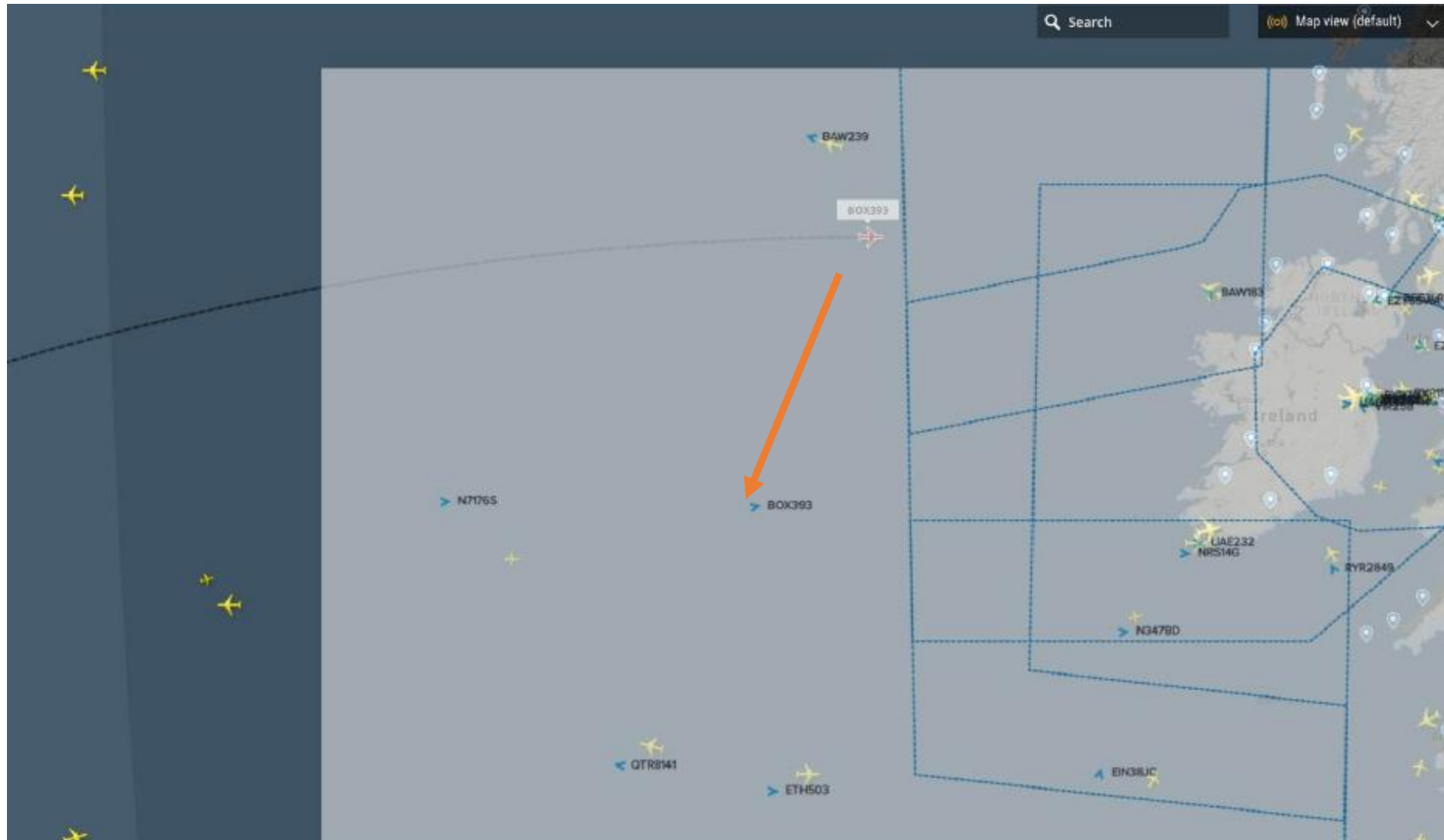


Source: ISA software

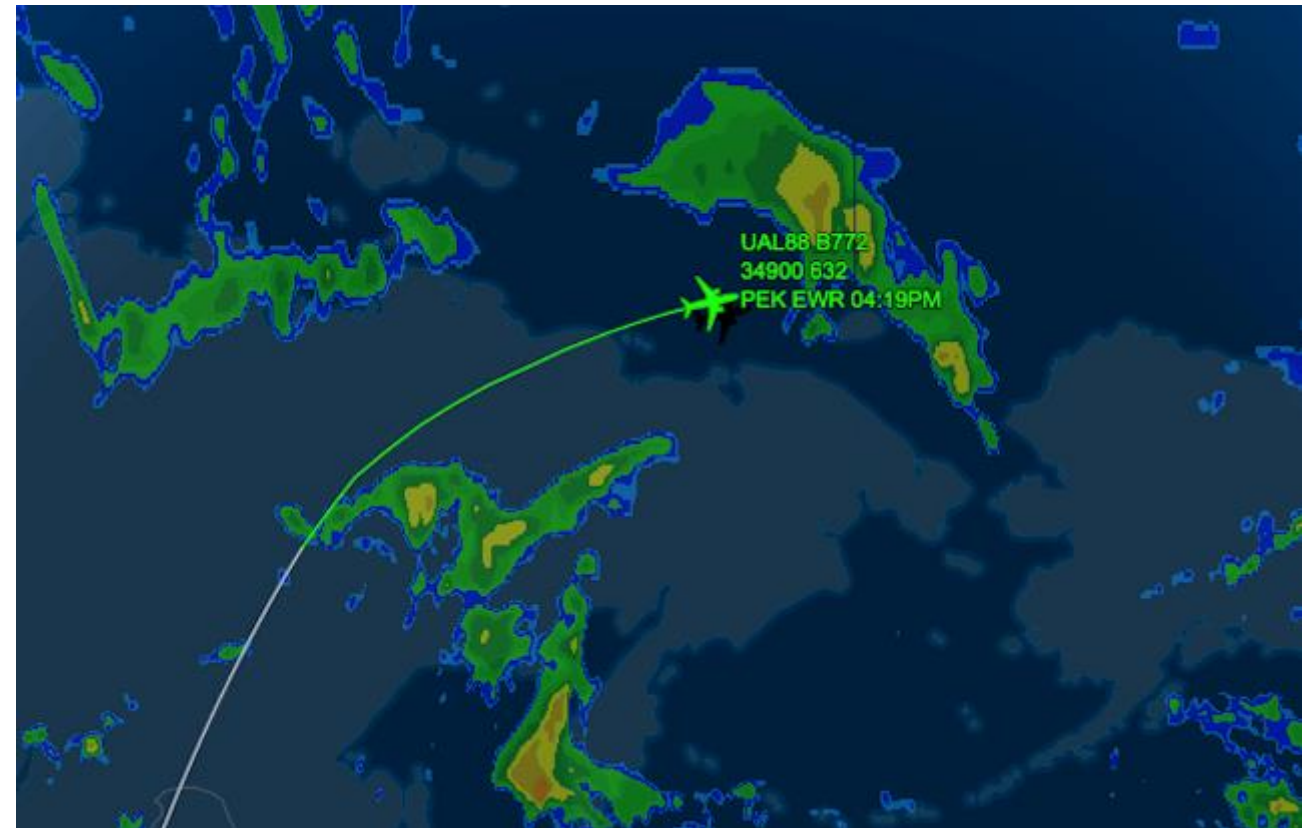
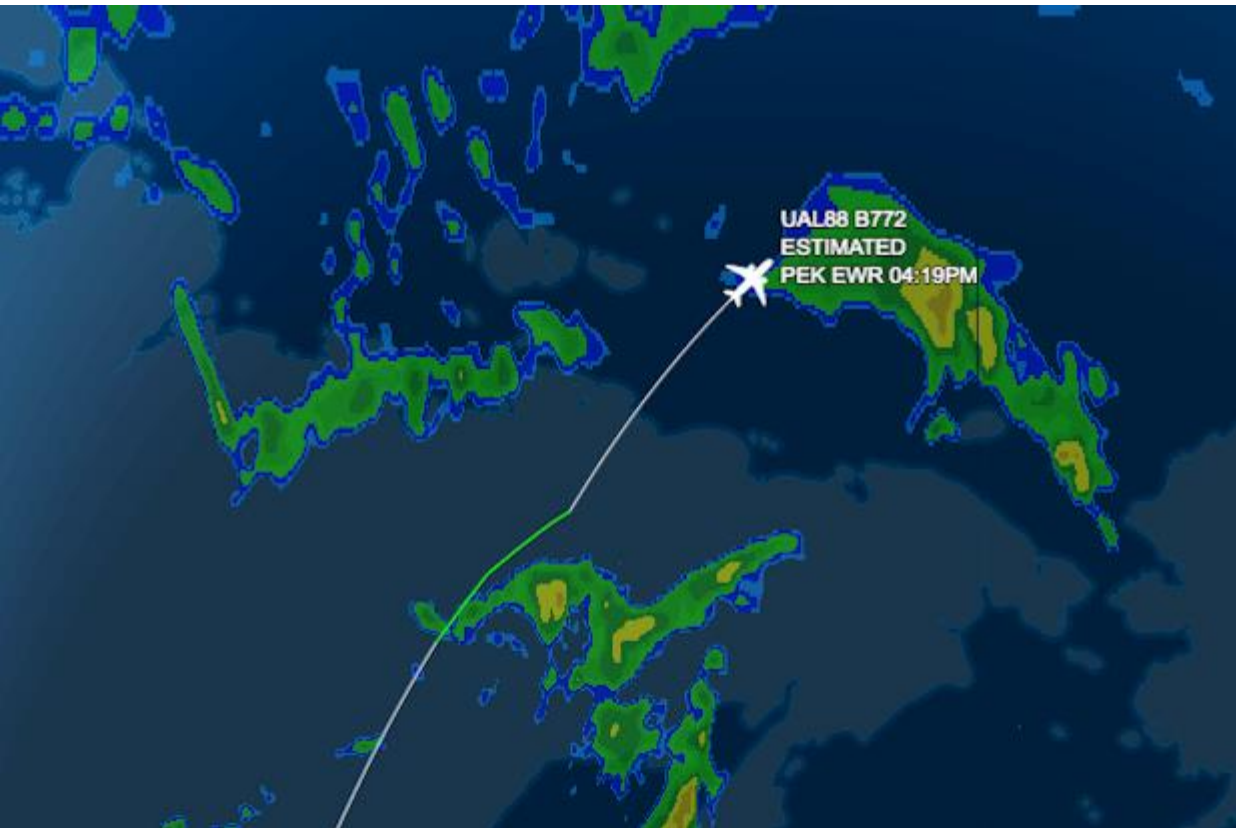


AIREON LLC PROPRIETARY INFORMATION

Extrapolation can lead to wrong conclusions



Establish a global common baseline, truth data



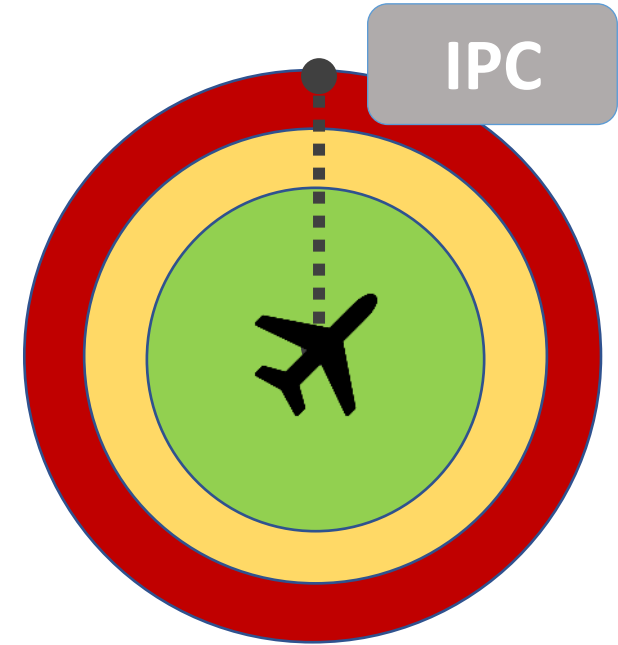
Source: FlightAware

Independent Position Validation Solution

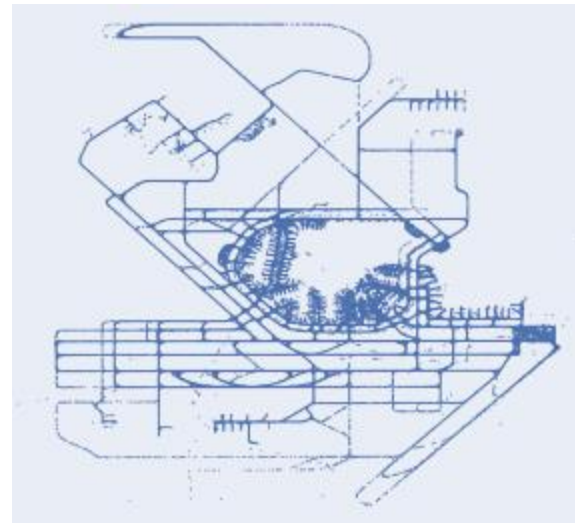
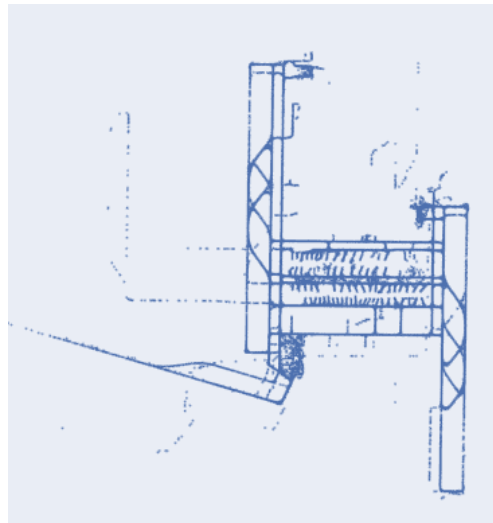
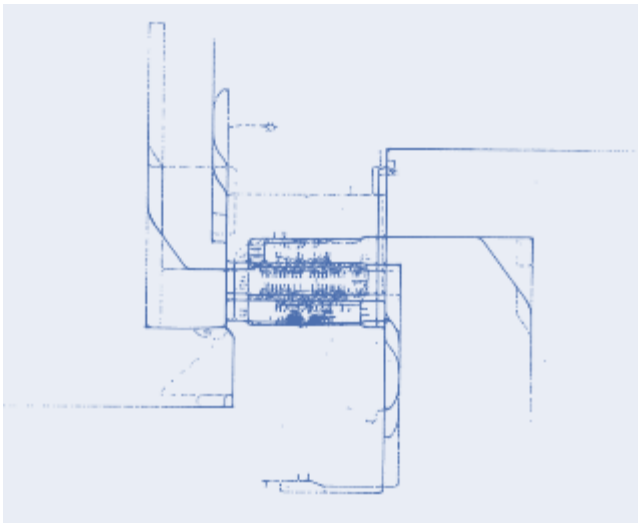
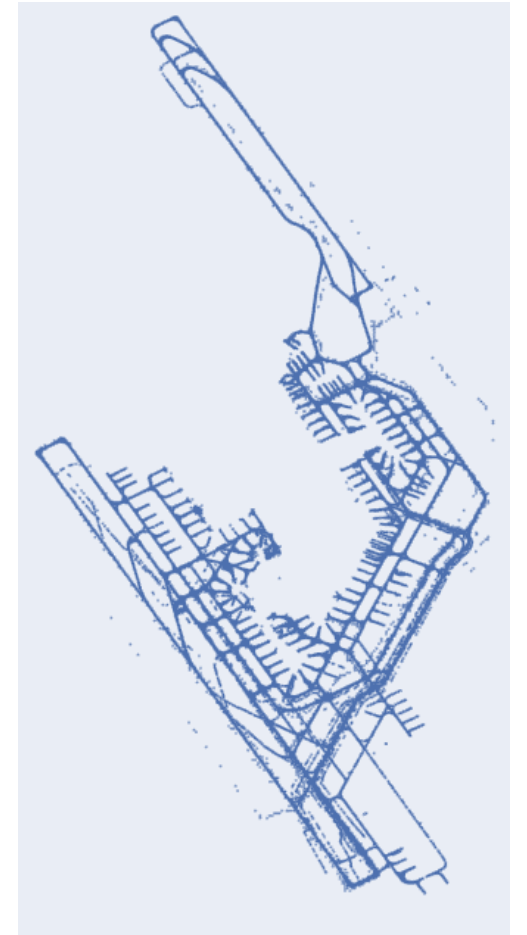
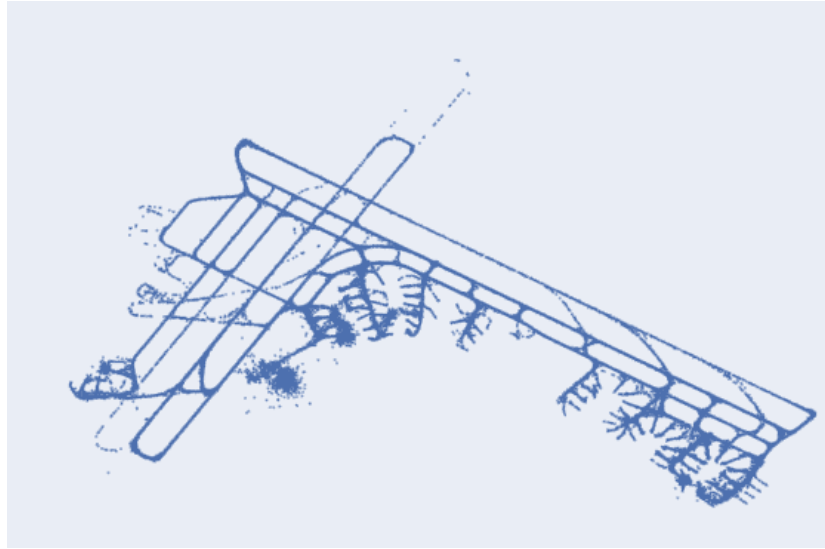
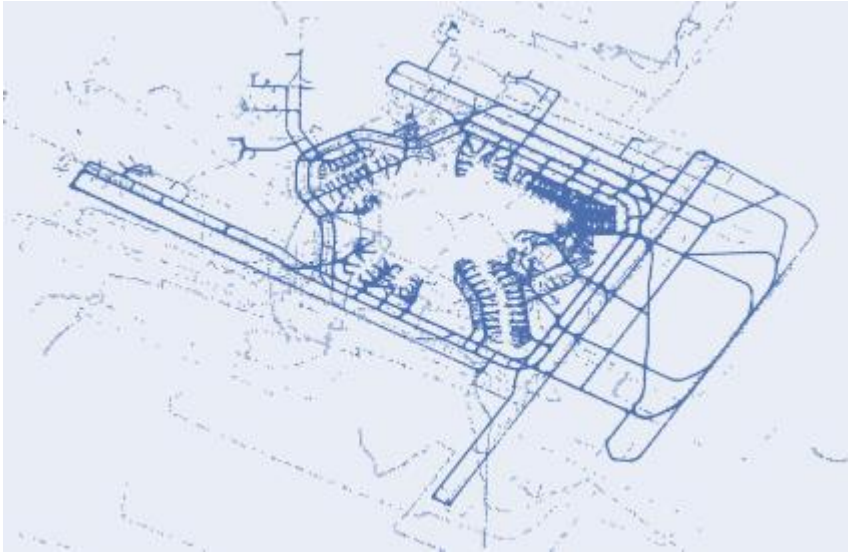
The expanded coverage footprint improves the Aireon to validate the reported position from ADS-B aircraft independent from GPS using methods such as Time Difference of Arrival (TDOA)

Development to integrate this into a customer solution is underway:

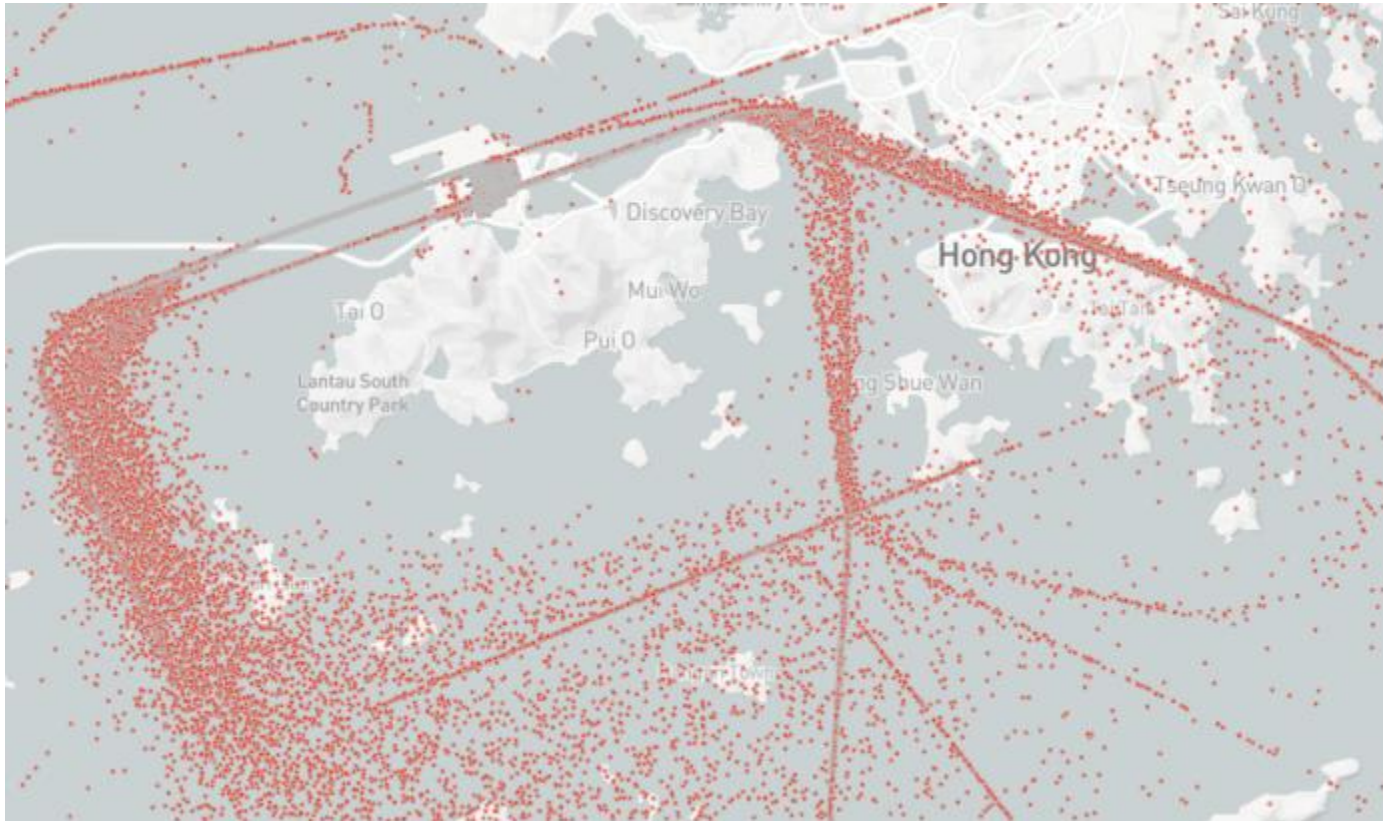
- Initially, the independent position check (IPC) flag in the CAT021 will be set based on a containment exceedance value of 5 NM.
- Closer validation values (e.g. 0.56 NM or even 0.2 NM) are being tested with very encouraging results allowing for WAM



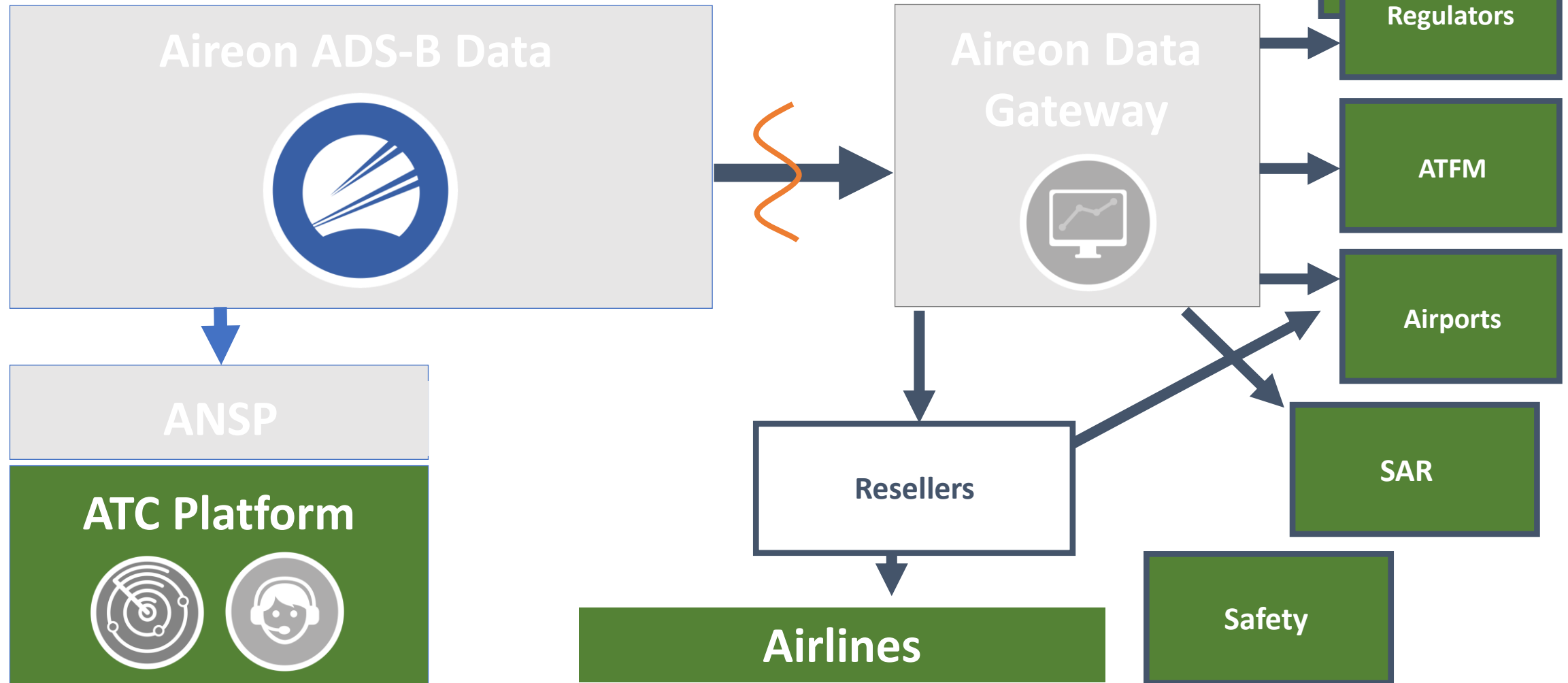
High Quality Airport Data creates Opportunities



Example HKG Airport



Enabling CDM by Design

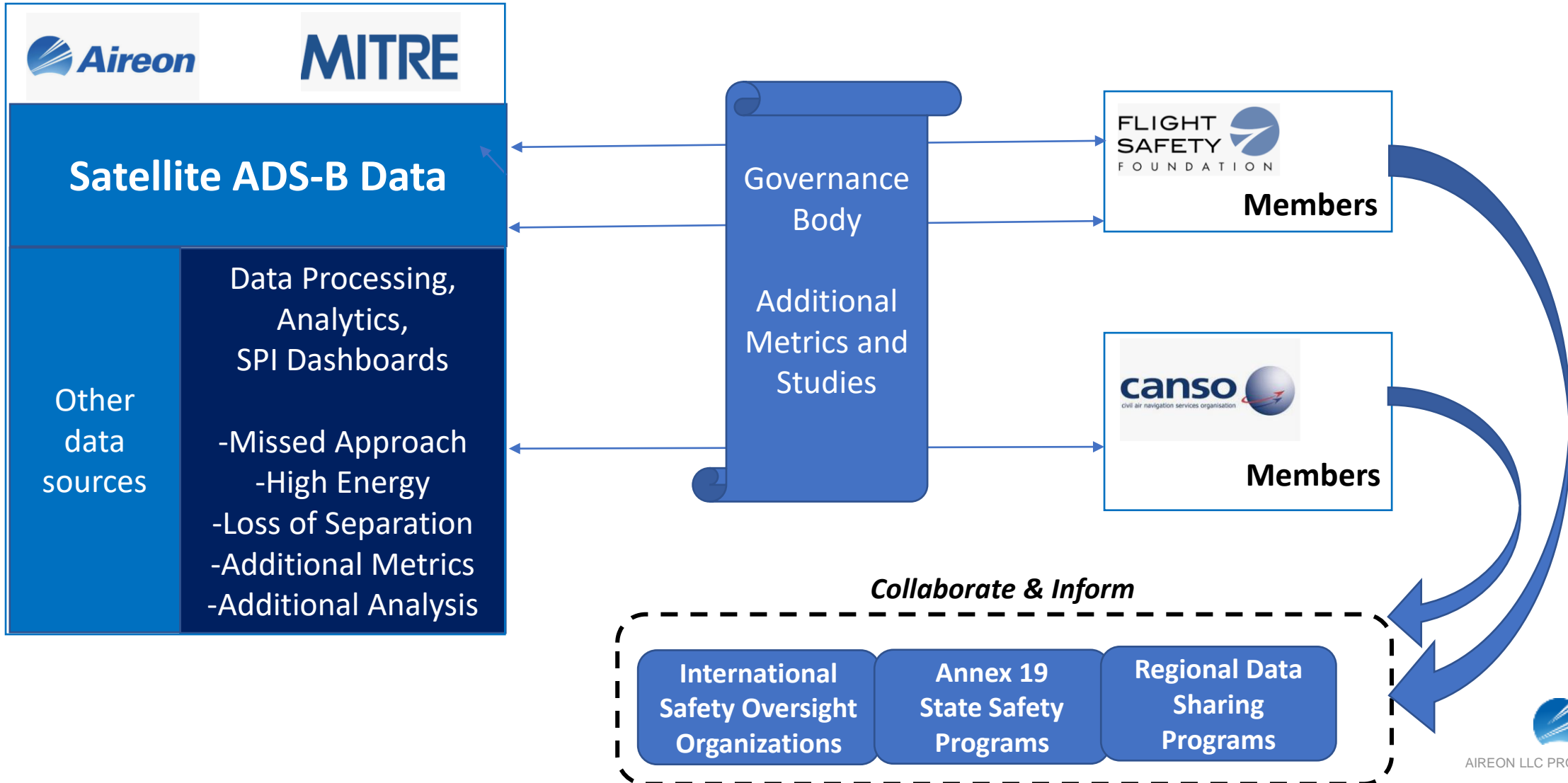


Global Safety Metrics Become Possible



- 40 possible future safety performance metrics using global ADS-B data were identified between Flight Safety Foundation and Aireon
- Working with Flight Safety Foundation and several possible launch partners to:
 - validate that SPIs and safety insights derived from space-based ADS-B are of use and value to stakeholders for improving global safety
 - Understand costs of processing data, producing, validating, oversight and on-going R&D

PROOF OF CONCEPT



Go-Arounds and Missed Approaches – Aircraft Details – MITRE Proprietary and Confidential

Filters and Parameters

Date Range [UTC]
1 Jan 2018 31 Dec 2018

Runway
(All)

Aircraft Type
(All)

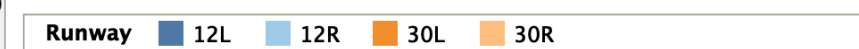
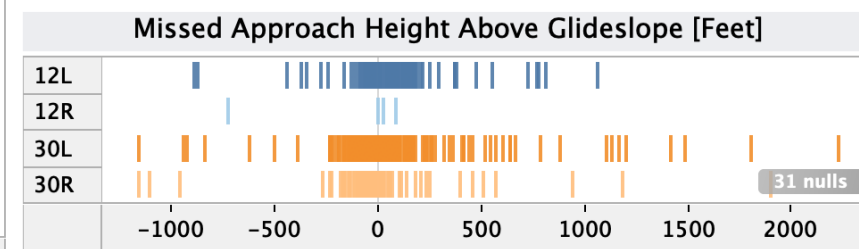
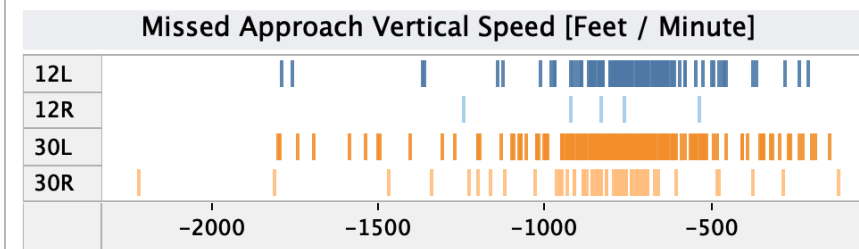
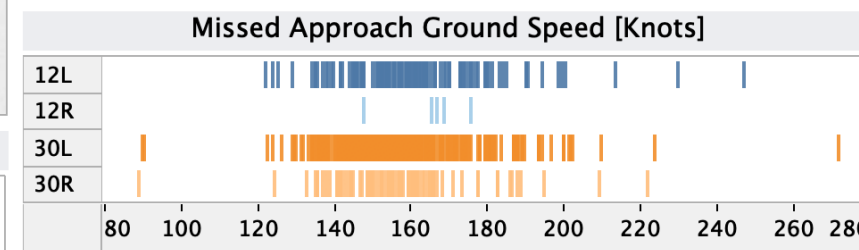
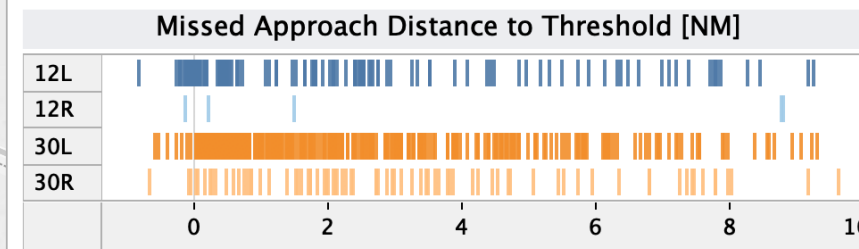
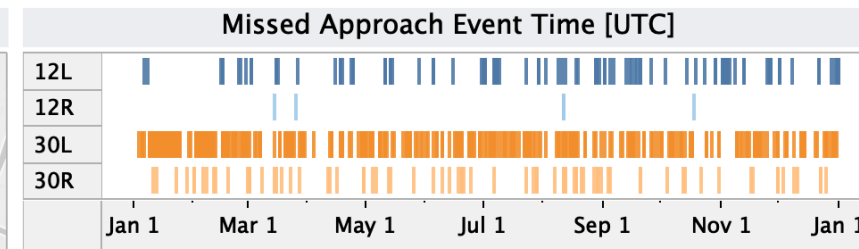
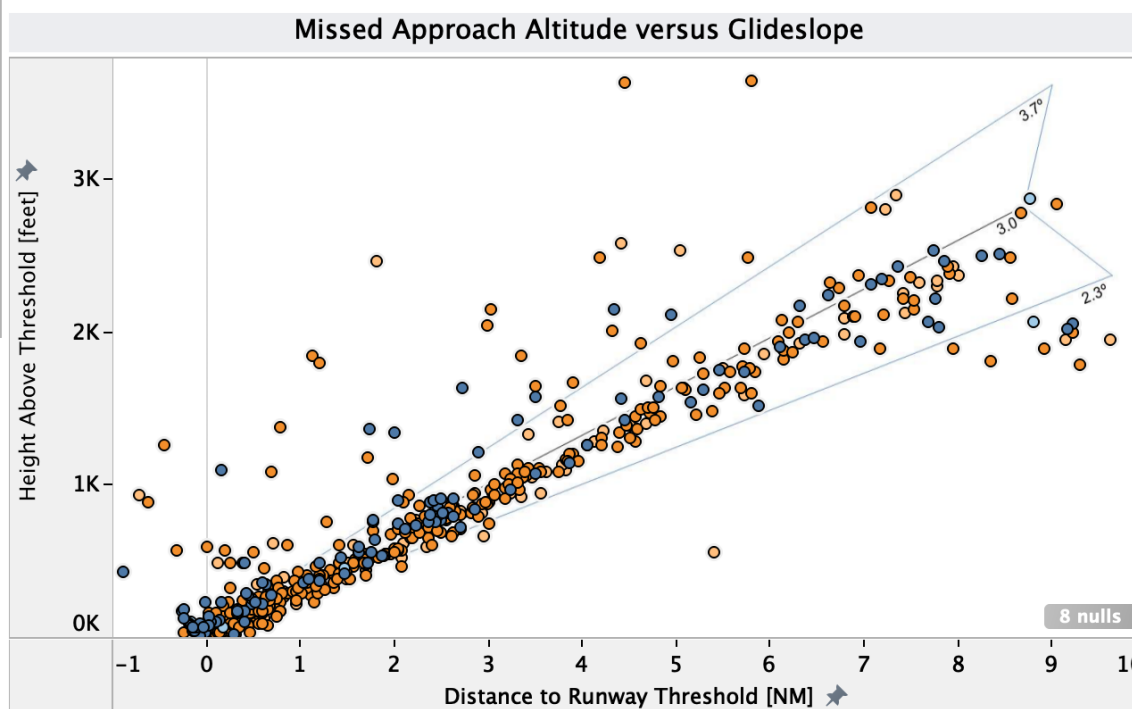
Distance to Threshold [NM]
-1.00 9.75

Weather Visibility [Feet]
0 52800

Weather Ceiling [Feet]
90 99900

Missed Approach Point [To Plot]
End of Descent

Rate Multiplier
1,000



Loss of Separation – MITRE Proprietary and Confidential

Filters and Parameters

Event Time Local [Date]
3 Jan 201527 Dec 2017

Select TTC or LOS
Loss of Separation [LOS]

Category
(All)

TTC or MOC Value
0.0030.00

Vertical Separation [Feet]
01000

Lateral Separation [NM]
0.0003.000

Minimum Altitude [Feet]
200042989

Maximum Altitude [Feet]
135450000

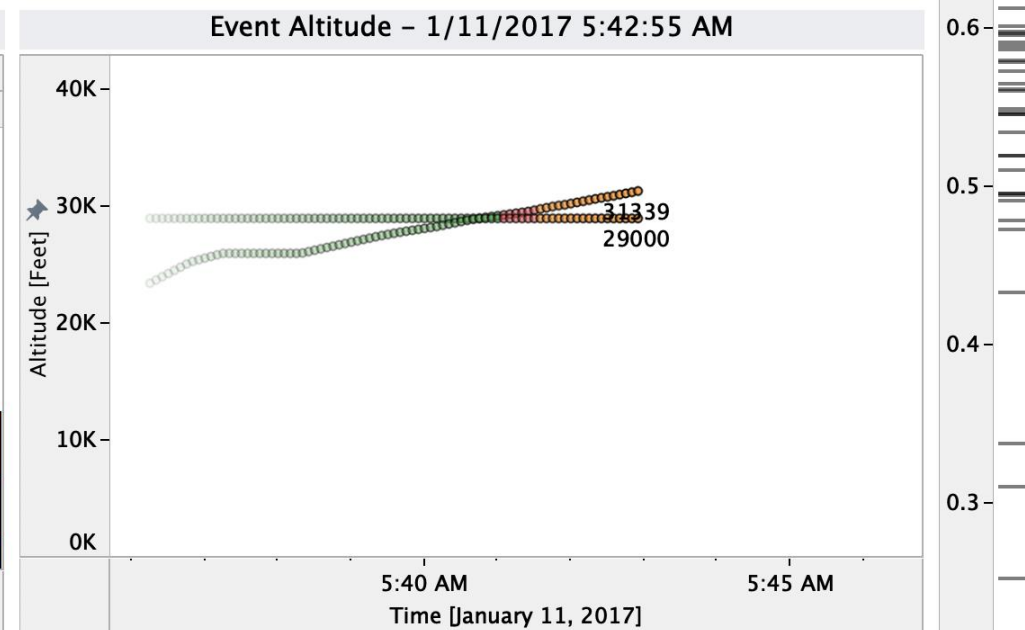
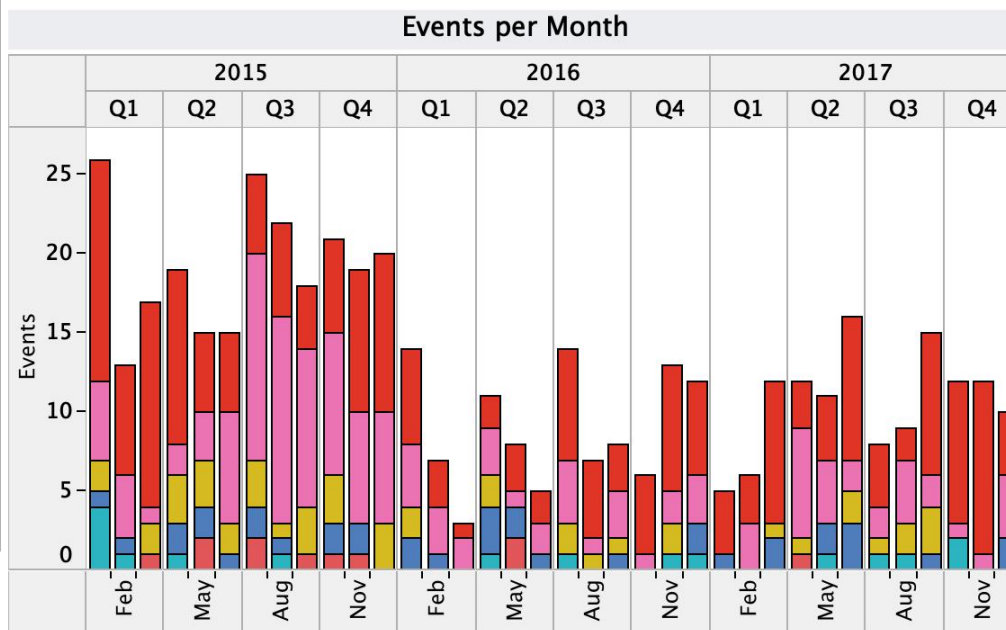
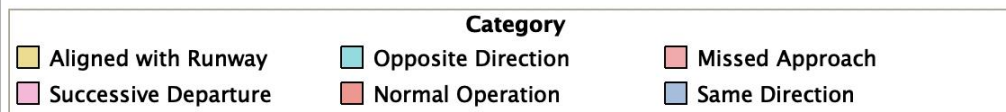
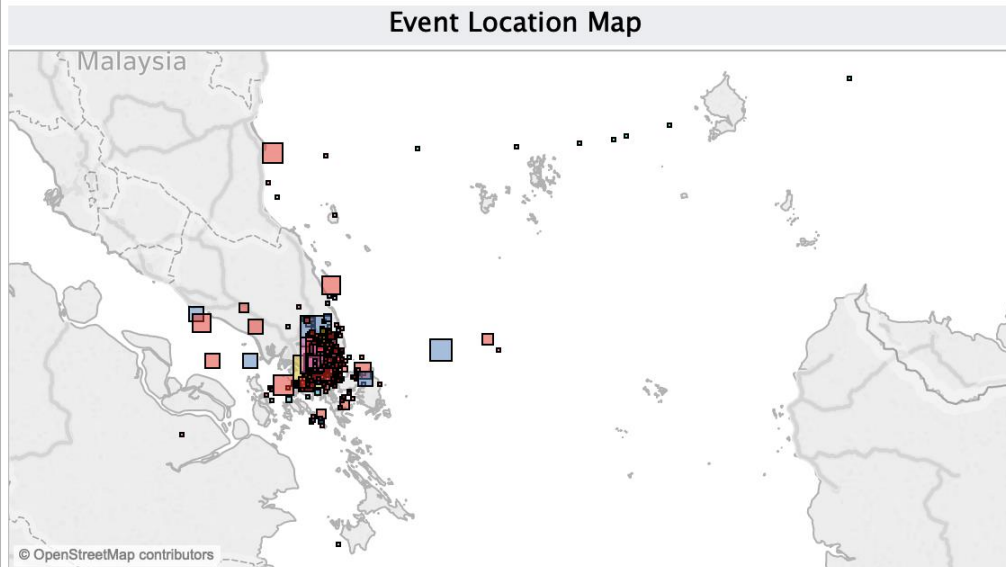
Aircraft Type 1
(All)

Aircraft Type 2
(All)

Callsign 1
(All)

Callsign 2
(All)

Number of Events
466



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2019: 100% Global

