



Space-based data for flight tracking

Aireon's Unique Capabilities

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Director of Business Development and Sales
Commercial Data Services

2nd April 2025
Aerospace Tech Week, Munich

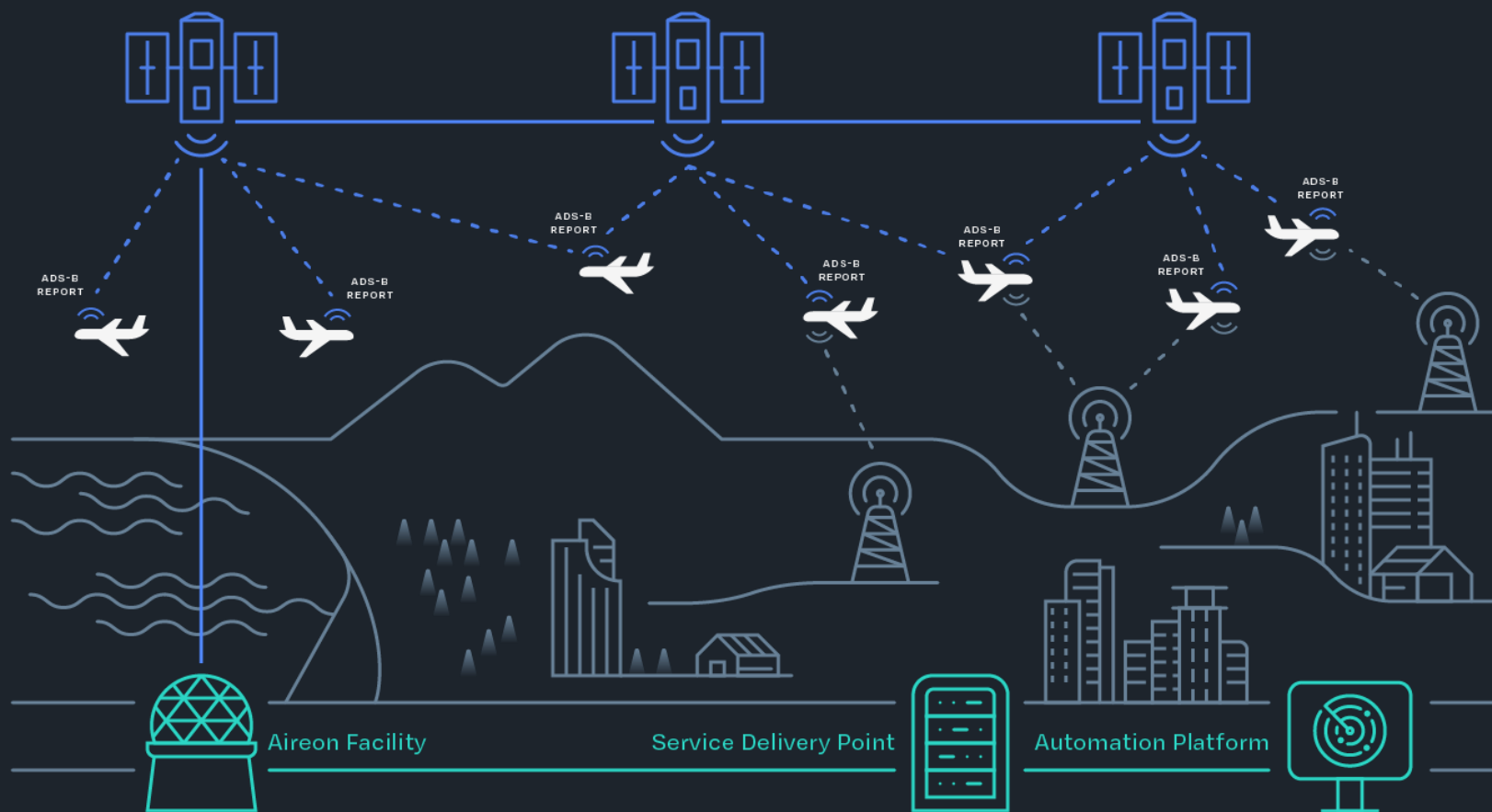


What is space-based data for flight tracking?



Space-based detection of ADS-B Data

Iridium Next satellites equipped with ADS-B receiver 1090ES



- **ADS-B = Automatic Dependent Surveillance - Broadcast**
- **Signal broadcast twice per second from all ADS-B equipped aircraft**
- **Mandated for most commercial operations around the world**
- **Transmits on the 1090 MHz frequency; requires line of sight detection**
- **Space-based receivers remove topographic or geographic interference giving pole to pole coverage**



ADS-B receivers on the Iridium NEXT Satellite Constellation



Aireon's ADS-B receivers are hosted on the Iridium NEXT constellation.
66 satellites distributed in six polar orbital planes
(+14 in-orbit 'spare' satellites)

Each **Hosted Payload (HPL)** receives, demodulates, and transfers ADS-B messages from each 1090 MHz equipped aircraft to the Ground.

A professional, robust
ADS-B receiver network, EASA
certified for safety of life operations.



Who is Aireon?



Aireon is the world's leading provider of space-based automatic dependent-surveillance broadcast (ADS-B) data to the global aviation community



Headquarters

McLean, Virginia
USA

Global Locations

Belgium, South
Africa, Switzerland,
Spain, New Zealand,
Singapore, Sweden,
Greece, Canada

Employees

140+

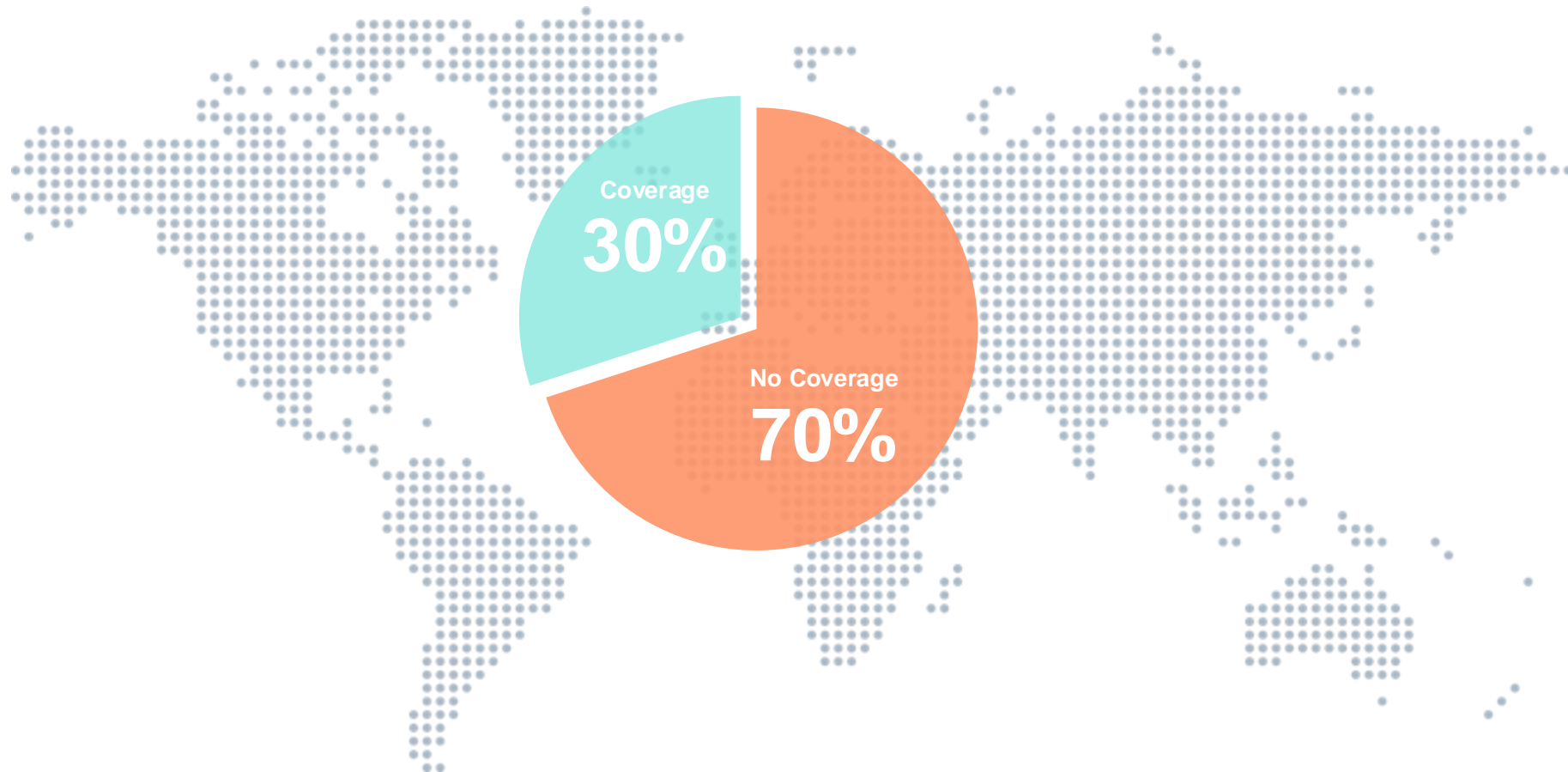


PROPRIETARY INFORMATION, © AIREON LLC

Best-in-Class aerospace investors



Prior to Aireon, much of the globe was not surveilled



A quick history of Aireon

2011

Aireon created

World's first service provider of global, real-time air traffic surveillance, regardless of location



January 2019

Iridium Constellation completed

Cutting-edge constellation with Aireon's ADS-B receivers on each satellite



April 2019

All Payloads in Orbit and Operational

All 66 Aireon ADS-B payloads active and operational



2020

Commercial Data Services introduced

Leveraging the same trusted data stream, Aireon launched AireonSTREAM™, AireonINSIGHTS™, and AireonFLOW™, designed to bring new capabilities to the broader aviation community



Today

Globally Established ATS & CDS Provider

More than 20 ANSPs representing >40 countries, and multiple Airlines around the world use Aireon ADS-B data to safely and efficiently manage their operations

New data capabilities introduced

Locate search & rescue tool
Safety Dashboard – RoRo, TCAS Advisories
GPS Interference monitoring
Turbulence Monitoring



Top Commercial Aviation Entities & ANSPs rely on Aireon



What can Aireon offer the Aviation Tech Community?



The Answer is our Data

Aireon can provide access to the only **air traffic surveillance-quality & EASA certified** aircraft position data in the world.



AireonSTREAM

Real time high-fidelity, low-latency, flight tracking feeds



AireonINSIGHTS

Historic ADS-B data and
Derived Flight Events Data.
Full Archive since Apr 2019.



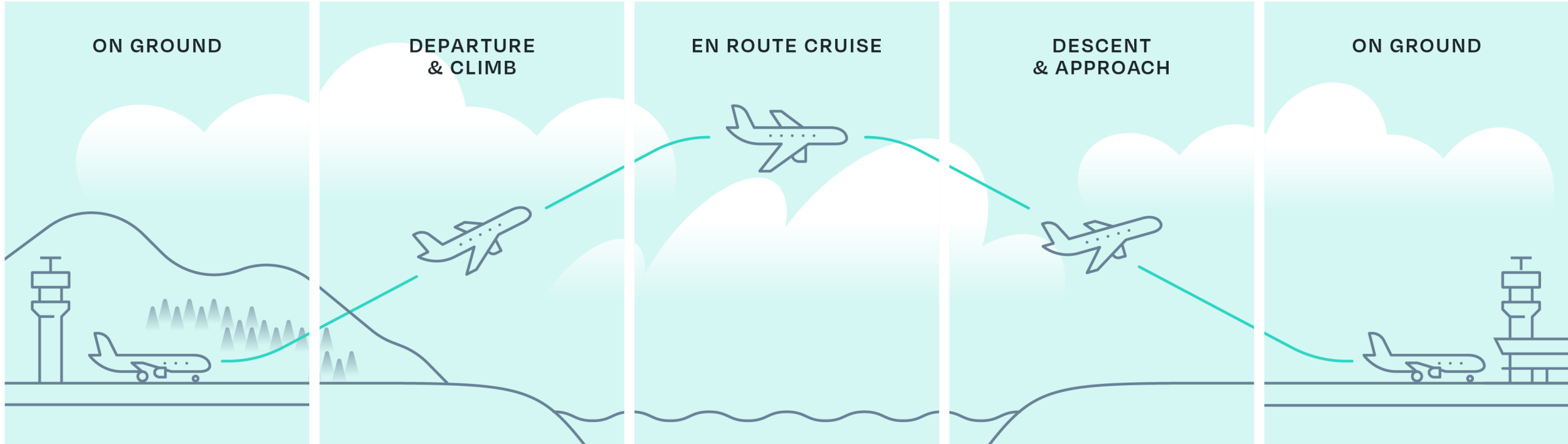
AireonVECTOR

A full suite of unique
capabilities to mitigate
against GPS Interference

Launching in 2025



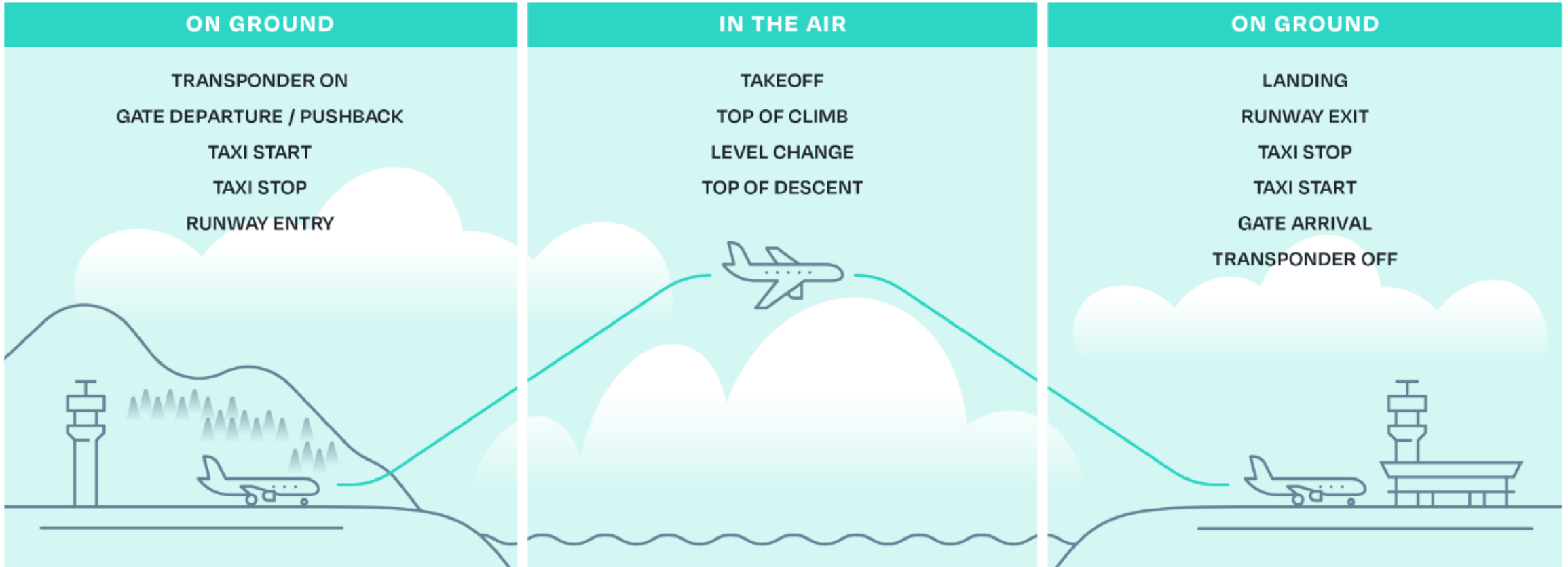
AireonSTREAM – Flight Positions



> 190k unique flights per day, > 600M ADS-B CAT021 messages



AireonINSIGHTS – Flight Events



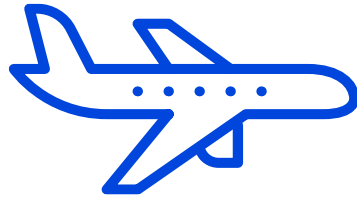
> 7.1M Flight Events per day, from Transponder On to Transponder Off



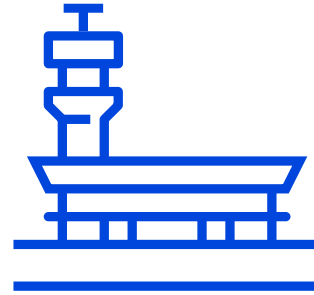
Delivering enhanced Safety, Efficiency and Environmental Benefits across the Industry



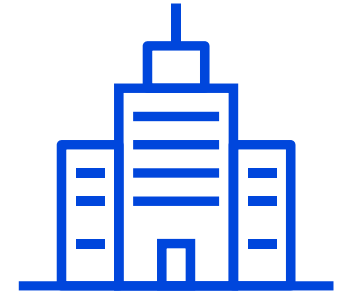
**Air Navigation Service
Providers (ANSP)**



**Airlines, Lessors and their
Solution Providers**



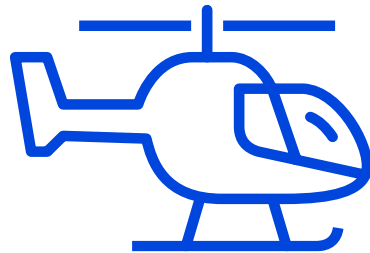
**Airports and their Solution
Providers**



**Financial institutions,
insurance providers**



**Aviation emissions and
efficiency analytics**



**Search & Rescue (SAR)
organizations**



**Maintenance, Repair &
Overhaul (MRO)**



**Unmanned Aircraft Systems
(UAV), Unmanned Traffic
Management (UTM)**



GNSS Interference

Aireon's Detection, Monitoring and Mitigation Capabilities



Intentional GNSS Interference: A threat to our aviation ecosystem

The Serious Threat Of GPS Spoofing: An Analysis

Patrick Veillette, Ph.D. October 09, 2023



Aircraft afflicted with GPS Spoofing have flown perilously close to the Iranian border without clearance to fly into Iran's airspace.

EASA partners with IATA to counter aviation safety threat from GNSS spoofing and jamming

26 Jan 2024 SUGGESTED



COLOGNE, January 26, 2024 - The European Union Aviation Safety Agency (EASA) and the International Air Transport Association (IATA) announced the conclusions of a [workshop](#) jointly hosted at EASA's headquarters to combat incidents of GNSS spoofing and jamming.

The workshop's high-level conclusion was that interference with satellite-based services that provide information on the precise position of an aircraft can pose significant challenges to aviation safety. Mitigating these risks requires short-, medium- and long-term measures, beginning with the sharing of incident information and remedies.

Increasing GNSS interference: UK and EU warn aviation

April 11, 2023 - By Dana Goward Est. reading time: 2:30



Image: Chalabala/iStock/Getty Images Plus/Getty Images

GPS interference now a major flight safety concern for airline industry

You're wrong to think that jammin' was a thing of the past


By Dan Robinson Mon 29 Jan 2024 / 13:26 UTC

Europe's aviation safety body is working with the airline industry to counter a danger posed by interference with GPS signals - now seen as a growing threat to the safety of air travel.

GPS Spoofing in the Middle East Is Now Capturing Avionics

Eric Tegler Contributor Follow

Dec 5, 2023, 09:15am EST




Avionics like those equipping Bombardier's Global 7500 business jet and other commercial aircraft ... [+] BOMBARDIER

"What we've seen since late September," University of Texas

Finnair cancels flights amid increased GNSS jamming

May 7, 2024 - By Jesse Khalil





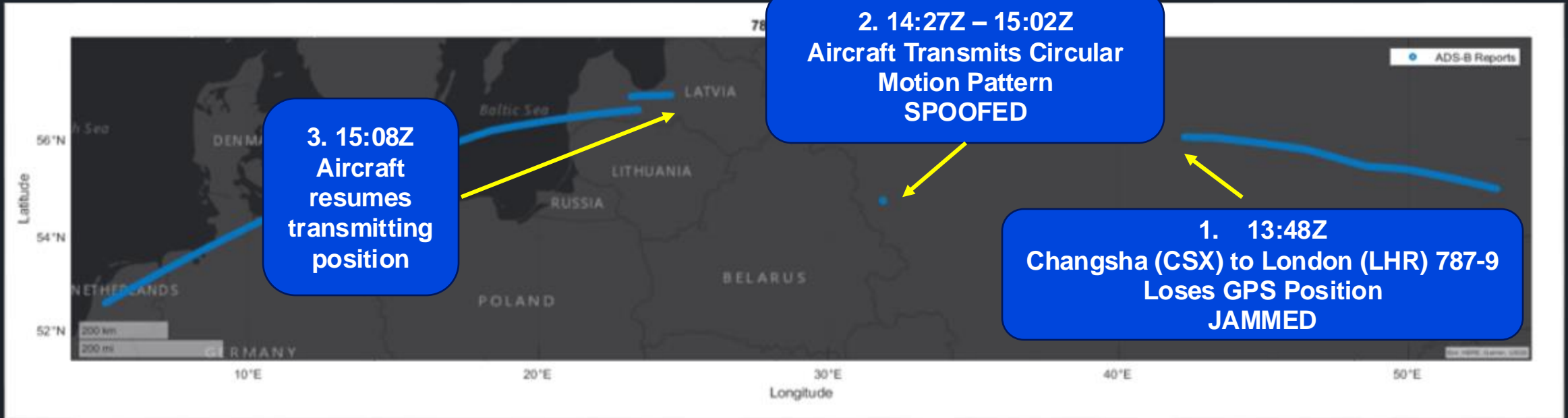
GNSS Interference: Jamming vs Spoofing

GPS Jamming

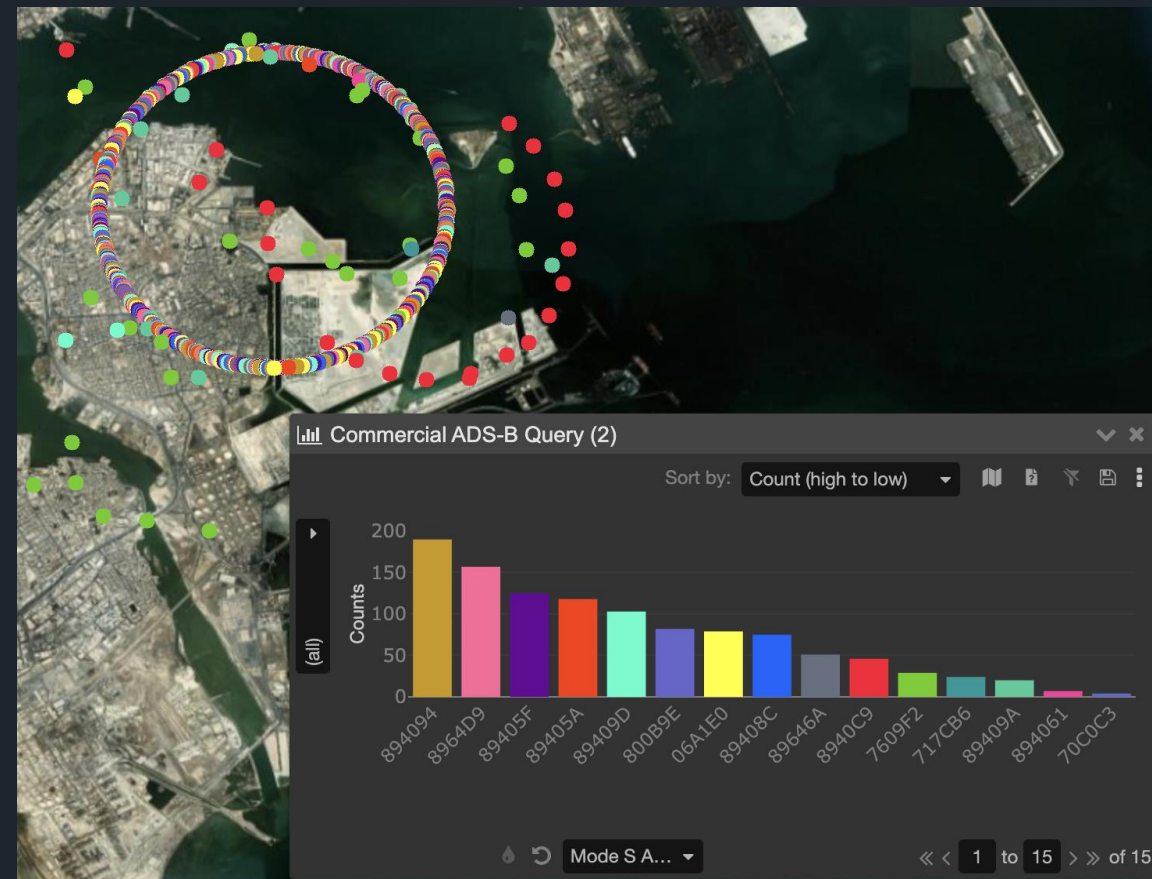
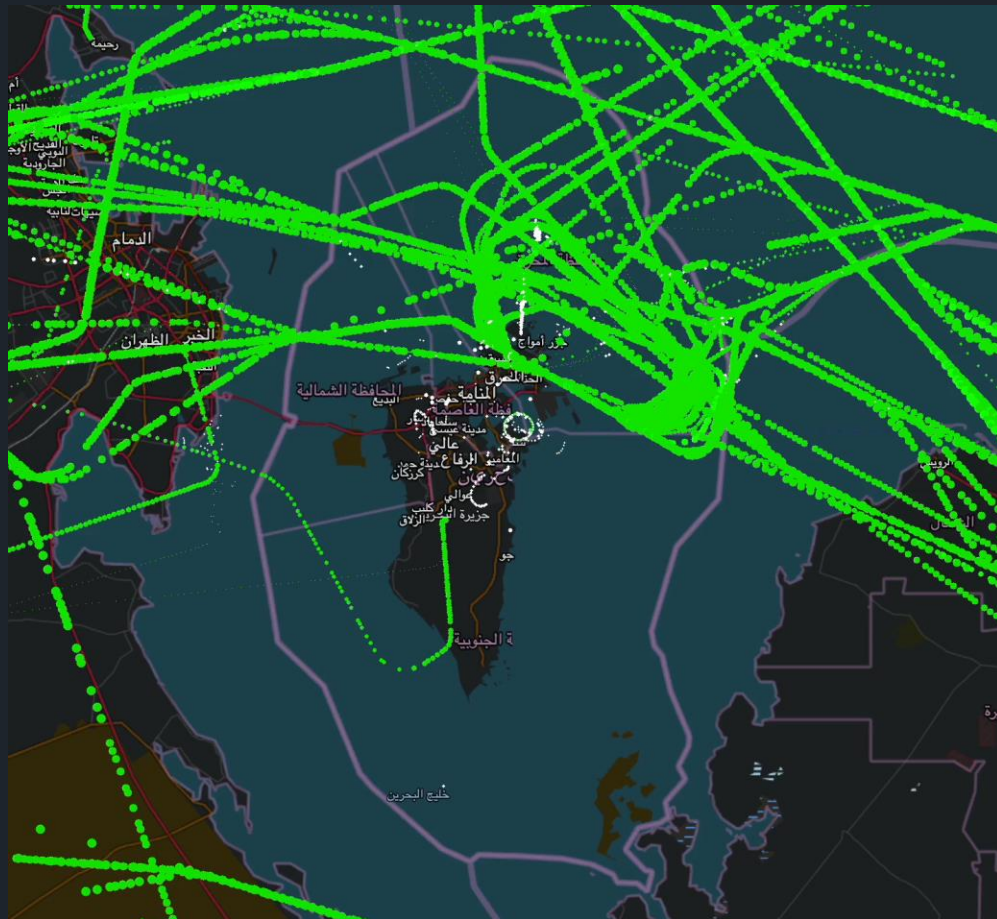
The intentional interference of GPS signals to degrade or block position accuracy

GPS Spoofing

The transmission of false GPS signals to deceive receivers into calculating incorrect positions



GNSS Interference: Typical Spoofing Indicators



Detecting GNSS Interference

1. Error Trending of Position Integrity Category (PIC) values.

An industry standard for measuring interference and possible jamming based on the positional containment value.

TARGET DETAILS X

✈️	AIRCRAFT ID ANA398	ICAO 84B794
	LATITUDE 38.6894	LONGITUDE 139.9290
	FLIGHT LEVEL FL97	GEO ALTITUDE 9,675 ft
	SELECTED ALTITUDE 28,000 ft	GROUND SPEED 315 kts
📡	MODE 3/A CODE 1752	LINK VERSION ED-102A/DO-260B
📡	ADDRESS TYPE ICAO	REPORT TYPE Target Transponder
	RANGE CHECK Default	POSITION INTEGRITY CATEGORY 11
🚨	EMERGENCY No Emergency / Not Reported	SURVEILLANCE STATUS No Condition Reported

For the value of "PIC", the following conversion table shall be used:

PIC	Integrity Containment Bound	NUCp ED102/DO260	NIC (+ suppl.) DO260A	NIC (+ suppl.'s) Version 2 or higher		
				NIC	A/B	A/C
15	not defined					
14	< 0.004 NM	9	11	11	-	-
13	< 0.013 NM	8	10	10	-	-
12	< 0.04 NM		9	9	-	-
11	< 0.1 NM	7	8	8	-	-
10	< 0.2 NM	6	7	7	-	-
9	< 0.3 NM	-	-	6	0/1	1/0
8	< 0.5 NM	5	6 (+ 0)	6	0/0	-
7	< 0.6 NM	-	6 (+ 1)	6	1/1	0/1
6	< 1.0 NM	4	5	5	-	-
5	< 2.0 NM	3	4	4	-	-
4	< 4.0 NM	-	3	3	-	-
3	< 8.0 NM	-	2	2	-	-
2	< 10.0 NM	2	-	-	-	-
1	< 20.0 NM	1	1	1	-	-
0	No integrity (or > 20.0 NM)	0	0	0	-	-

2. Trending of Aireon Independent Position Check (IPC) values

A unique to Aireon attribute, possible only with Aireon's global satellite network. IATA Approved even for ATS.

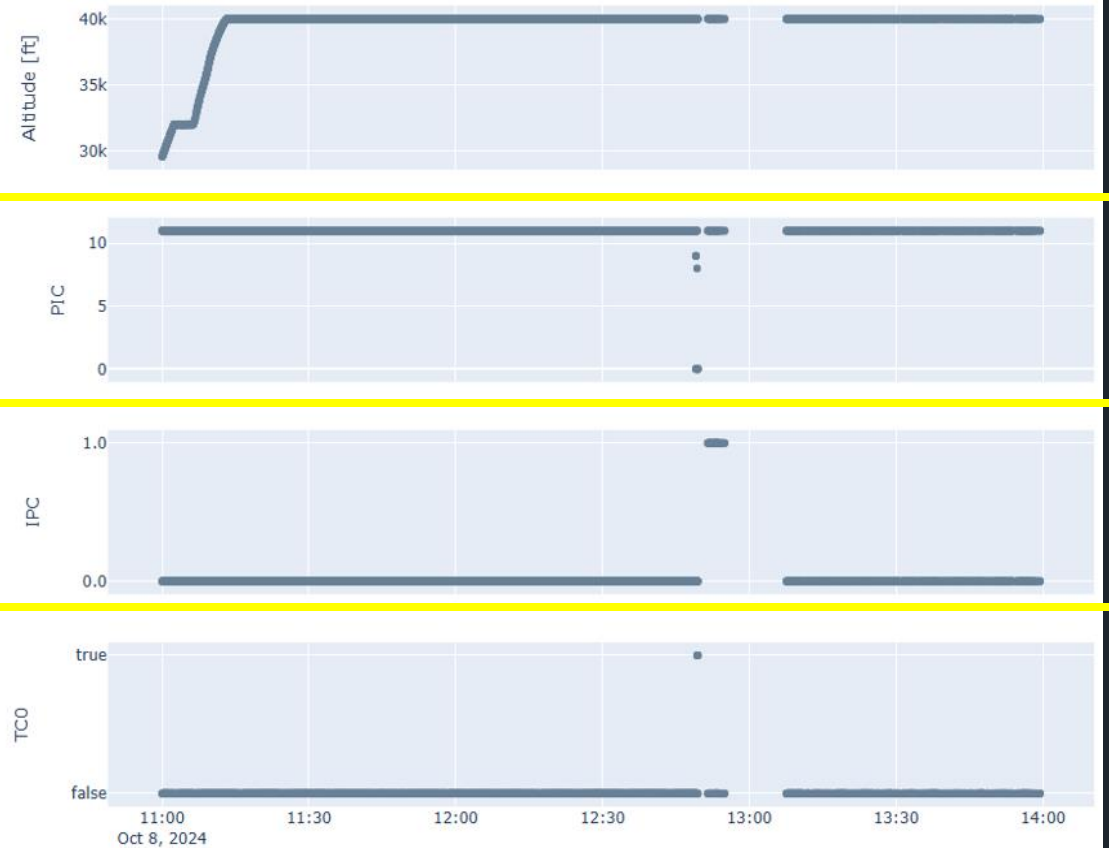


Using Iridium Satellite positioning and Time Difference of Arrival (TDOA) Geolocations, Aireon is able to not only independantly validate the integrity of GPS Positions to flag unrealistic reports, but also **calculate the location of aircraft without relying on GPS lat/long data.**

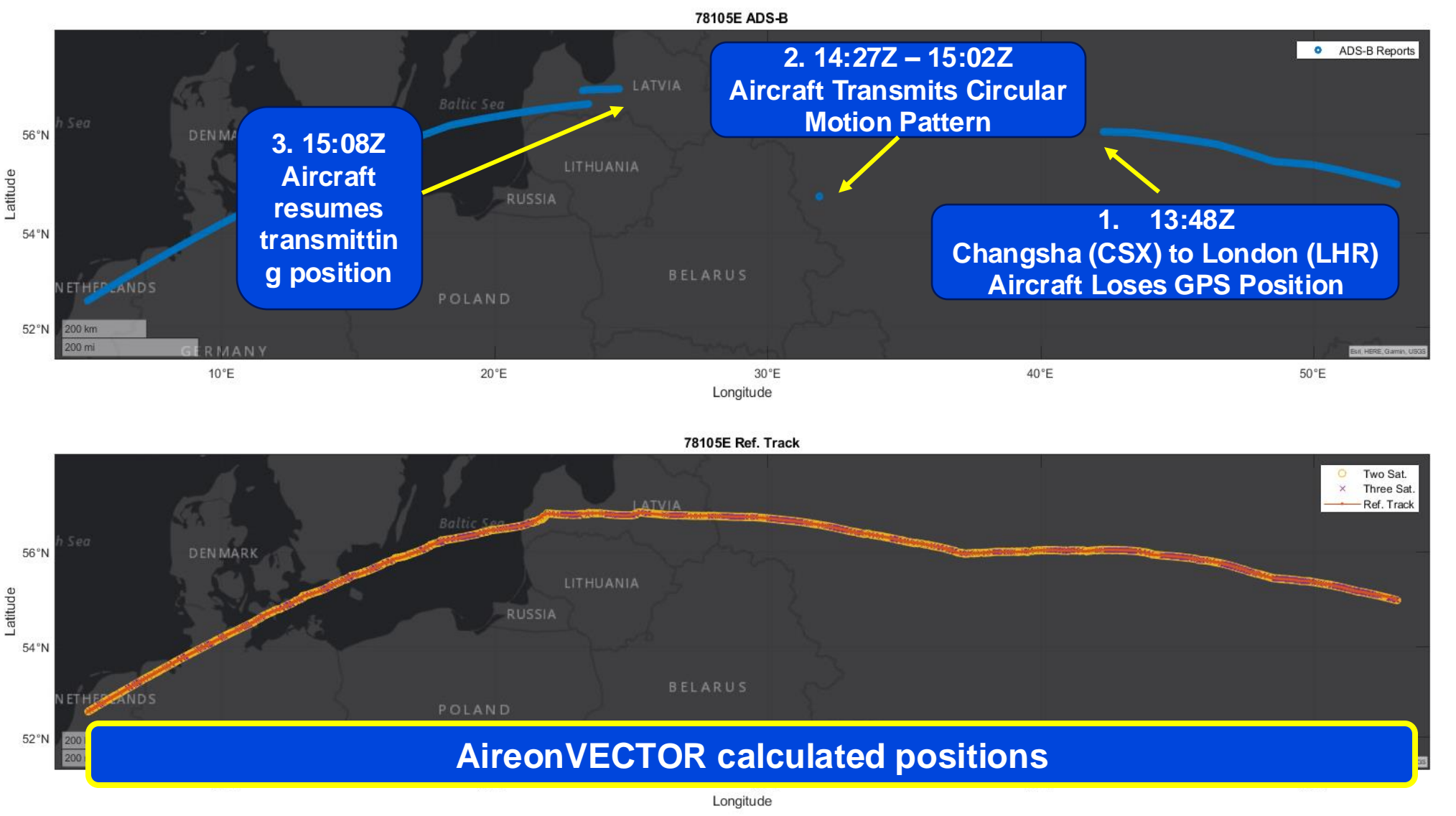


GNSS Interference: The Signals

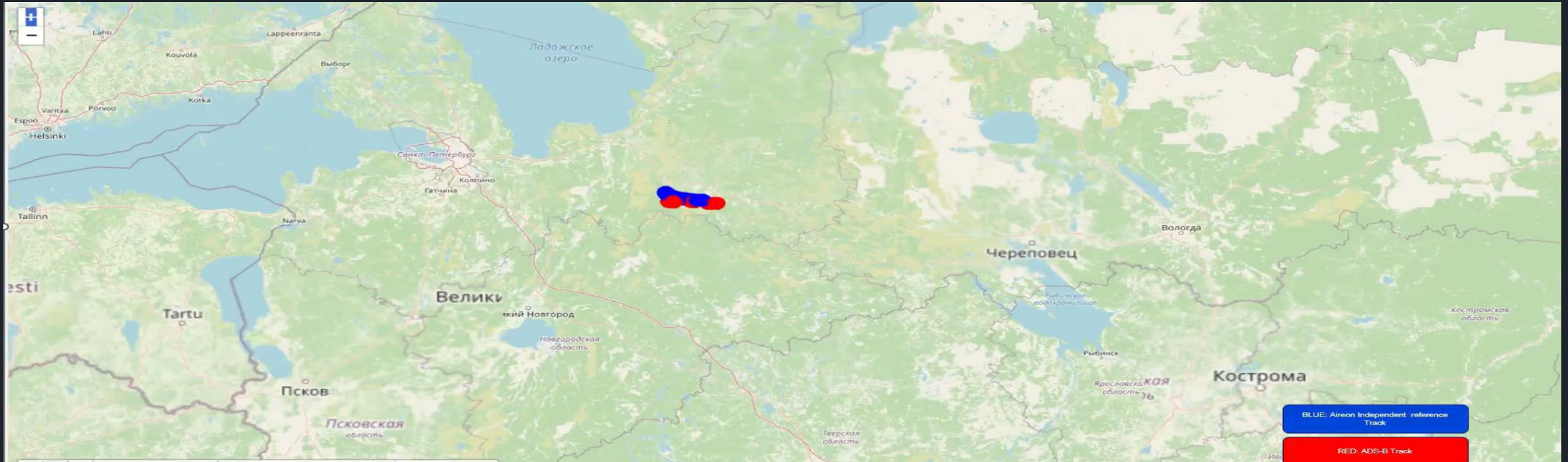
Target address: 06A0AA - Flight ID: QTR24N



GNSS Interference: Real Time Mitigation of Jamming & Spoofing



GNSS Interference: Real Time Mitigation via AireonVECTOR

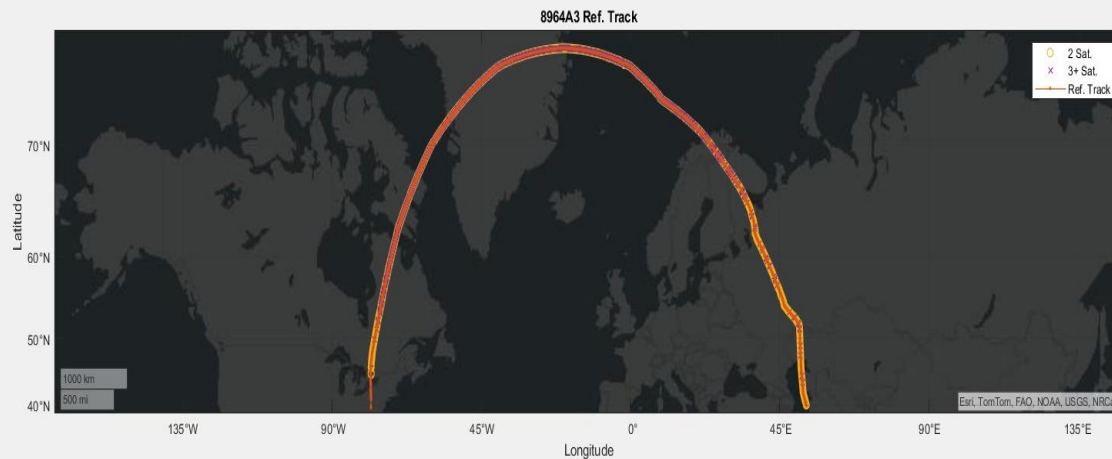


Aireon's space-based technology allows for the calculation of live aircraft positions in times of interference providing a resilient source of flight tracking, despite degraded GPS Integrity.



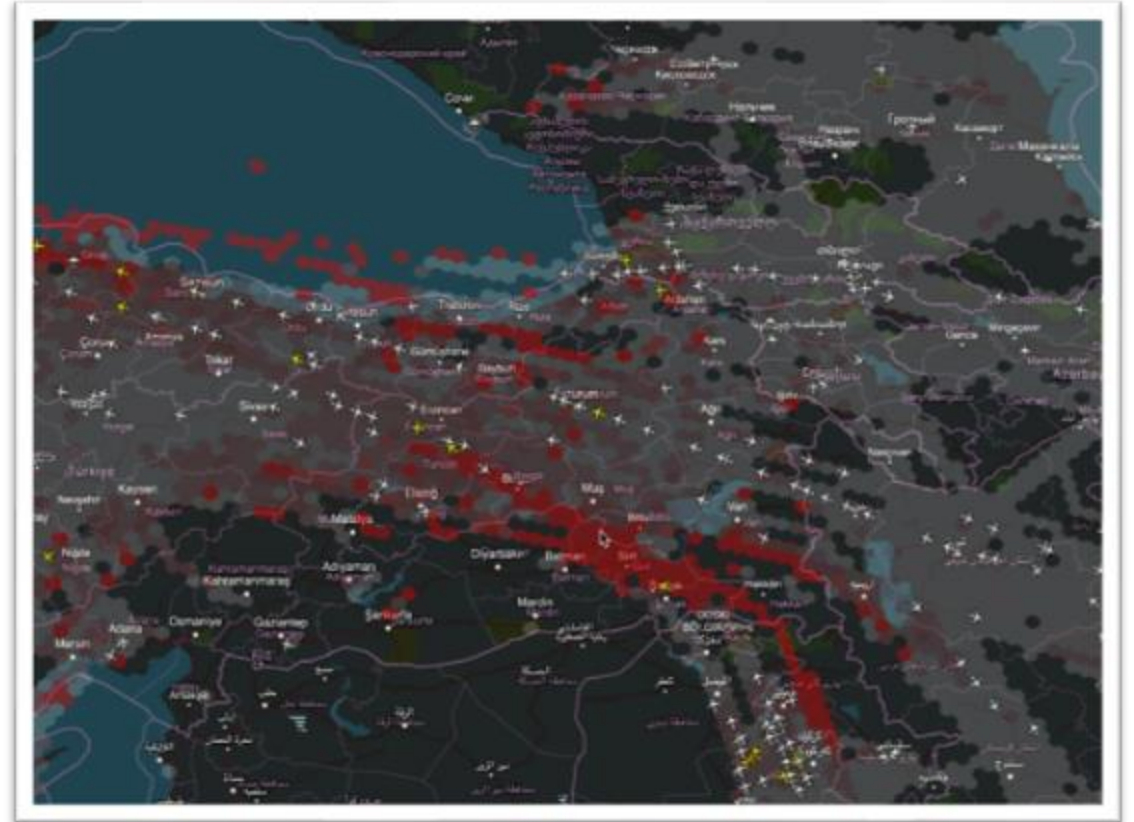
GNSS Interference: Global Mitigation via AireonVECTOR

Due to Aireon's global receiver network, true positions can be calculated pole to pole.



AireonVECTOR Product Suite

- ✓ Map layers of global GPS interference, updated in near real time.
- ✓ Live GPS interference event notifications
- ✓ Global data feeds with ADS-B position accuracy and validity markers
- ✓ Aircraft position feeds independent of GPS
- ✓ GPS Interference Dashboards




Launching Q2 2025 through Q1 2026



Would you like to learn more?

→ Visit us at Booth K21.

WHITE PAPER

MAY 2024

Dr. Michael Garcia Chief Innovation Scientist
John Dolan Director, Modeling & Analysis/Data Science
Dr. Giuseppe Sirigu Principal Data Scientist


GPS interference and spoofing in the Baltics

Air Navigation Service Providers (ANSP) and aircraft operators rely on the integrity of the GPS signal to navigate the aircraft to its destination. Increasingly, however, the integrity of the GPS signal has become a target for interference—via nefarious actions like spoofing or jamming, or non-intentional actions like malfunctioning avionics. This trend has prompted many in the aviation industry to seek creative, technological redundancies to the GPS signal to ensure the aircraft is able to continue operating safely in the event of an interference.


Using its one-of-kind, space-based automatic surveillance broadcast (ADS-B) data, Aireon has developed a proof-of-concept multilateration solution that allows for independent position determination of ADS-B-equipped aircraft. This solution will allow Aireon to continue tracking aircraft even when they are unable to broadcast their GPS position using only their transmitted 24-bit aircraft address and the time of reception at the Aireon Hosted Payloads onboard the Iridium satellites.

This is done through a Satellite Wide Area Multilateration (SWAM) application that uses Time Difference of Arrival (TDOA) measurements from simultaneous detection of ADS-B transmissions on multiple payloads.

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NATIONAL SECURITY

Enhanced air domain awareness for the national security community



Key attributes for national security applications

- ▶ **Global:** Coverage from floor to 127,600 feet
- ▶ **Persistent:** 1-8 second update interval
- ▶ **Low latency:** normally < 2 seconds
- ▶ **High availability:** > 99.0% end-to-end system
- ▶ **Resilient:** Overlapping coverage and on-orbit spares
- ▶ **Enduring:** Historical data set from 2019
- ▶ **Focused:** RF spectrum coverage (1080MHz)
- ▶ **Trusted:** Architecture includes encryption and cyber-spoofing detection capabilities
- ▶ **Shareable:** Commercially available data is easily shared with coalition partners
- ▶ **Accessible:** Distributable from Gov Cloud planned in 2024
- ▶ **Valid:** Independent verification and validation of positional data

The National Security Community relies on surveillance and intelligence sources that can be trusted, accessed in real time, and analyzed to deliver critical insights and improve decision making. Aireon controls all methods and means of its space-based surveillance, encrypting data from collection to distribution, to ensure its validity.

Aireon's Automatic Dependent Surveillance-Broadcast (ADS-B) service delivers mission-critical, aircraft-derived information—including identity, GPS position, altitude and more. Collected by payloads hosted on the Iridium satellite constellation and delivered in real-time, it provides your surveillance and intelligence operations with an unprecedented layer of reliability, security, and flexibility, anywhere on the globe.

Since becoming operational in 2019, the Aireon system has generated an archive of location and position data of all ADS-B-equipped aircraft worldwide. Scalable to any need, Aireon's data-as-a-service subscription offerings include real-time reporting to enhance track quality, custody, and identification; while improving anomaly detection with historical data sets available to assist pattern-of-life analysis.

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WHITE PAPER

OCTOBER 2023

John Dolan Director, Modeling & Analysis/Data Science
Mike Garcia Chief Innovation Scientist
Giuseppe Sirigu Principal Data Scientist

Space-based ADS-B for GPS-independent position validation

Aircraft operators, Air Navigation Service Providers (ANSP), air traffic control organizations, and others rely heavily on data and associated systems to safely and efficiently operate and navigate aircraft throughout the airspace. From takeoff to touchdown and beyond, positional data is critical. But what happens when the systems fail? What if the GPS data is somehow compromised?

Aireon has developed a proof-of-concept multilateration solution that allows for independent position determination of ADS-B-equipped aircraft. This solution will allow Aireon to continue tracking aircraft even when they are unable to broadcast their GPS position using only their transmitted 24-bit aircraft address and the time of reception at the Aireon Hosted Payloads onboard the Iridium satellites.

This is done through a Satellite Wide Area Multilateration (SWAM) application that uses Time Difference of Arrival (TDOA) measurements from simultaneous detection of ADS-B transmissions on multiple payloads. This solution leverages traditional multilateration techniques used by terrestrial systems but applied via satellite. This is possible due to both the Iridium constellation, with its significant overlapping satellite coverage, and Iridium's ability to accurately track the position and timing of each satellite (on the order of hundreds of nanoseconds), which is shared with Aireon.

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Whitepapers available at Aireon.com





Thank You

Aireon.com

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Backup slides



Space-based vs Terrestrial ADS-B

- **Coverage:** Aireon is the only ADS-B data provider worldwide to guarantee and deliver 100% global coverage. Terrestrial ADS-B data providers rely on 'line of sight' connections with the aircraft's ADS-B transponder via the 1090 MHz frequency. Coverage over oceans or remote regions is not possible. On-ground, full coverage across runways and aprons requires extensive installation and maintenance of multiple receivers.
- **100% Ownership:** Aireon tracks flights via a permanent, professionally maintained constellation of hosted payloads (HPLs) on the Iridium Next satellite constellation, whereas terrestrial networks crowd source from private hosts of ground receivers.
- **Professional Monitoring & Service:** Aireon's data is monitored 24/7/365 and offers uptimes over 99.9%.
- **Certification:** Aireon is the only flight data provider worldwide that can offer data and systems that are EASA certified.
- **ATC Grade Quality & Reliability:** Aireon is trusted to provide ATM surveillance data for **>50%** of the world's airspace.



AireonSTREAM + GPS

- Live Aircraft Position stream
 - Built from ADS-B Messages
 - Global Coverage
 - Customizable Data
 - Easy to integrate into Flight Tracking Software
- Additional GPS data
 - NIC – Navigational Integrity Category
 - NUCp/r – Navigation Uncertainty for Position/Velocity
 - NACv – Navigation Accuracy for Velocity
 - PIC – Position Integrity Category
 - IPV – Aireon Independent Position Validation Check
 - Baro/Geo Altitude Integrity Category



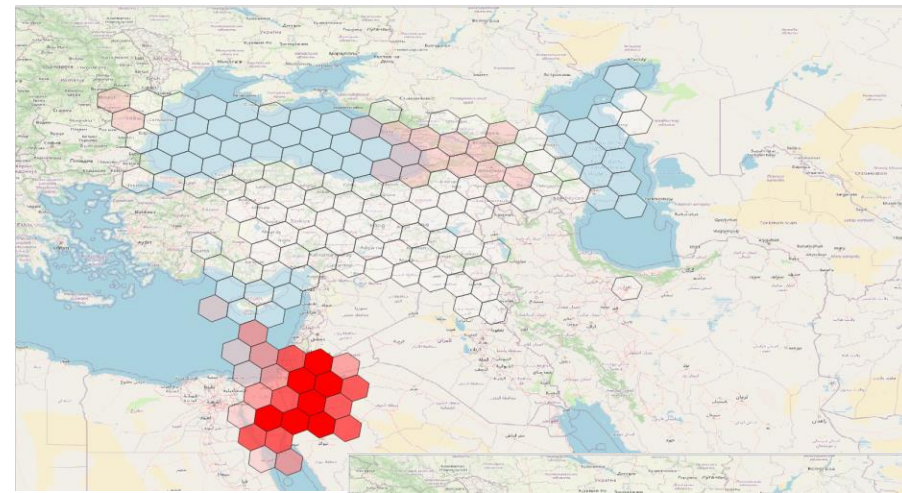
Live Event Types

Spooing	Interference / Jamming	Proximity	Geospatial	Pattern Detection
<ul style="list-style-type: none">• Duplicate ID (Hex/Call)• High Position Confidence – Independent Position Check Fails• Erratic Position Shift• @Altitude/Low Velocity• Spoofing Patterns (e.g. Crop Circles)	<ul style="list-style-type: none">• Low Position Confidence• Low Position Confidence + IPC	<ul style="list-style-type: none">• Location/Altitude• To Aircraft	<ul style="list-style-type: none">• Enter/Exit Geofence• Dynamic Area<ul style="list-style-type: none">• Within area around aircraft location	<ul style="list-style-type: none">• Holding• Circles• Custom



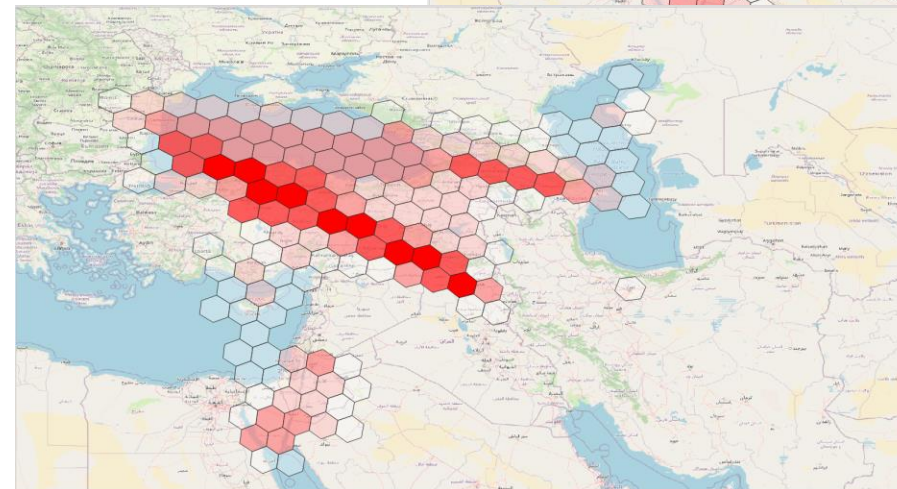
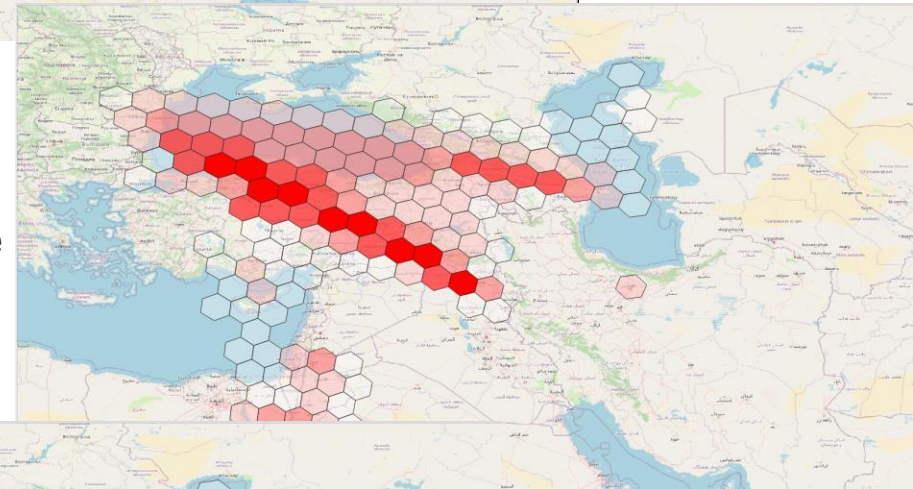
GPS Interference Map

- Heat Map delivered in geoJSON
 - Spoofing (IPC Flagging)
 - Interference (Low PIC values)
 - No Location Report (FTC0)
- Hourly update every 2 hours
 - H3 ID
 - Polygons of the H3
 - Center Point of H3
 - Total Count of Events (Tails Impacted)
 - Ratio of Events to Total Tails
 - Total Tails
 - Delta Events from the previous hour.



Spoofing

Interference

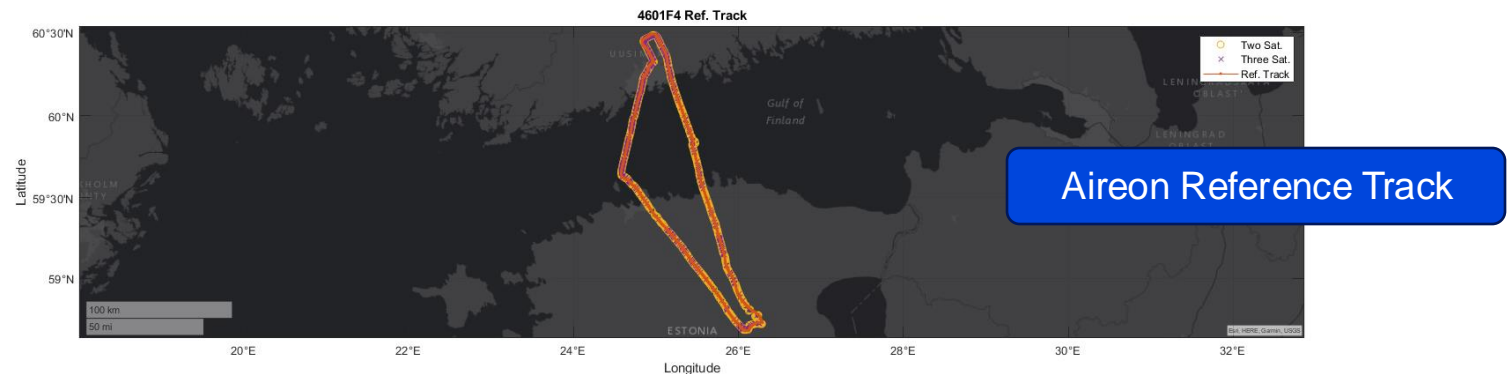
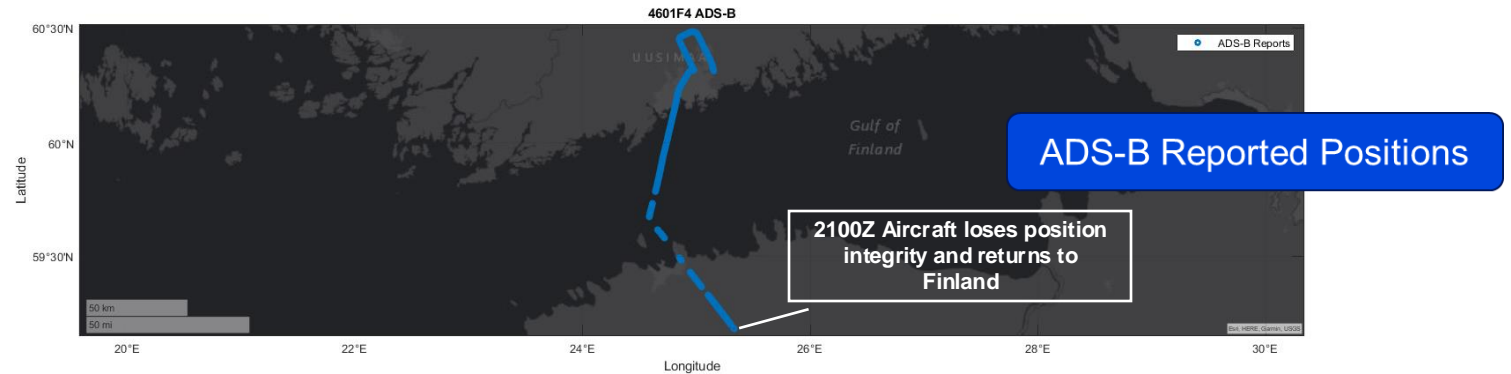


No Location



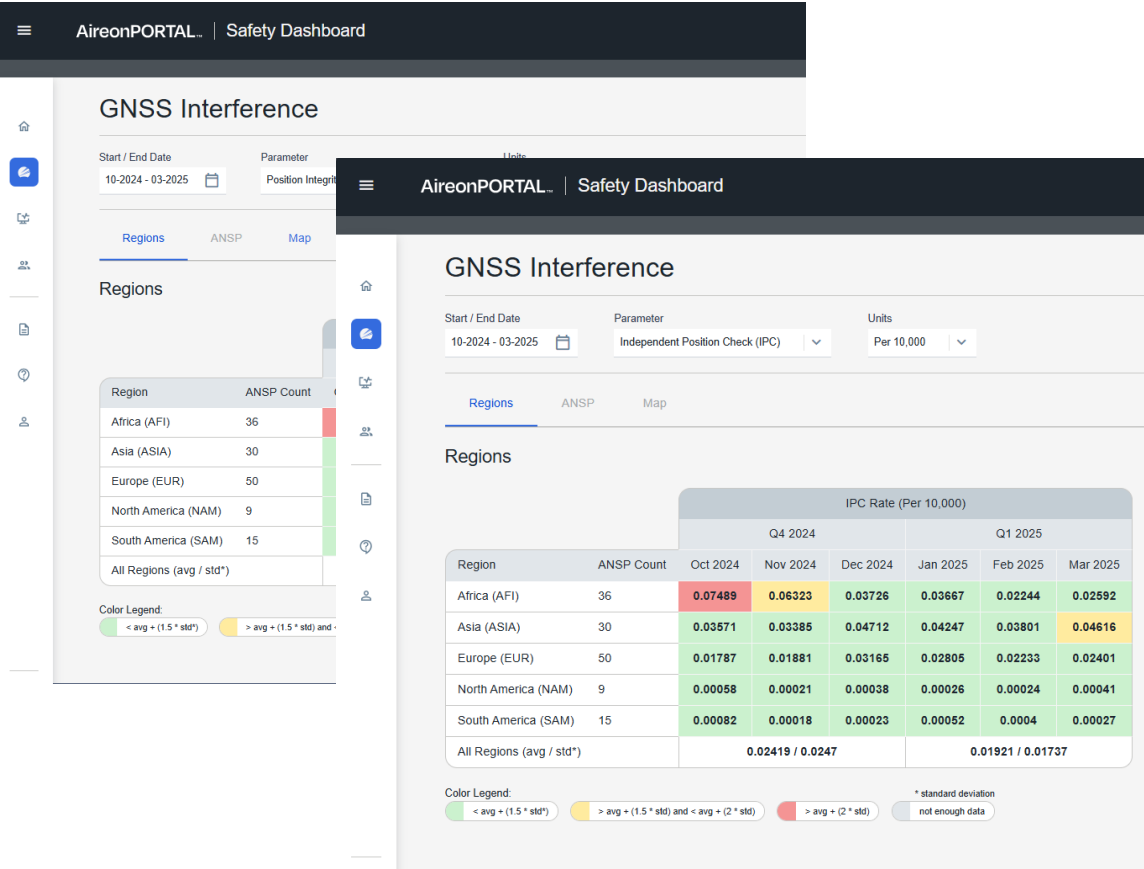
Derive Track Positions

- Independent Track delivered with AireonSTREAM
- Includes
 - Identifier
 - Position
 - Velocity
 - Altitude
 - Heading
 - Quality Indicator



GPS Dashboard

- AireonPortal
 - Summarized Reports on GPS events
 - Safety and ANSP focused
- Roadmap Plans to expand to support Airlines and other use cases



How does Aireon data benefit our Industry?



Benefits of Space-Based ADS-B

Efficiency

Aireon data allows customers and end users to plan and fly more optimal routes, which creates consumer value in the form of lower prices.



Safety

Aireon service provides enhanced operational safety for 100% of ADS-B-equipped aircraft in real-time, around the world, pole-to-pole.



Environment

Optimized routes means lower fuel burn, which lowers aviation's impact on the environment.



Key points to speak about

- Prior to GPS being a problem we were validating the positions
- Now we are leveraging this capability to produce a true path
- Not just a flag of it being a bad position, but a measure of it's calculated position
- End goal is to provide separation quality with our derived track
- Striving for multilateration from space
- No isolated areas where coverage is good – we can do this globally.
- **We do this in real time – not locally, and not delayed.**



Professional proof

- Foreflight
- SITA via channel partners
- Cirium
- Intelligence market and agencies – chosen and trusted.

