

# ICAO EUR/MID Radio Navigation Symposium

## Vision for PNT Resiliency

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## **GNSS remains a critical enabler for:**

- Performance Based Navigation standard terminal arrival procedures with optimized profile descents
- Established on Required Navigation Performance
- Time Based Flow Management's en route departure capability & integrated departure/arrival capability
- Simultaneous converging instrument approaches
- Controller pilot data link communications (DataCom)

**Transit to Space**

**Higher Airspace Services**

**Air Traffic Separation Services**

**Advanced Air Mobility Services**

**Unmanned Air Traffic Services**



# In the News

**TECHSPOT**

TRENDING FEATURES REVIEWS THE BEST DOWNLOADS PRODUCT FINDER FORUMS JOBS

SECURITY AIRCRAFT SPOOFING

## Aircraft GPS spoofing problem grows as aviation industry fails to agree on a solution

Better training for pilots could be the only near-term answer

By Rob Thubron January 29, 2024 at 5:20 AM



**WSJ PRO CYBERSECURITY**

WSJ PRO

## Aviation Industry to Tackle GPS Security Concerns

Airlines report an increase in tampering with GPS signals, especially around conflict zones

By Catherine Stupp

Feb 1, 2024 5:30 am ET | WSJ PRO

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# Safety Alert for Operators

SAFO# 24002, 25 Jan 2024

*Recognizing and Mitigating Global Positioning System (GPS) / Global Navigation Satellite System (GNSS) Disruptions*

[https://www.faa.gov/other\\_visit/aviation\\_industry/airline\\_operators/airline\\_safety/safo/all\\_safos](https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos)

*Increased safety of flight risks due to possible loss of situational awareness and increased pilot and ATC workload*

*Operators should plan to use conventional Navigational Aids (NAVAIDs) in these locations*

*FAA recommends that each operator follow detailed guidance from their respective OEM*

*Indications of disruption may include . . .*

*Promptly report disruption to ATC, followed by a detailed written report post flight at: [GPS Anomaly](#) and through normal safety channels when safety effects are encountered.*



U.S. Department  
of Transportation  
Federal Aviation  
Administration

[http://www.faa.gov/other\\_visit/aviation\\_industry/airline\\_operators/airline\\_safety/safo/all\\_safos](http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos)

*A SAFO contains important safety information and may include recommended action. Besides the specific action recommended in a SAFO, an alternative action may be as effective in addressing the safety issue named in the SAFO. The contents of this document do not have the force and effect of law and are not meant to bind the public in any way. This document is intended only to provide clarity to the public regarding existing requirements under the law or agency policies.*

**Subject:** Recognizing and Mitigating Global Positioning System (GPS) / Global Navigation Satellite System (GNSS) Disruptions.

**Purpose:** This SAFO provides information and guidance to operators and manufacturers regarding operations in a GPS/GNSS disrupted environment.

**Background:** Recent GPS/GNSS jamming and spoofing activities reported by civil air operators operating globally pose a potential safety of flight risk to civil aviation. GPS/GNSS disruptions often occur in and around conflict zones, military operations areas, and areas of counter unmanned aircraft systems (UAS) protection. The term GNSS includes satellite augmentation systems.

The recent jamming and spoofing incidents may pose increased safety of flight risks due to possible loss of situational awareness and increased pilot and regional Air Traffic Control (ATC) workload issues. Due to the increasing frequency of GPS/GNSS disruptions, the Federal Aviation Administration (FAA) recommends flightcrews put additional emphasis on closely monitoring aircraft equipment performance for any discrepancies or anomalies, promptly informing ATC of any apparent GPS/GNSS degradation, and being prepared to operate without GPS/GNSS navigation systems.

**Discussion:** The effects of GPS/GNSS jamming and/or spoofing have been observed by crews in various phases of flight. In some cases, these effects led to re-routing or diversions, due to the inability to perform safe instrument procedures. The magnitude of the issues generated by these disruptions would depend upon the impacted area, the duration of the event, type of aircraft, type of avionics, and the phase of flight of the affected aircraft. To improve analysis and dissemination of these issues, the FAA stresses the need for "real time" pilot reporting to ATC and the use of the Pilot Reporting site, [Report a GPS Anomaly | Federal Aviation Administration](#), ([https://www.faa.gov/air\\_traffic/nas/gps\\_reports](https://www.faa.gov/air_traffic/nas/gps_reports)) for reporting of GPS/GNSS anomalies, to enable tracking and mitigation. Safety impacts should be reported through normal safety channels.

Aircraft operators should be aware of impacts to their specific aircraft systems identified by Original Equipment Manufacturers (OEMs). Manufacturers, operators, and ATC should be aware of the general impacts of GPS/GNSS interference, jamming, and spoofing, such as:

## SAFO

Safety Alert for Operators

SAFO 24002  
DATE: 01/25/24

Flight Standards Service  
Washington, DC

## 2014 FAA Guidance for Industry to address GNSS Misleading Position and Navigation Threats

- May 2014, FAA modified AC 20-138D *Airworthiness Approval of Positioning and Navigation Systems* and avionics standards to enable spoofing mitigations
  - Prescriptive Guidance mitigates spoofing as well as re-radiators

2014 FAA Aviation Circular (AC20-138D) as well as GPS, GBAS, & SBAS FAA Technical Order Standards and RTCA/EUROCAE MOPS state:

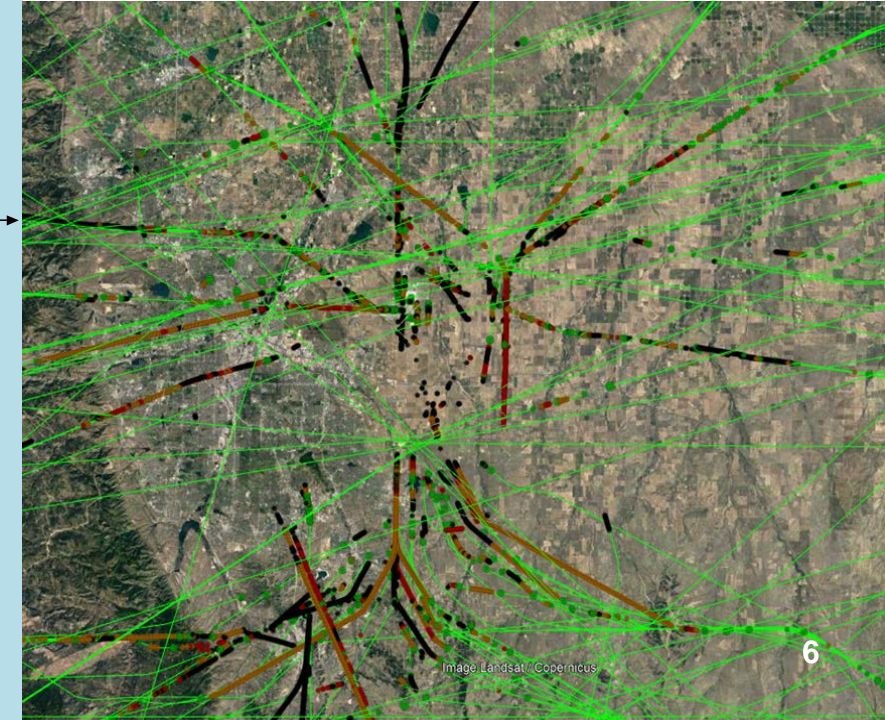
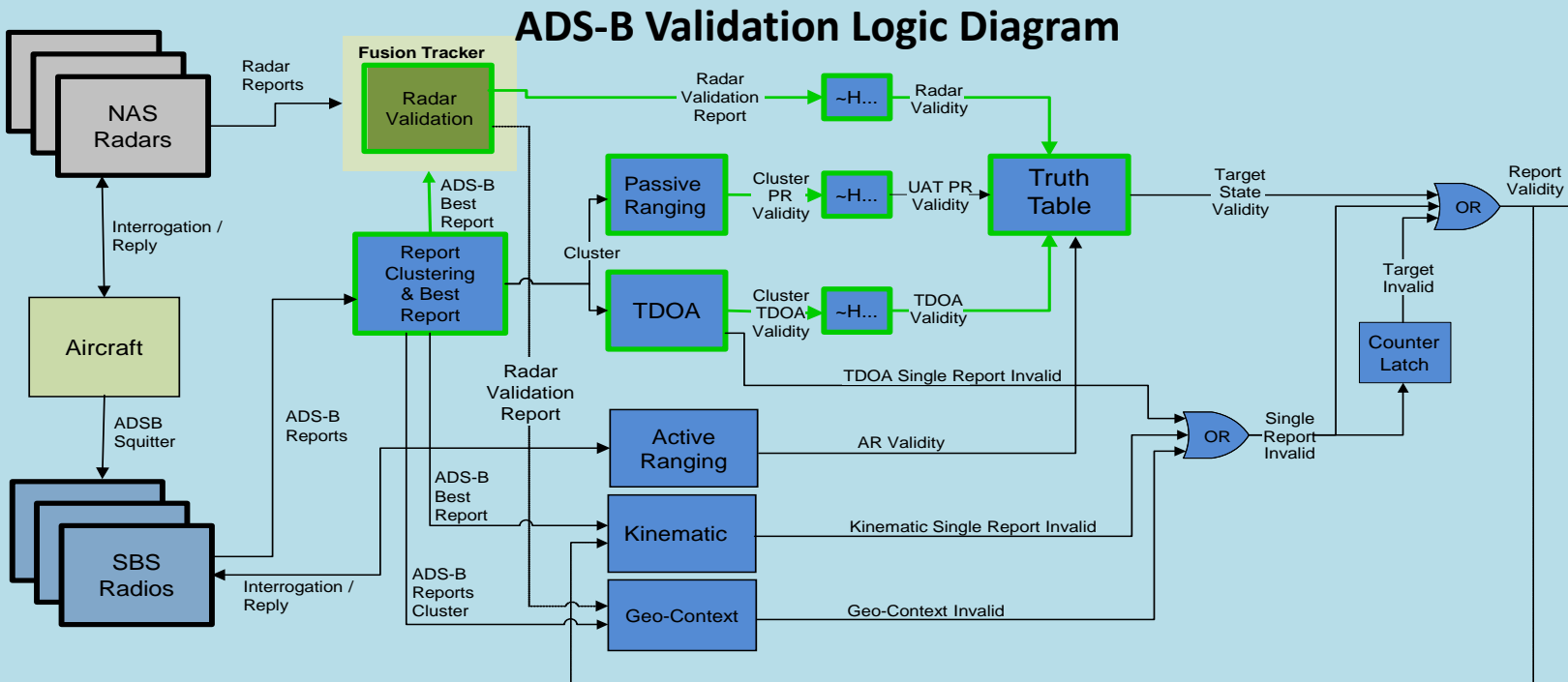
- *Improperly used or installed GNSS re-radiators can present misleading information to GNSS equipment*
- *Equipment manufacturers should consider measures to mitigate against use of erroneous data for GNSS position and navigation*
- *Possible measures to consider include implementing or enabling cross-checks of GNSS sensor data against independent position sources and/or use of other detection monitors using GNSS signal metrics or data*

# FAA ADS-B Validation Processes address Common-mode Dependences



## ADS-B reported position is compared with:

- **Time-Difference-of-Arrival (TDOA):** estimated position computed from multi-radio observation of ADS-B signals
- **Radar:** secondary and primary radar track position
- **Passive Ranging:** range determined from ground-based transceiver (GBT) using UAT ADS-B Out precise time
- **Kinematics:** estimates position based on velocity extrapolation of ADS-B position track
- **Geo-Context:** filters targets not detected by a required minimum number of GBTs in a defined airspace
- **Active Ranging:** target range from radar interrogation and reply sequence





## Communications are essential to Continuing Operational Safety



We need resilient, robust and responsible provision (and use) of positioning, navigation and timing (PNT) services to ensure aviation's continued provision of global economic and societal benefits

“Responsible use of PNT services” is the deliberate, risk-informed use of PNT services, including their acquisition, integration, and deployment, such that disruption or manipulation of PNT services minimally affects States' security, the global economy and aviation critical functions



## PNT Strategic Goals (Preliminary)

- Understand aviation GNSS equities and address risks to protect benefits
- Promote and manage coordinated, unified responses to GNSS disruptions
- Reduce operational impacts and maintain continuity of aircraft operations
- Provide ATC and operator shared situational awareness tools for GNSS disruptions and NAVAID services to enable continuity of operations
- Develop a strategy for complementary PNT (CPNT) with a focus on leveraging existing navigational aids and aircraft avionics
- Manage aircraft, operations, and infrastructure PNT vulnerabilities and risks
- Address aviation PNT cybersecurity challenges in comprehensive manner
- Ensure spectrum availability and protections for all PNT services continued use

## Views on Increased Aircraft Positioning, Navigation & Timing Resiliency

- FAA published TSO-C220 (22 June 2023) for hybrid GNSS-Aided Inertial Systems to detect and mitigate effects of erroneous (or alternate) GNSS trajectories
- Supporting EUROCAE/RTCA new GNSS receiver standard (ED-259/DO-401) to further improve aircraft GNSS avionics resistance to interference, jamming, and spoofing
- FAA is evaluating GNSS Jam and Spoof Resistant adaptive antenna for use on civil aircraft to protect aircraft avionics from effects due to loss of GNSS and false GNSS signals/data
  - FAA has requested U.S. Department of State address adaptive antenna trade restrictions for civil, safety-of-life use

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## Common-mode Dependencies on GNSS

Need to address:

- RNAV and RNP operations dependence upon GNSS availability
  - Specific RNAV routes and procedures that specify “GNSS Required” should be limited to those necessary to ensure operational safety
- Need to enable all-in-view DME avionics, and DME Inertial integration for Performance Based Navigation including required navigation performance (RNP)
- Multiple aircraft systems can be dependent upon GNSS time (as well as position and navigation)
  - Like most uses of GNSS, specific impacts must be addressed aircraft by aircraft
- Aircraft (and aviation infrastructure CNS Safety and automation dependence on space-based services needs mitigations



## Views on Enabling Increased Aircraft Resiliency

Continuing work with aviation industries and standards organizations to enable:

- Layered approach to protect aircraft operations from erroneous trajectories due to spoofing
- Leverage multiple, diverse, complementary (non-GNSS) PNT sources to mitigate disruptions
  - Improve utilization of existing aviation infrastructure and aircraft equipage investments
- ATC and operator identification, location and mitigation tools for situational awareness and continued air commerce during GNSS disruption events

Enable use of multi-sensor navigation

- Operationally enable aircraft-level RNP capability leveraging DME avionics, inertial, and additional PNT sensors; include crosschecks within and across PNT sources to detect spoofing and increase operational resiliency and robustness
- Leverage GNSS data (and signal) authentication opportunities at earliest opportunity
- Address disruption events through information sharing and Notices to Air Missions (NOTAMs) to inform pilots about GNSS disruptions

*1973-2023: Honoring 50 Years of GPS Program*

*1993-2003: Celebrating 30 Years of GPS Full Operations*

*2003-2023: Celebrating 20 Years of WAAS SBAS Commissioning*



Thank You!