

Supporting
European
Aviation



GNSS Interference and Civil Aviation

UN-ICG, WG-S, IDM

30 August 2023

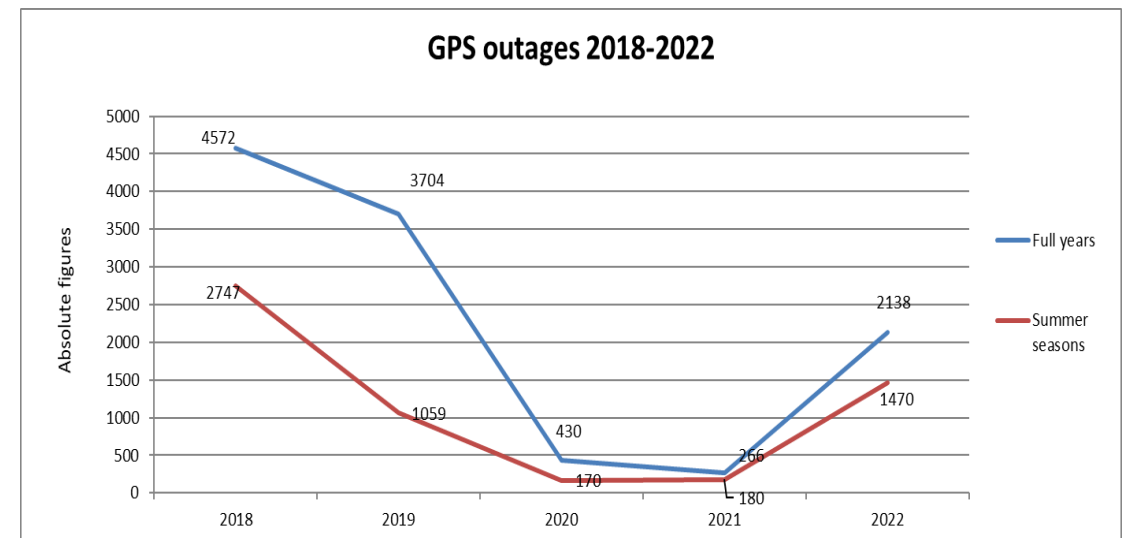
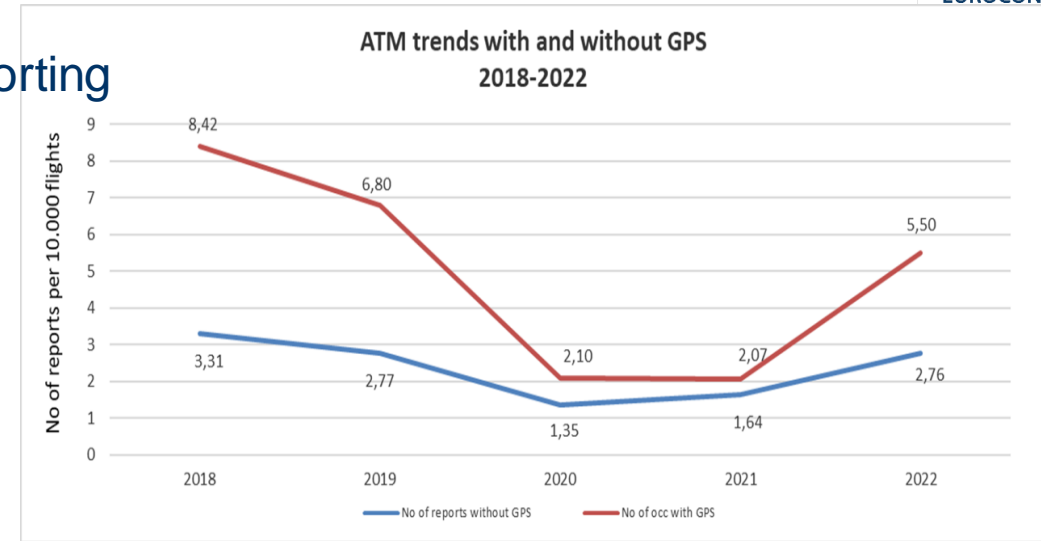
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Pilot Reports of GNSS Problems

EVAIR: EUROCONTROL Voluntary ATM Incident Reporting

- GPS Problem reports dominate over all other type of safety reports
- Air traffic has recovered post COVID, and so have pilot reports of GPS problems...
- The years 2022/2023 demonstrate further increase of the problem, confirmed by multiple sources:
 - EASA, EU Aviation Safety Agency, European Common Repository (ECR)
 - 2022: 4689 GNSS Events
 - 1st half of 2023: 4147 GNSS Events
 - Airbus Flight Data Monitoring (participating airlines):
 - 2021: 10843 Events
 - 2022: **49605 Events**



Automated Aircraft Reporting of GPS Loss by IATA

International Air Transport Association

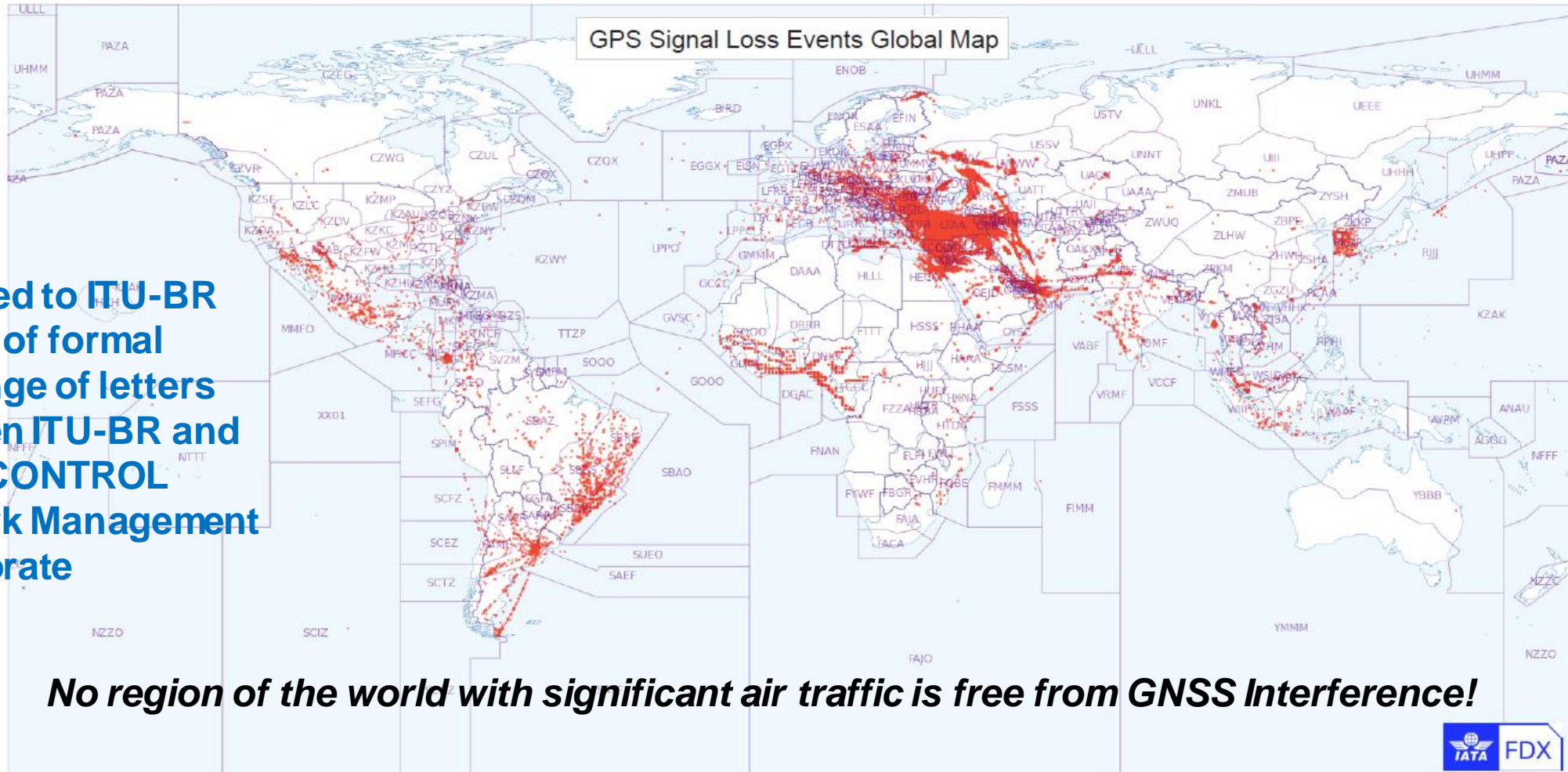


FDX Analysis - GPS Signal Loss



Flight Data SPIs: GPS Signal Loss

Flight Period: Aug 2021 - Dec 2022 Region of Occurrence: Global



Provided to ITU-BR as part of formal exchange of letters between ITU-BR and EUROCONTROL Network Management Directorate

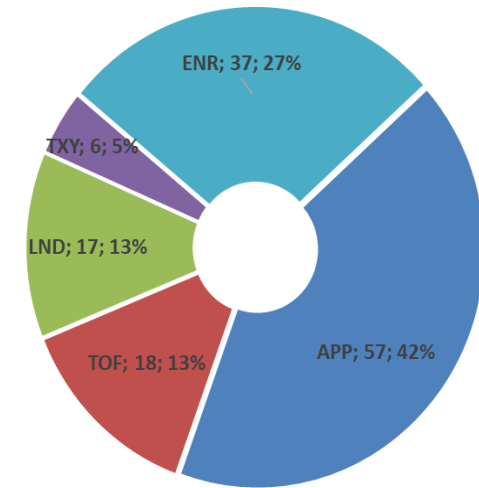
No region of the world with significant air traffic is free from GNSS Interference!



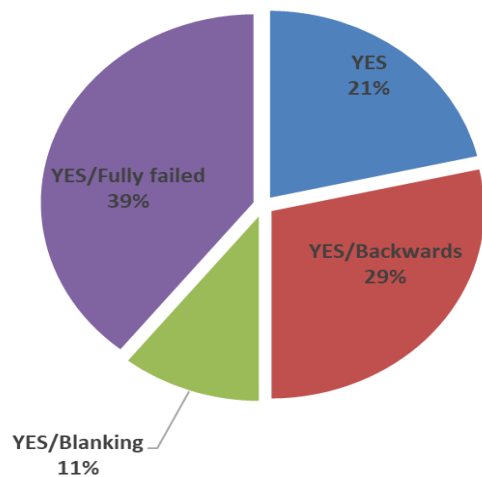
Reported Problems Associated with GNSS Outages

- Failure of one or both GPS receivers and frequent system alerts
- Disagreement between GPS positions and NAV FMS Positions
- Inability to fly intended procedure and requests for radar vectoring
- Wrong wind and ground speed presentations
- Loss of ADS-B Position reporting
- Aircraft clock anomalies
- Terrain warnings – incorrect pull up instructions

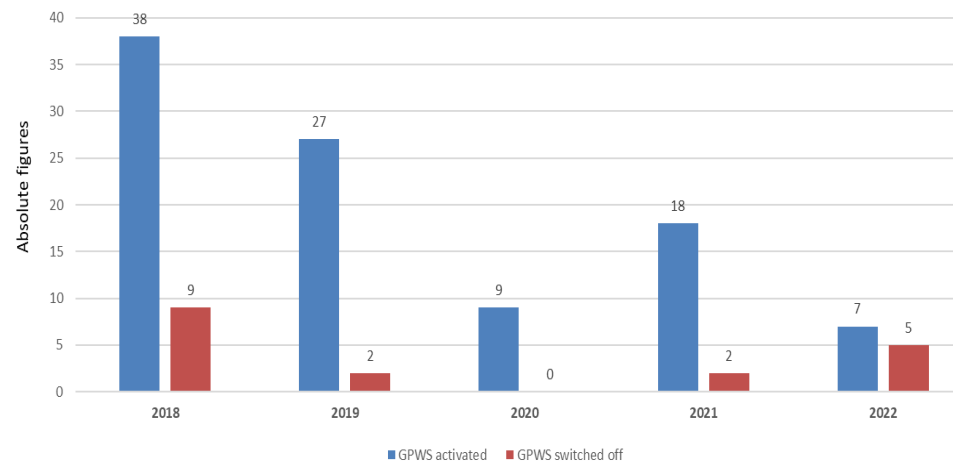
GPWS Phases of flight 2018-2022



On-board clock during GPS outages 2018-2022

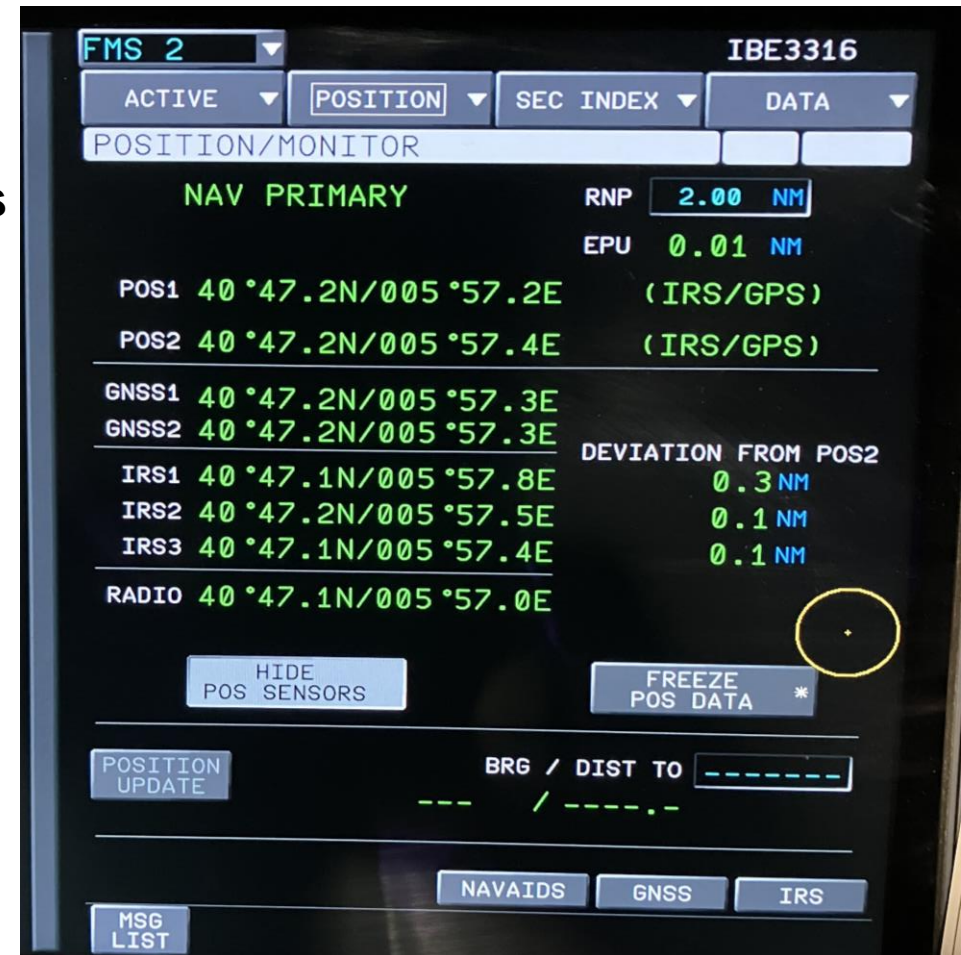
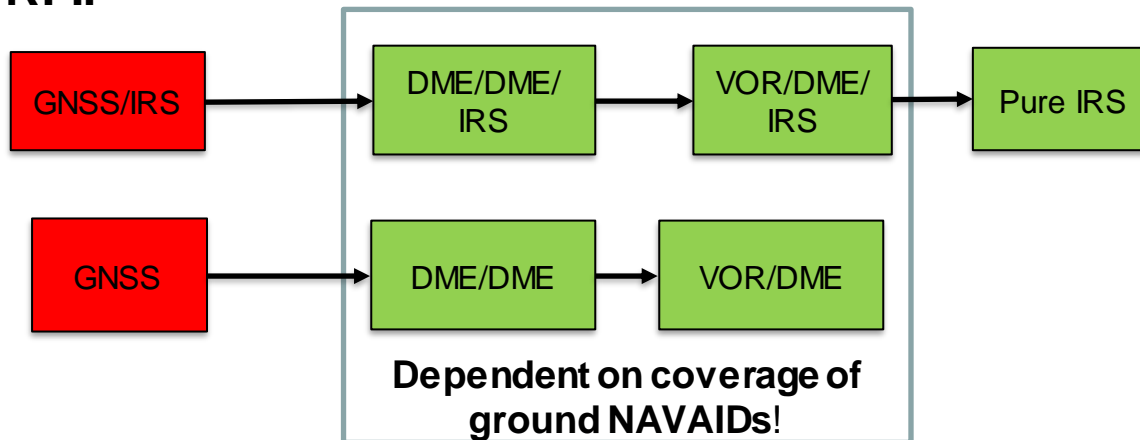


GPWS activation 2018-2022



Navigation Redundancy and Robustness

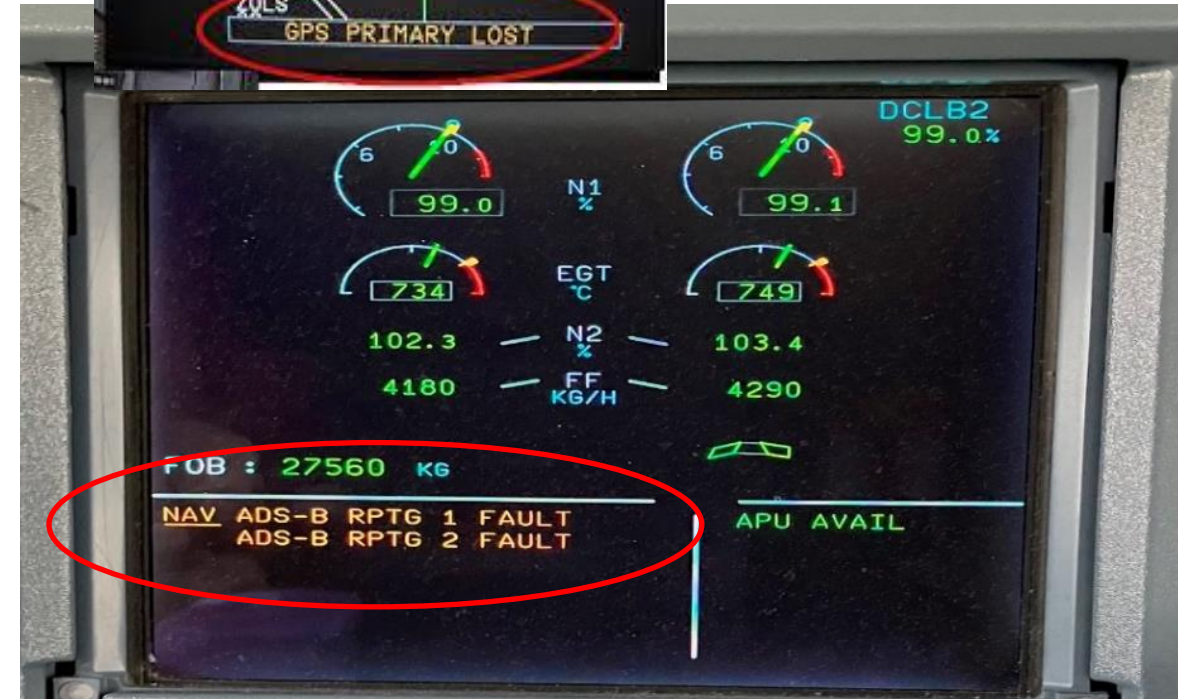
- Large Air Transport Category Aircraft have multiple, redundant navigation systems
 - This does not apply to all types of aircraft or operational environments
- **Redundant systems are the only reason why aviation has been able to maintain normal operations despite GNSS RFI!**



GNSS integrated into many systems; exact RFI impact difficult to predict, manufacturers had to issue aircraft specific guidance → **Complexity and workload increase**

Aviation Safety Impact

- Aviation Safety is built on two main principles:
- **Trust your instruments**
- **Follow standard operating procedure**
- GNSS RFI causes pilots to have to question both principles!
 - Chief Operations Officer of one major airline: Navigation is not my problem. My problem is “normalization of deviance”!
 - Incidents have occurred simply due to pilot distraction because of having to deal with too many system alerts

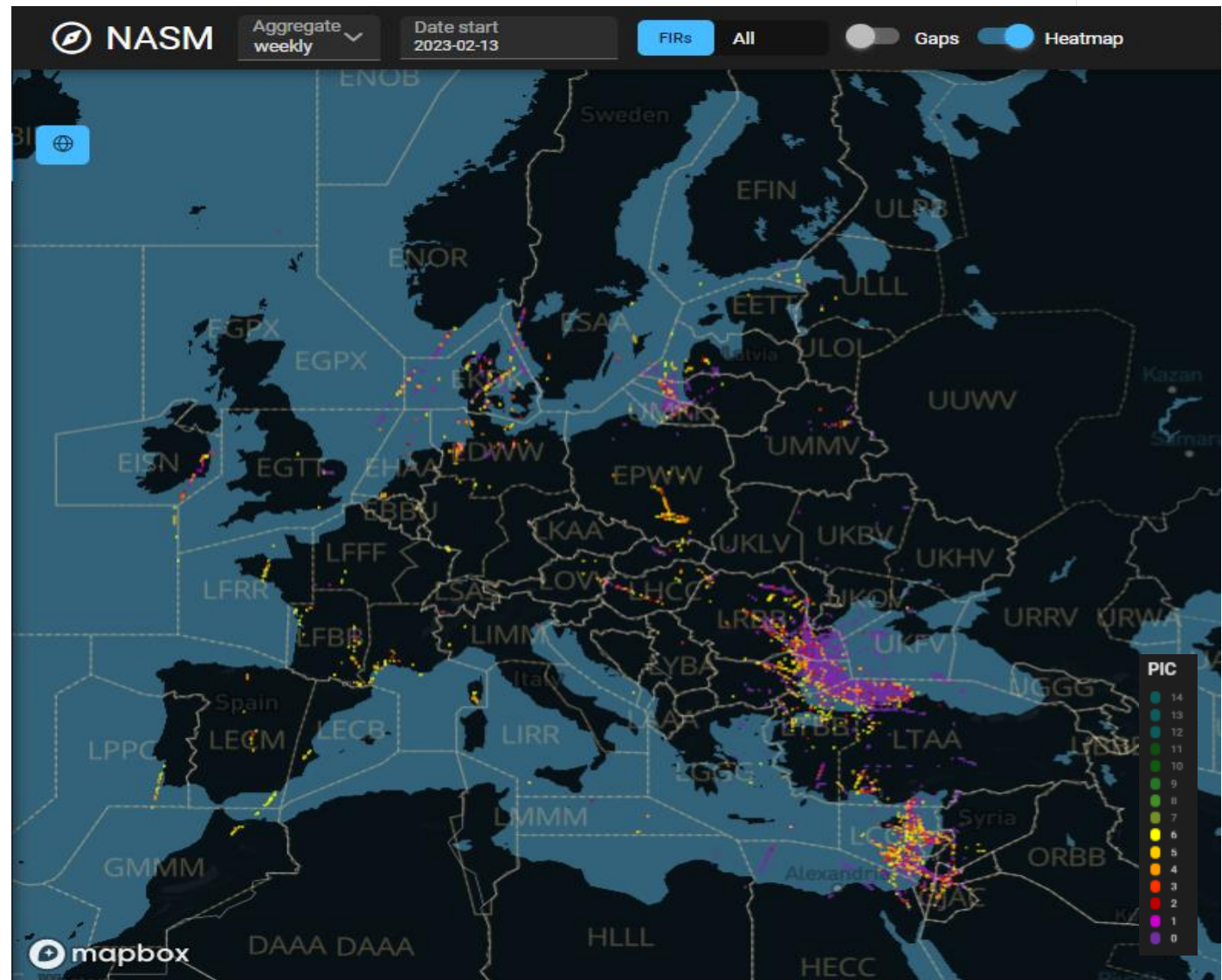


Aviation and ITU Actions 2022

- EASA Safety Information Bulletin 2022-02 issued March 17, 2022, Updated Feb 17, 2023
- “Over-Reliance on Satellite Navigation Safety Issue” entered in CAT Aeroplanes Safety Risk Portfolio
 - EASA Collaborative Analysis Task Team studying the issue – conclusion due end 2023
- ICAO 41st Assembly Resolution, AR41-8C (excerpt)
 1. *Encourages* States to transition towards optimized, **secure** CNS systems based on **complementary integration** of suitable and independent aircraft capabilities, satellite- and ground-based infrastructure which **maximize resiliency and robustness** to any type of interference;
 2. *Encourages* **standardization bodies and industry to develop appropriate interference detection, mitigation and reporting capabilities** for the aircraft on-board, satellite- and ground-based CNS system components, in order to ensure higher CNS resiliency, continuity of operations and **prevent any cascading effects** from the use of compromised position, velocity or time data;
- ITU Circular CR/488 issued 8 July 2022

Network Manager Operational Status Monitoring

- EUROCONTROL built up ground-based network to monitor aircraft ADS-B position reports
 - GNSS RFI cases can be inferred from this data all across the European Network
 - Currently weekly summary statistics, moving towards near real-time capability
- Closure of Ukraine airspace led to many changes of the traffic network
 - ATC wants to know if additional “GNSS headaches” to deal with
 - Data part of weekly OPS Briefing!



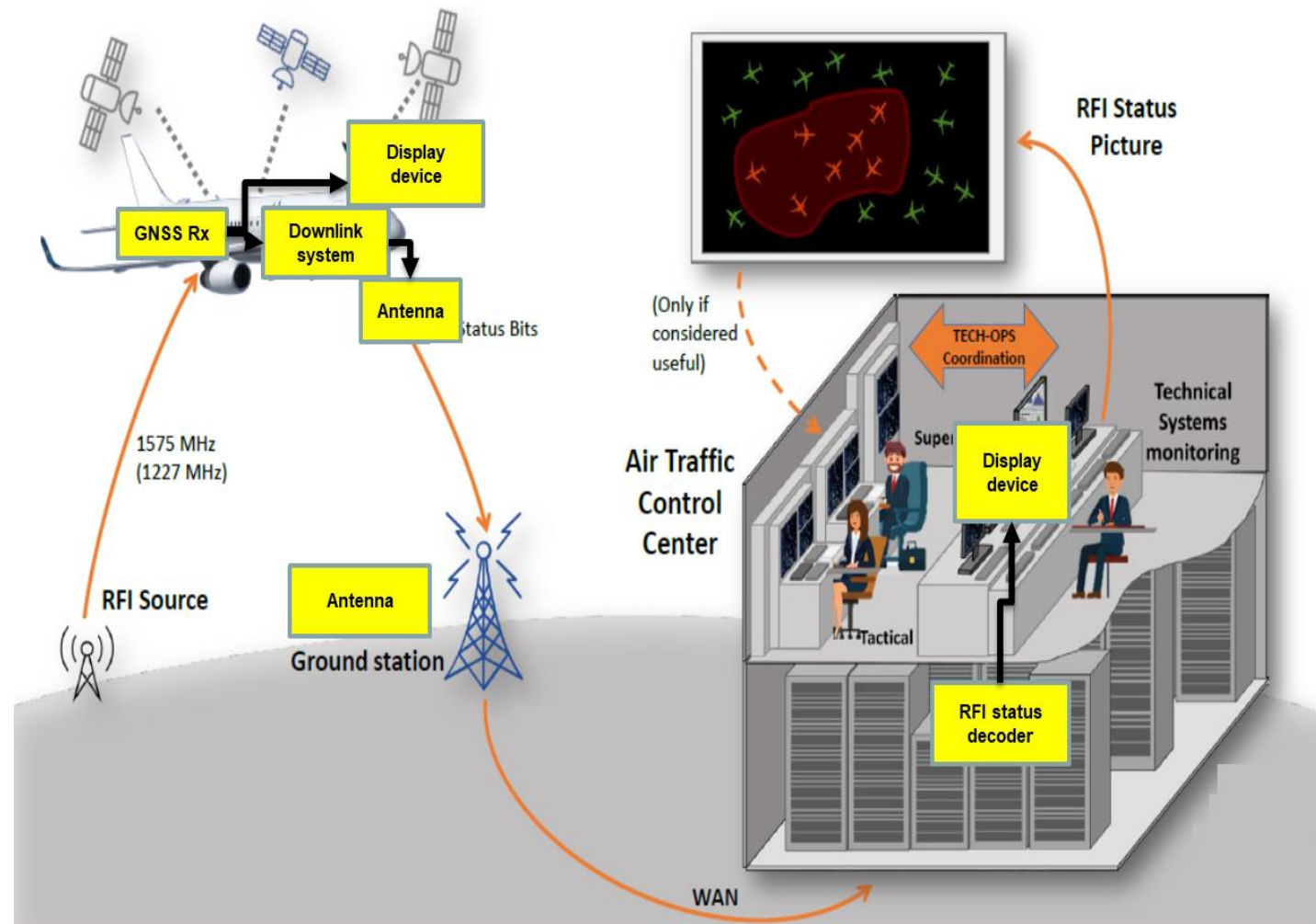
Displayed points correspond to reported degraded PIC (≤ 6)

Next Generation RFI Mitigation Function under Development

Achievements since 2021:

- RFI Detection Function agreed as part of next generation Dual Frequency, Multi-Constellation GNSS Receiver Standard
 - Close cooperation with Airbus
 - Airbus interest: reduce maintenance actions with no fault found
 - Requirements validation ongoing
- Next Generation ADS-B: Identified 2 spare bits in message set, and developed functionality (message downlink rate etc)
- Significant engineering effort, implementation will take many years

Functional architecture



Current Observations on GNSS Spoofing

- A number of **unusual events** have been observed:
 - For example, unusual GPS clock time behaviour, map shifts, position jumps with unusual patterns
- Some events **appear** like the result of spoofing
 - Very difficult to analyze post-OPS
 - Majority of events likely linked to jamming side effects and associated avionics integration issues
 - If aircraft are subject to spoofing signals, **likely** as **collateral**, not direct target
 - Such signals often result in denial of service (jamming)
 - **So far no conclusive evidence**
- Aviation very concerned that escalation of drone and electronic warfare near conflict zones may exacerbate the problem



CONCLUSIONS

- GNSS operates as an RNSS Service with Safety Status
 - Significant investment by Constellation Operators (States) and Aviation
 - Aviation is not the only affected Sector: Maritime, many others
 - Global coverage of GNSS essential to operational efficiency and safety of aviation
- GNSS RFI has increased dramatically since 2018, all over the globe
 - Aviation forced to retain terrestrial back-up systems
 - Aviation forced to develop capabilities to manage GNSS RFI
 - Including geo-localization of GNSS RFI sources – jammers cannot hide!
 - Other Space assets (LEO) may provide complementary capabilities
 - Aircraft at altitude exposed to a large ground transmitter footprint – can't change the physics
- **Inviting States to support an ITU WRC23 Resolution on GNSS RFI**
 - **National security interests must be respected**
 - **There remains room for improvement for reducing other impacts & increasing coordination**
 - **States are welcome to support the EUROCONTROL letter to ITU-BR**