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Airline Perspectives on RFI

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Background

- GNSS is a key enabler of modern aviation. Satellite-based CNS services play an important part in ATM with a growing dependence on space-based infrastructure
- Airspace Users rely on the normal functioning of aircraft systems, including automated monitoring, caution, and warning sub-systems. Therefore, interference-free GNSS position, navigation, and timing (PNT) service is essential for flight safety.
- GNSS signals can be blocked, altered or otherwise compromised by a growing array of threats including solar activity, man-made interference and malicious spoofing
- Signal jamming and/or spoofing can seriously impact aircraft navigation systems, resulting in non-normal avionic system behavior.

Threats

IATA has developed and released a GNSS Radio Frequency Interference Safety Risk Assessment that includes Threat, Possible Consequence / Impacts, and Preventative Controls.

Precursors	Description
Jamming	Locally generated RFI is used to “drown out” satellite signals. Possible sources: PPD – Personal Privacy devices, TV broadcast station malfunction, and military RFI.
Spoofing	Counterfeit GNSS signals are broadcast and decoded by airborne receivers, resulting in a false position displayed in the cockpit and used by avionics. (Position Manipulation.)
Solar Storms	Electromagnetic interference from space weather events such as solar CMEs “drowns out” the GNSS satellite signals.
Signal Reflection	Reflection and/or refraction of GNSS signals due to objects such as buildings or ionospheric scintillation

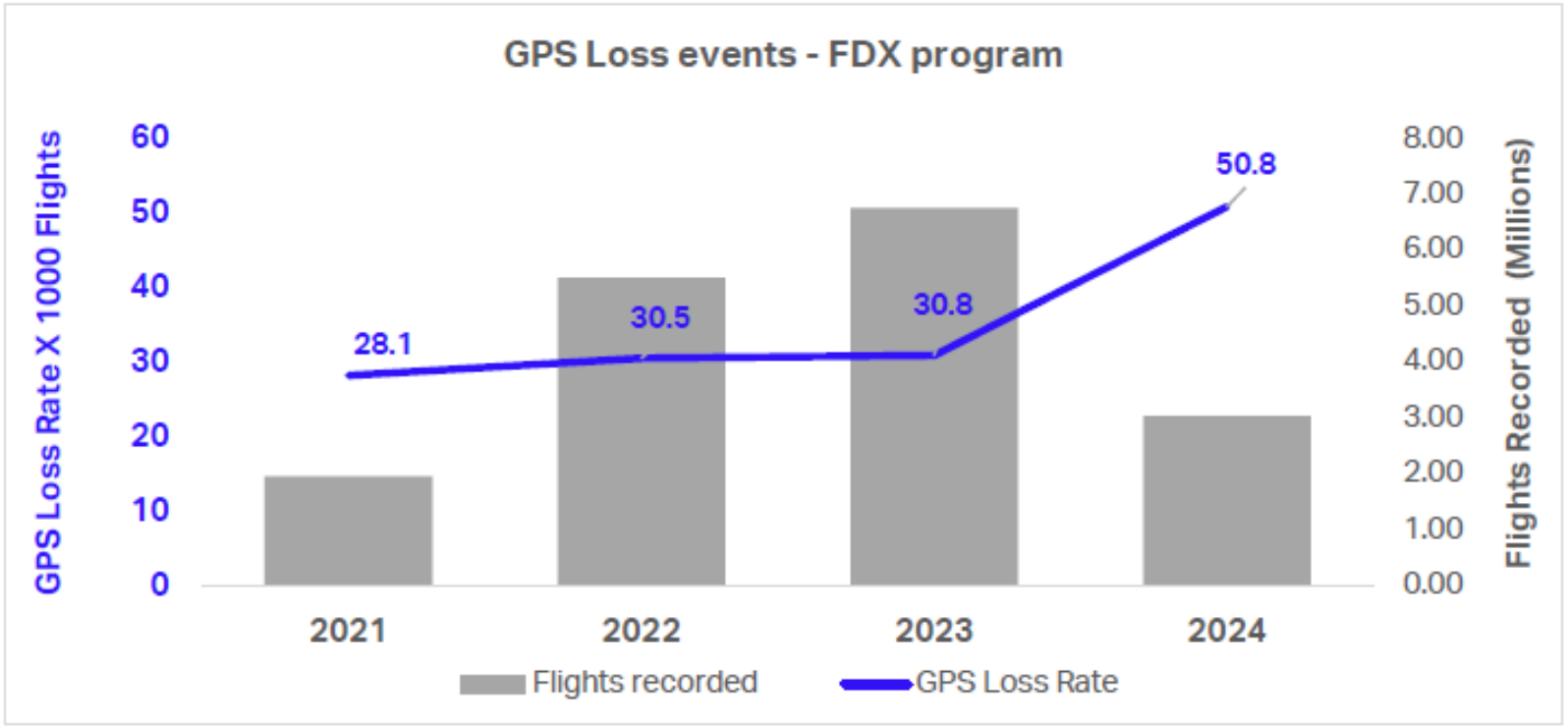
Possible Consequences / Impacts

Systems affected / Potential Accident scenarios		CFIT	MAC	RE
Navigation	Downgraded aircraft position computation. GPS (Loss of GPS primary)	X		
	Loss of FLS, GLS, SLS deviations, and loss of RNP and RNAV capability	X		
	Abnormal differences between Ground Speed and True Airspeed	X		
Surveillance	Loss of Terrain Awareness Warning System (TAWS) Undue TAWS Alerts false “Pull up” calls (or no calls)	X		
	Terrain display shift on ND	X		
	Loss of ADS-B Out Reporting False ADS-B Out Position Reporting		X	
	Loss of TCAS		X	
Communication	Loss of CPDLC and SATCOM		X	
Others	Loss of Runway Overrun Prevention System – (ROPS) or Runway Situation Awareness Tools			X

Ref: IATA GNSS Radio Frequency Interference Safety Risk Assessment

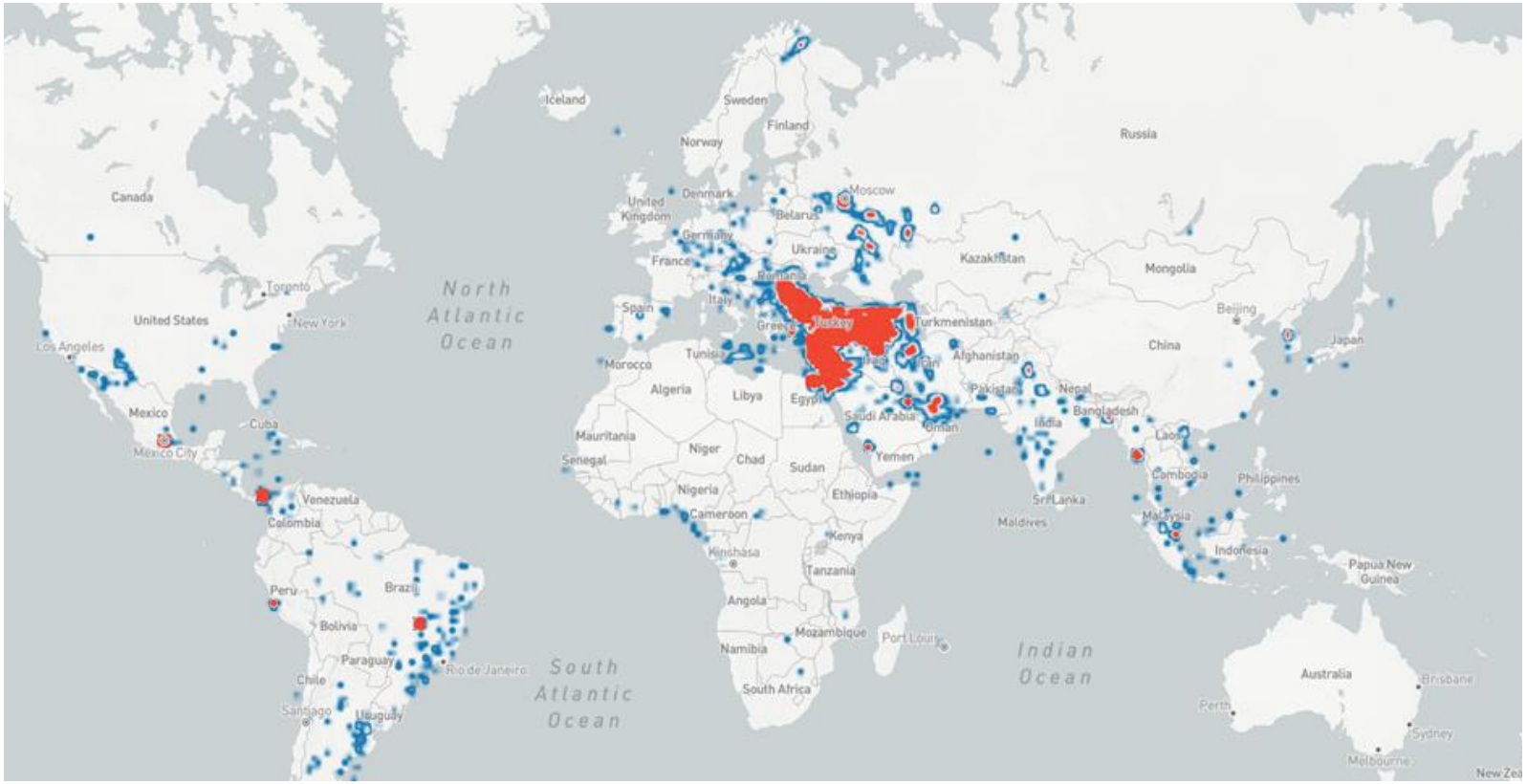
GNSS / GPS Signal Losses

- The aviation industry is concerned at elevated levels of GNSS RFI occurring in multiple regions with increasing numbers of pilot and automated reports, often corelated with conflict zones
- Elevated levels of long duration and deliberate jamming and spoofing of GNSS/GPS threatens the integrity of Positioning, Navigation, and Timing (PNT) services



Ref: IATA GNSS Radio Frequency Interference Safety Risk Assessment

GNSS / GPS Signal Losses



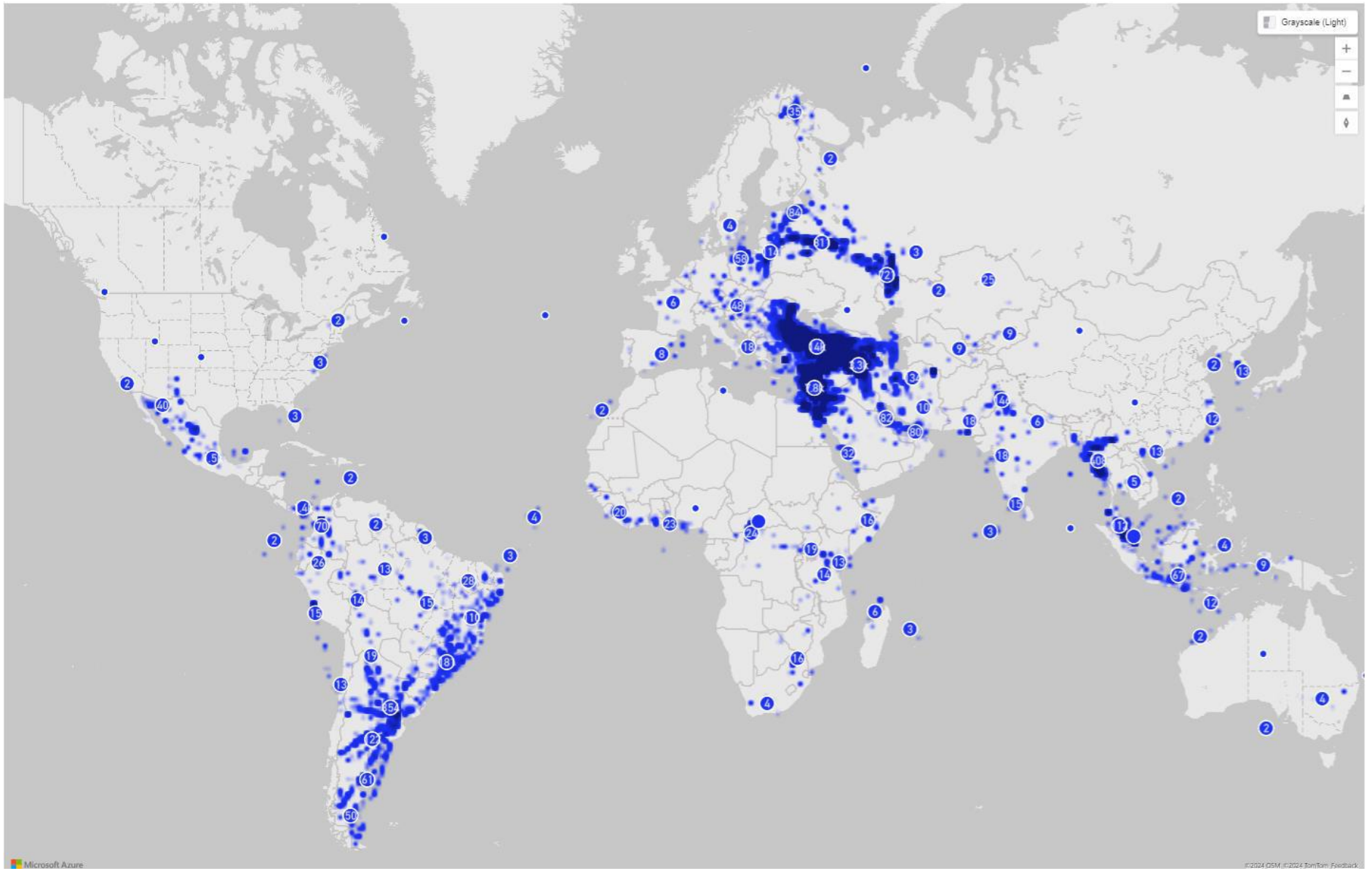
GNSS RFI Recorded events 2022.

Ref: IATA GNSS Radio Frequency Interference Safety Risk Assessment

- From August 2021 to June 2024, FDX program members experienced +580K instances of GPS signal loss of around 18.4 million flights processed by the program.
- The figures are not based on voluntary reports but aircraft-recorded data, so FDX provides a good geographic identification of the RFI hotspots.

GNSS / GPS Signal Losses

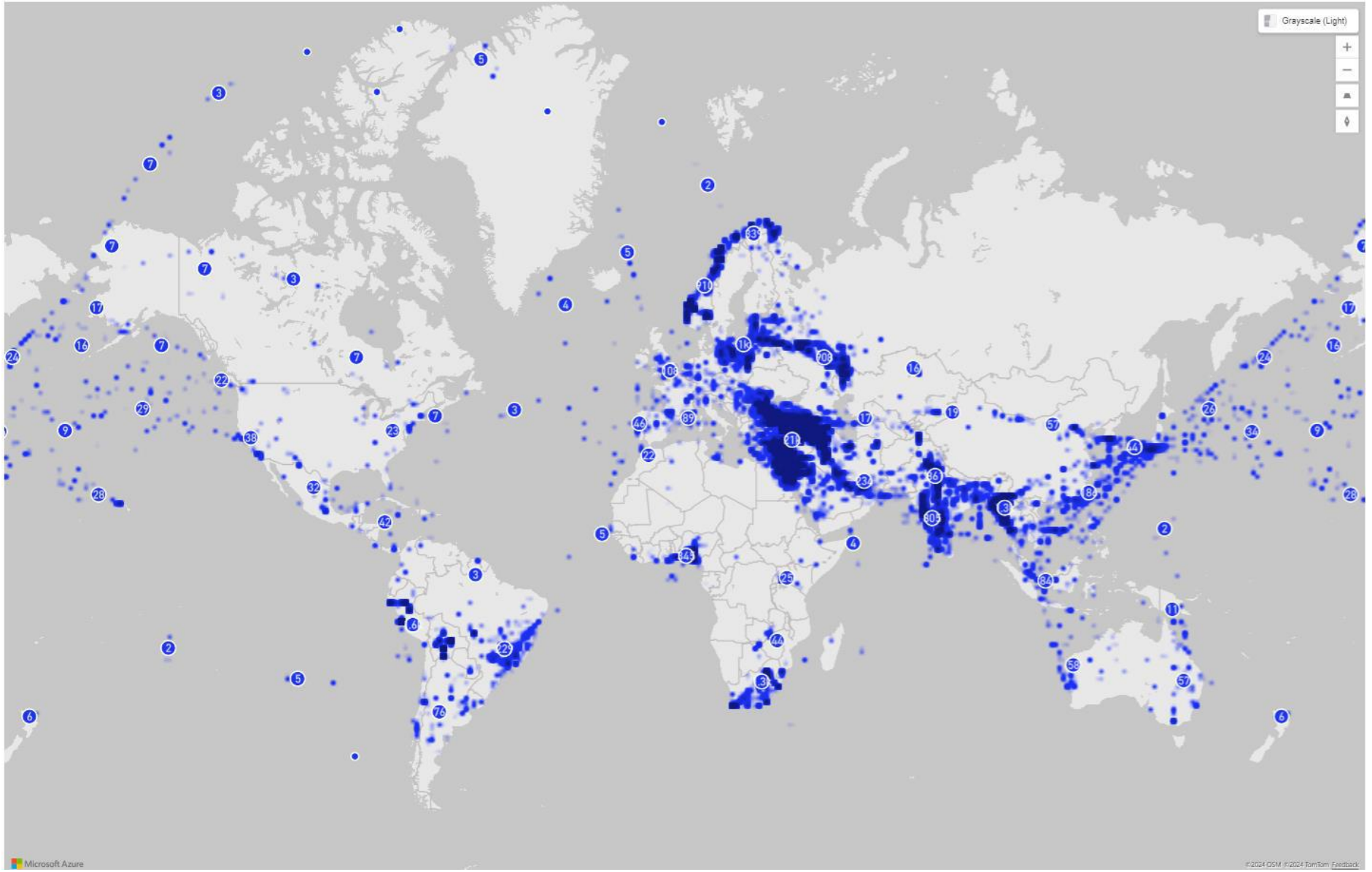
Ref: IATA GNSS Radio Frequency Interference Safety Risk Assessment



GNSS RFI Recorded events 2023.

GNSS / GPS Signal Losses

Ref: IATA GNSS Radio Frequency Interference Safety Risk Assessment



GNSS RFI Recorded events 2024.

Preventive Controls – Airspace Users

Mode	Control
Flight Planning	Checking NOTAMS related to known or expected GNSS RFI
	Checking the availability of non-GNSS-based routes, procedures, and approaches (ILS, VOR, and DME)
	Consider limitations caused by inoperative radio navigation systems to operate in GNSS RFI-affected areas
Enroute	Enforce action ECAM/EICAS and FCOM or supplemental procedures for loss of GNSS
Post-flight	Technical report in the maintenance logbook in case any cockpit effects related to GNSS RFI are experienced
	Establish maintenance/operations feedback after troubleshooting GNSS RFI reports
	Report any suspected GNSS RFI events to relevant regional and international organizations (e.g., IATA, ANSPs)
	When RFI is identified, aircraft data should be sent to OEMs for further investigation

Ref: IATA GNSS Radio Frequency Interference Safety Risk Assessment

Preventive Controls – National/International organizations and OEMs

Mode	Control
Regulatory control of RFI	ITU regulations and the resolution on GNSS RFI agreed at WRC23
	Coordination activities for civil/military GNSS interference testing
Identification and localization of interfering sources	ITU's Satellite Interference Reporting and Resolution System (SIRRS)
Mitigation of RFI onboard	Development of Dual-Frequency/Multi-Constellation (DFMC) and Multi-Frequency Multi-Constellation (MFMC) receivers and Minimum Operational Performance Standards (MOPS)

Ref: IATA GNSS Radio Frequency Interference Safety Risk Assessment

CASE STUDY: A350, SIN-HKG

Map shift during descent:

Date/Time/Station: 2024, Night, HKG

Aircraft Type: AIRBUS 350

Event Summary:

- GPS Spoofing occurred 5 nm before reaching waypoint MANGO
- ATC informed and pilot request radar vectors
- NAV Primary lost, Airport Navigation Function (ANF) and Brake To Vacate (BTV) not available.
- Map Shift was observed on ILS finals (relying on ILS signals – lateral and vertical instead of ND due to map shift)

CASE STUDY: B777, SIN-HKG

Map shift during descent:

Date/Time/Station: 2024, Day, HKG

Aircraft Type: Boeing 777

Event Summary:

- Whist on descent into VHHH Terminal Area passing FL130, GNSS/GPS interference occurred, causing the following spurious EICAS messages to appear repeatedly and intermittently.
    - Flight Deck Effects (FDE) - ADS-B OUT L, ADS-B OUT R, NAV UNABLE RNP, TERR POS, GND PROX SYSTEM
- In addition, erroneous GPWS caution and warning aural alerts came on intermittently.
- ATC was advised accordingly. It was also observed (via the RT) that many other traffic in the terminal area were also similarly affected.

Operational Considerations:

Documentation and Procedures:

- All fleets have published FSI with information such as background information, reported FDE and operational considerations during all phases of flight
- All fleets have reporting procedures to report GNSS/GPS RFI
- Data collection, safety forum awareness, INTAM

Common Faults Experienced on the Airbus Fleet:

- NAV Primary lost latched on after experiencing GNSS jamming in cruise (Delhi, Lahore, Yangon, Ankara, Singapore, Hong Kong, etc)
- Loss of ANF and BTV

Common Faults Experienced on the Boeing Fleet:

- GPWS Pull Up spurious warning during cruise

CASE STUDY: Europe to BKK

- GPS jamming was experienced over the airspace of the Black Sea, GPS was de-selected and navigation changed to DME/DME. GPS was switched on again after the aircraft left the area with GPS jamming.
- Later GPS jamming occurred over the airspace of Myanmar. As a result of the GPS jamming the crew received TERRAIN warnings during cruise
- As a mitigation the TERR OVRD was selected as a standard procedure. If the TERR OVRD remains deselected the aircraft cannot execute an RNP AR approach; an RNP approach can be executed if one of the two GPS systems is available
- The flight continued and as a precautionary measure the ILS approach was requested from ATC. Flight landed without issues and on the ground normal GPS signal was restored
- Some airports encourage airlines to request authorization for the RNP-AR approaches for noise abatement, but as many airlines fly through GNSS RFI areas, this may result in the inability to execute these approaches.
- Maintaining conventional approach facilities help airlines to operate normally even after encountering GNSS RFI.

Conclusion

- Mitigating against GNSS RFI has become a critical risk management activity for airlines.
- Few pragmatic options currently exist to guarantee GNSS integrity considering the increasing levels of interference. This is unlikely to change in the near term due to the number of conflict zones, globally.
- IATA evaluation of data from over 370,000 flights reveals that a significant number of current GNSS aircraft receivers can take 30 minutes to recover normal functionality when subjected to RFI.
- Several receivers do not recover until subjected to a ground maintenance reset.

Conclusion

- IATA invited member airlines to specify GBNA they consider could be decommissioned without significantly impacting safety of flight, assuming GNSS is unavailable
- As aircraft use of GNSS is subjected to increasing levels of interference, airlines and their representative organizations are being forced to re-evaluate retention of specific GBNA as part of a Minimum Operating Network (MON)
- States and air navigation services providers (ANSPs) are encouraged to re-evaluate GBNA infrastructure under their control and establish a MON that facilitates continued safety of flight in circumstances where GNSS can potentially be unreliable or unavailable.

Thank You

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