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SAFE SKIES.
SUSTAINABLE FUTURE.

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For ICAO

GNSS RFI – An Industry Overview

Reported Types and Effects

Collected Reports, Interference Types and Effects observed

Affected Regions

Areas across the globe where maximum RFI happens

Airplane Systems Strategy

Contain, Improve, Resilient

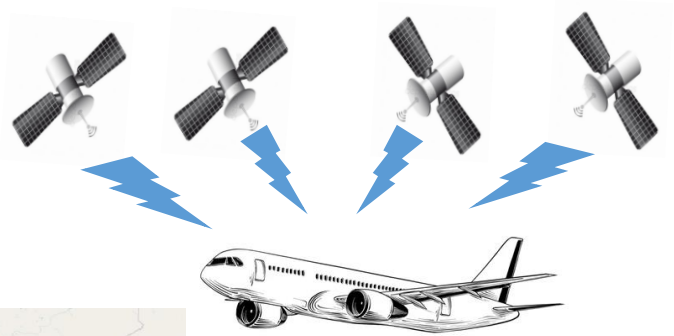
Wholistic Mitigation Strategy

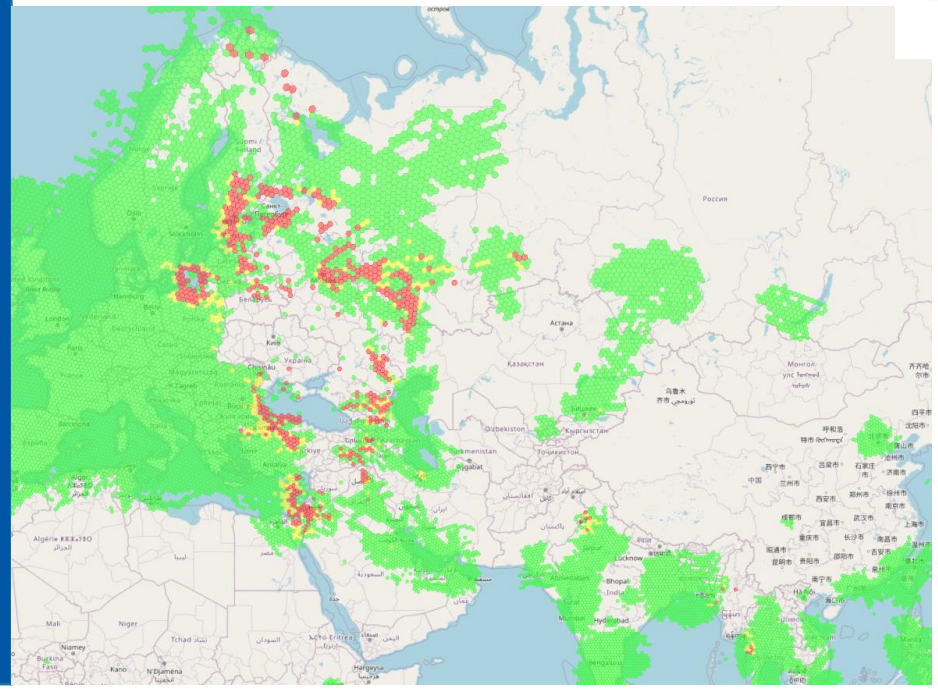
Mitigation at Multiple Levels

Recommended Actions

Recommendations for mitigation

Reports, Types and Effects





Increasing Interference

Threats are Evolving

- Industry has received an increase in GPS Radio Frequency Interference (RFI) events
  - Potential sources: portable devices, jammers, and repeaters
  - Wider areas of intentional interference are prevalent in regions with geopolitical conflict

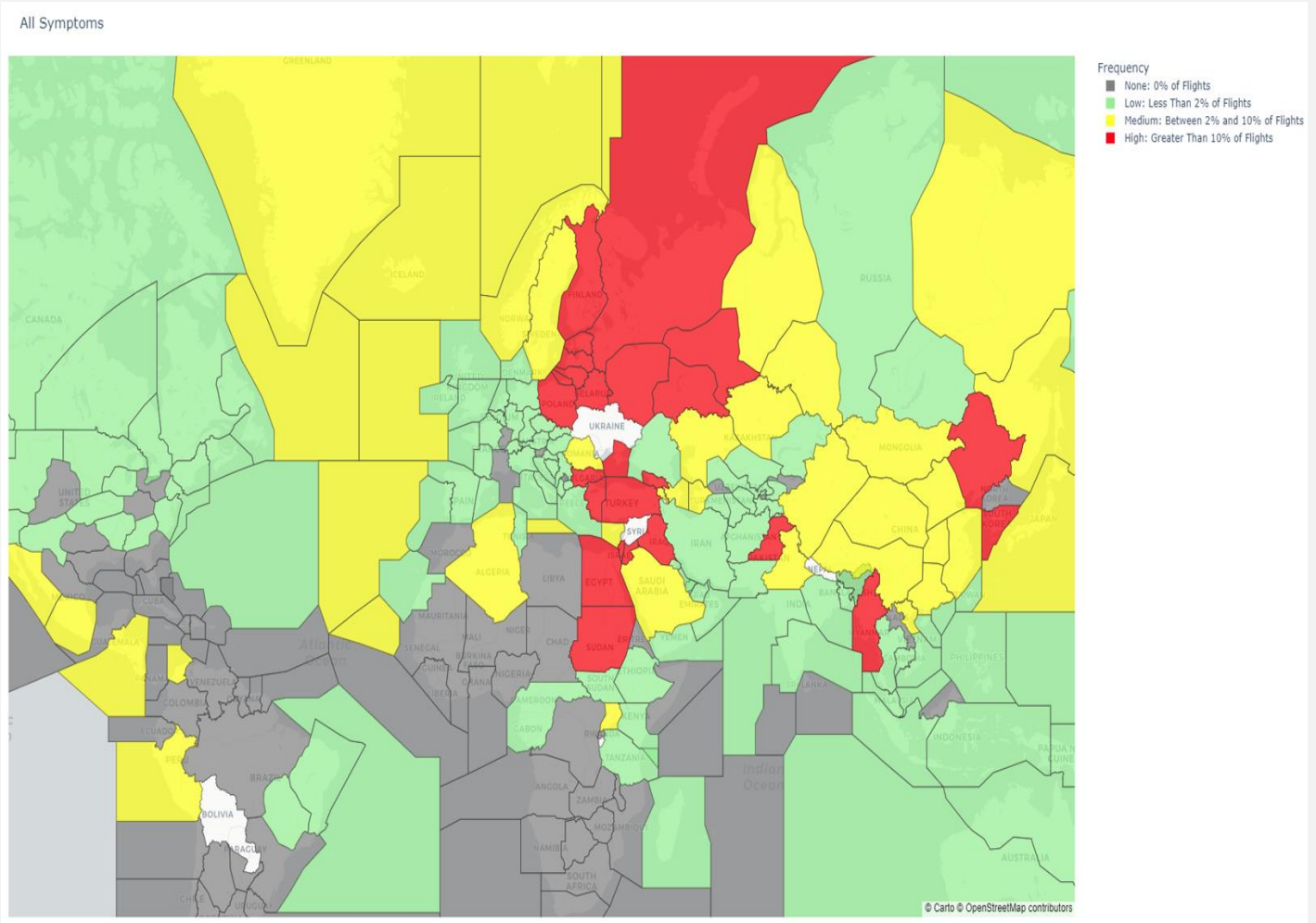
- GPS Interference Types
  - Jamming: Narrow band or broadband energy in the GPS frequency band that can prevent receivers from decoding GPS signals
  - Spoofing (simple): Signals transmitted which mimic real GPS signals, are decoded by the receiver, and indicate a predetermined location
  - Spoofing (complex): Signals transmitted which mimic real GPS signals, are decoded by the receiver, and are targeted at a specific tail in attempt to making maneuvers not discernable to the crew

Observed Effects

- Incoherence in navigation position, such as GNSS/FMS position disagree warnings
- Abnormal differences between Ground Speed and True Air Speed including Time / Date shift
- Spurious EGPWS / TAWS alerts
- Potential deviation of hybrid position (IRS/GNSS)
- Loss of ADS-B or erroneous position
- Adverse Effects on
  - ✓ HUD Guidance, Autopilot / flight director approach capability (NO LAND 3)
  - ✓ Weather Radar System
  - ✓ Controller Pilot Data Link Communications (CPDLC)
  - ✓ SATCOM

02

Affected Regions



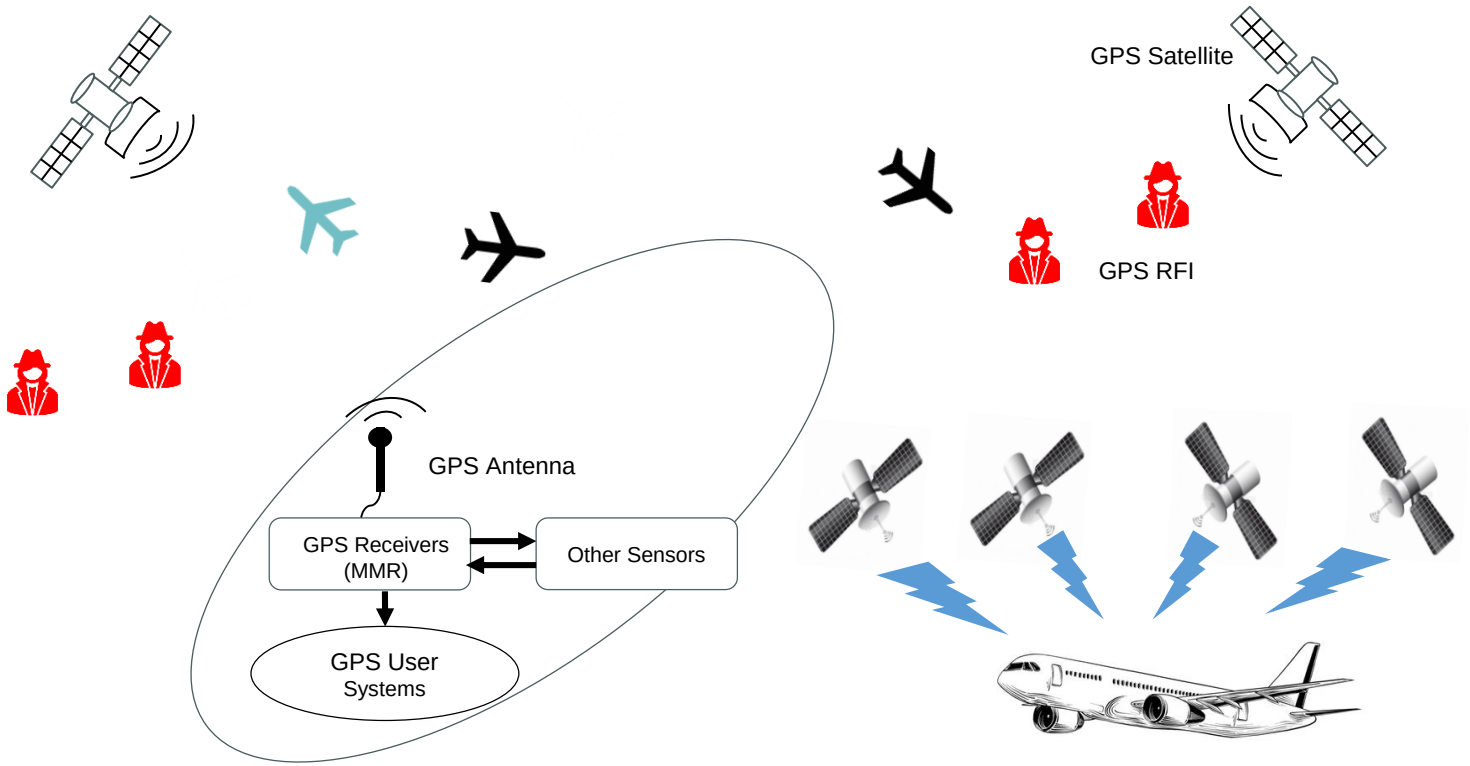
Affected Regions across the Globe

- The Black Sea area, Eastern Europe
  - Flight Information Region (FIR) Istanbul, Ankara, E of FIR Bucuresti, FIR Sofia, Tbilisi, Yerevan, Baku
  - FIR Bratislava, FIR Budapest, FIR Chisinau
- The South-Eastern Mediterranean area, Middle East
  - FIR Nicosia, Beirut, Damascus, Tel-Aviv, Amman, NE of FIR Cairo, E of FIR Athinai
  - FIR Baghdad, FIR Kuwait, FIR Bahrain, NW of FIR Tehran, N of FIR Tripoli
- The Baltic Sea area
  - W of FIR Vilnius, NE of FIR Warszawa, SW of FIR Riga
- Arctic area
  - Northern Parts of FIR Helsinki and FIR Polaris

** Source: EASA :https://www.easa.europa.eu/GNSS*

03

Airplane Systems Strategy



Strategy – Airplane Systems

Contain

Define/document when RFI is occurring and what actions can be taken.

- ✓ Launched GPS RFI Task Force
- ✓ Monthly GPS RFI All Operator Calls
- ✓ Developed FOTBs for all major models
- ✓ Updated AMM/FIM Tasks
- ✓ Released MTs
- ○ Regularly updating FOTBs based on the latest reports
- ○ Safety investigations: PCOSP, PSRB, SMS
- ○ GPS Event Monitor ACMF Live Report

Improve

Airplane system resilience improvements

- ○ Updates for GNSS Sensor software
- ○ Updates for TAWS Resiliency
- ○ Updates for Sensor selection and integration
- ○ Objective is to minimize impact of turning Spoofing into denial of service

Resilient

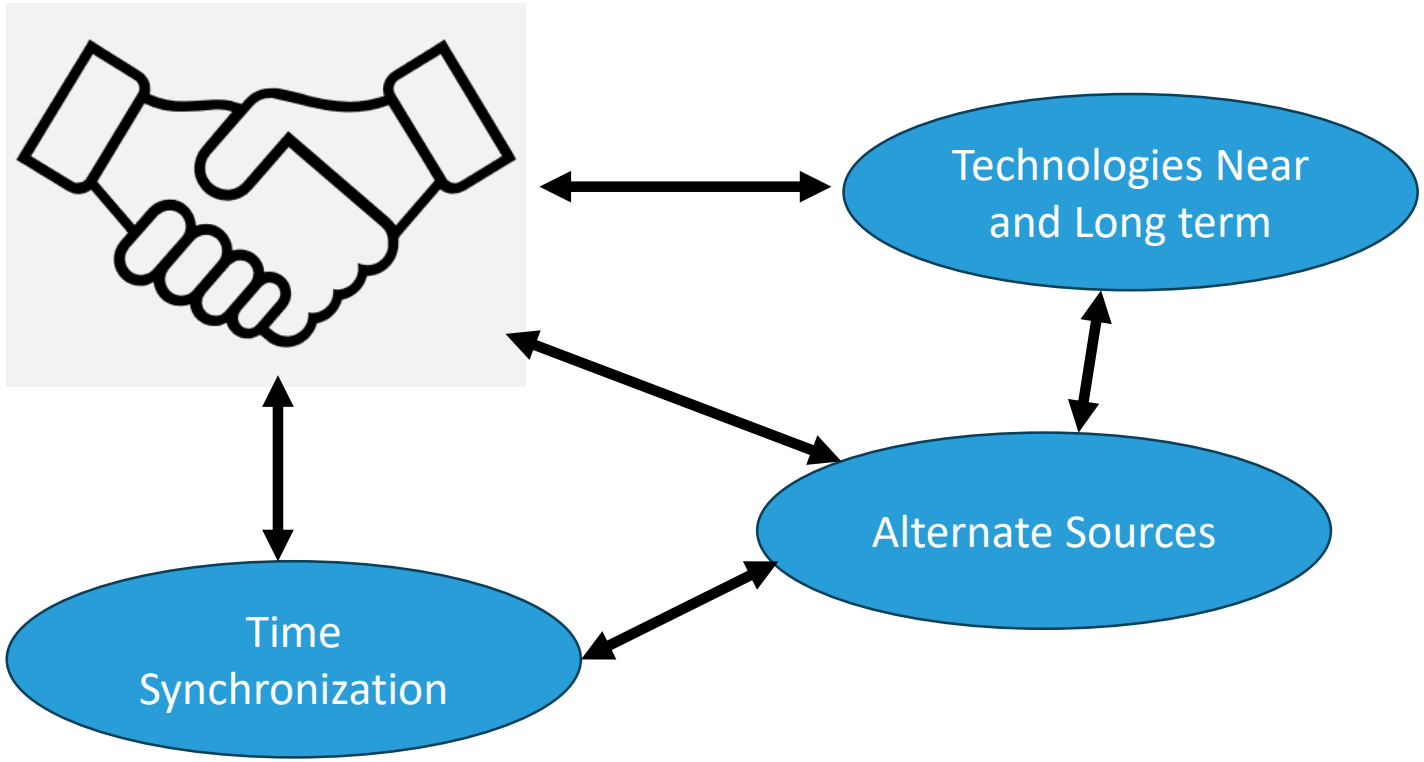
All airplane systems are resilient to GPS RFI.

- ○ Comprehensive review of GPS User Systems' design requirements & philosophy
- ○ Objective is to make GNSS RFI a non-issue operationally (i.e. play through)
- ○ Interference Resistant Avionics technologies
- ○ Next Generation GNSS Receivers (DFMC)
- ○ Improved Complementary Position Navigation and Timing (CPNT)

✓ Completed
○ On-going

04

Wholistic Mitigation Strategy



Mitigations at Multiple Levels

- **Technological solutions to make GNSS more robust exist**
  - Some near-term actions can make GNSS RFI less disruptive, enhance robustness (e.g. signal authentication)
  - Some technology solutions are longer term (e.g. next gen receivers, adaptive antennas etc.)

- **There is a limit to how robust GNSS can be made**
  - Reversion to alternative sources of position and timing will continue to be part of the overall solution
  - Reversion to inertial positioning for outages of limited duration
  - Improvements/evolution of existing navigation aids could enable Performance Based Navigation (PBN) operations to be maintained in essential airspace
  - Development of new Complimentary PNT (CPNT) sources would be beneficial

- **Time Synchronization Requirements need to be studied**
  - GNSS allows for everyone to be on the same time reference. However, inadequate consideration has been given to the required performance (i.e. accuracy, integrity, continuity) of time synchronization.

Work with Partners

- **Event monitoring and Root Cause Analysis**
  - Work with airline customers and aircrew
  - Monitor events across the world on a regular basis
  - SMEs do root cause analysis of each event

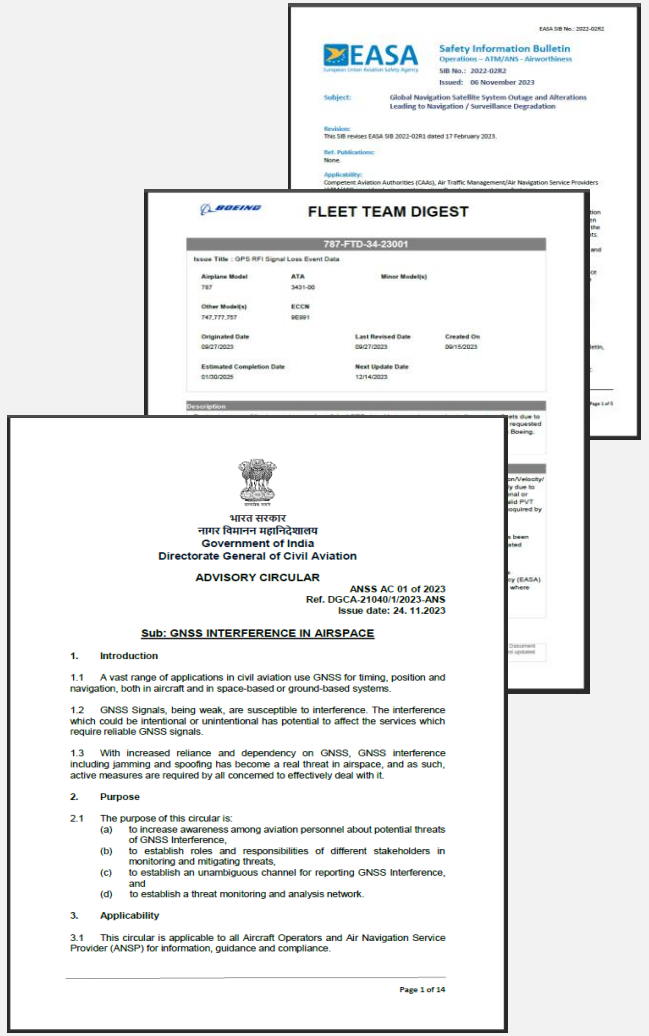
- **Share Lessons Learnt and Recommend Actions**
  - Model-wise and event-wise analysis is shared with all partners
  - Information shared through Flight Operators Technical Bulletins (FOTBs) and Fleet Team Digests (FTDs)
  - Recommend Operational and Product Improvement mitigations to users
  - Safety Risk Profiles are developed and executed for each aircraft and equipment type

- **Work with Regulators and ANSPs**
  - Work with ANSPs and Regulators across the globe and contribute to local safety Bulletins by transparent data sharing
  - Help Airlines and Regulators prepare and release Safety Circulars as and when necessary

** Source: EASA :https://www.easa.europa.eu/GNSS*

05

Recommended Actions



Actions Recommended

1. Accelerate efforts to define and standardize Complementary Position Navigation and Timing (CPNT) systems (above and beyond conventional navigation aids).
2. Continue engagement with ITU to facilitate protection of GNSS spectrum and discourage use of jamming and spoofing where not absolutely necessary for defense. Better coordination with air defense networks of military.
3. Accelerate development of standards for signal authentication for GNSS core constellations and augmentations.
4. Develop additional guidance to States and ANSPs on provision of alternatives to GNSS through minimum operational networks of conventional navigation aids.
5. Consider modifications of standards for conventional navigation aids to evolve those systems to provide better performance and ultimately support PBN operational use. (e.g. DME performance update)
6. Study requirements and potential for standards for time synchronization across all flight domains to promote operational safety and efficiency. Develop guidance concerning required levels of assured time synchronization to include accuracy, integrity and continuity of time synchronization.
7. Encourage States to develop interference detection systems and develop standardized means to provide operationally relevant information about interference to operators.

Thank You

ICAO 80