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GNSS Radio Frequency Interference

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GNSS RFI – Agenda

Agenda

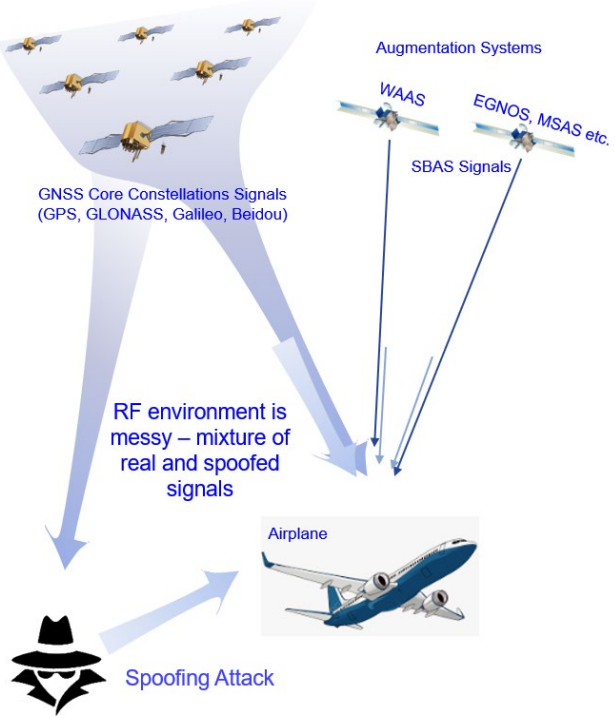
- GNSS Overview
- Operational Effects
- Boeing’s GNSS Strategy
- Boeing’s GNSS Event Monitoring
- Next Steps

GNSS RFI – Overview

- **The global navigation satellite system (GNSS) provides positioning, navigation, and timing information**

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

- **GNSS Interference Types**
  - Jamming: when the GNSS signal is lost
  - Spoofing: when the aircraft receives a counterfeit GNSS signal



GNSS RFI – Operational Effects

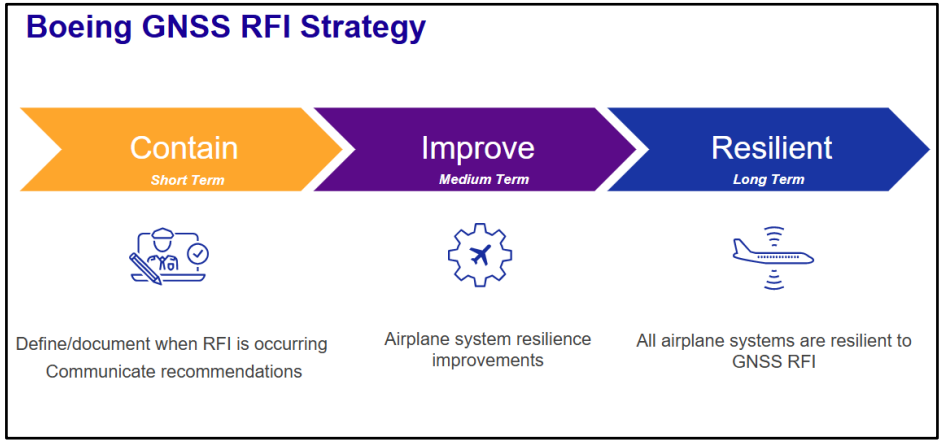
- **Many functions/systems use GNSS-based data that can result in effects:**
  - Hybrid GPS Inertial – For aircrafts equipped with hybrid GPS system
  - Flight Management Function (FMF)
  - Spurious GPWS Alerts
  - Erroneous/Unavailable ADS-B Data
  - Time/Date Shift
  - HUD Guidance – For aircrafts equipped with HUD
  - Datalink Unavailable

GNSS RFI – Boeing's Strategy

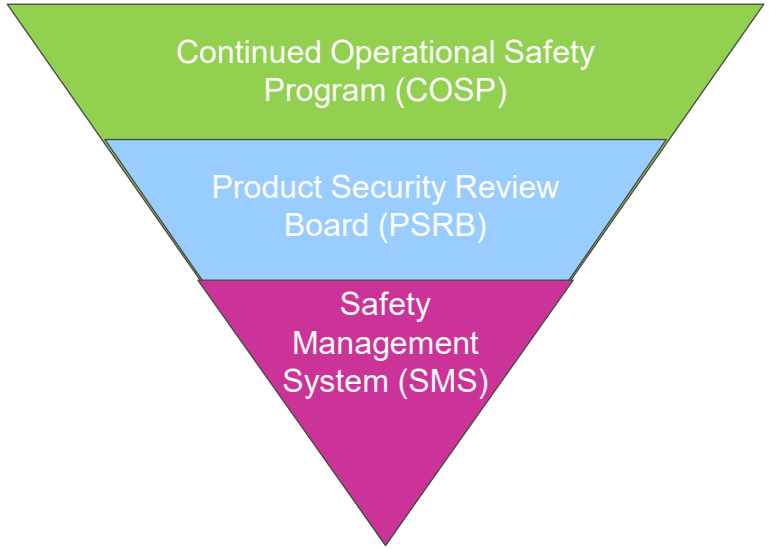
- **Boeing's GNSS RFI Strategy**
  - Contain > Improve > Resilient

- **Contain Phase (Complete)**
  - ✓ Launched Boeing GNSS RFI Task Force
  - ✓ Recurring GNSS RFI All Operator Calls
  - ✓ Released updates to operational and maintenance procedures for all major models (FTDs, FOTBs, etc.)
  - ✓ GNSS Event Monitoring (GEM) ACMS Reports
  - ✓ Safety Investigations: COSP, PSRB, SMS

- **Improve Phase (In-Work)**
  - GNSS receiver updates
    - Improved position/time/date recovery
    - Improved RFI Recovery
    - Spoofing detection
  - TAWS updates
    - Detect and ignore erroneous data from GNSS
    - Recovery after erroneous inputs are resolved
    - Improved reasonableness checks



GNSS RFI Investigation Model



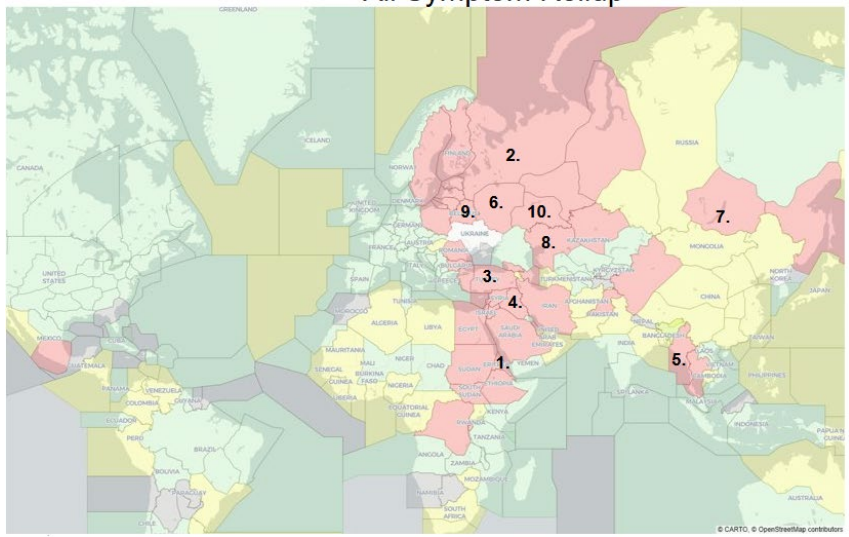
GNSS RFI – GNSS Event Monitoring (GEM)

- GEM is designed to detect GNSS disruptions through a robust logic that compares GNSS data with other sensor information available to ACMS
- GEM reports are downlinked live to the ACARS server (accessible by both Boeing & Operator's ground station)
- Capability to uplink the report to the flight deck (as a COMM message) to provide situational awareness to the crew
- GEM is currently installed on 777s and 787s, 50 operators and growing
- Plan to roll out for other major Boeing models
- Boeing is using the data to understand *trends, "hot-zones",* and *avionics systems' performance*

GNSS RFI – GNSS Event Monitoring

777 and 787 data is collected from May 1, 2025 – October 31, 2025

GNSS Event Monitor Regional Symptom Map:
All Symptom Rollup



None: 0% of Flights
Low: Less Than 2% of Flights
Medium: Between 2% and 10% of Flights
High: Greater Than 10% of Flights

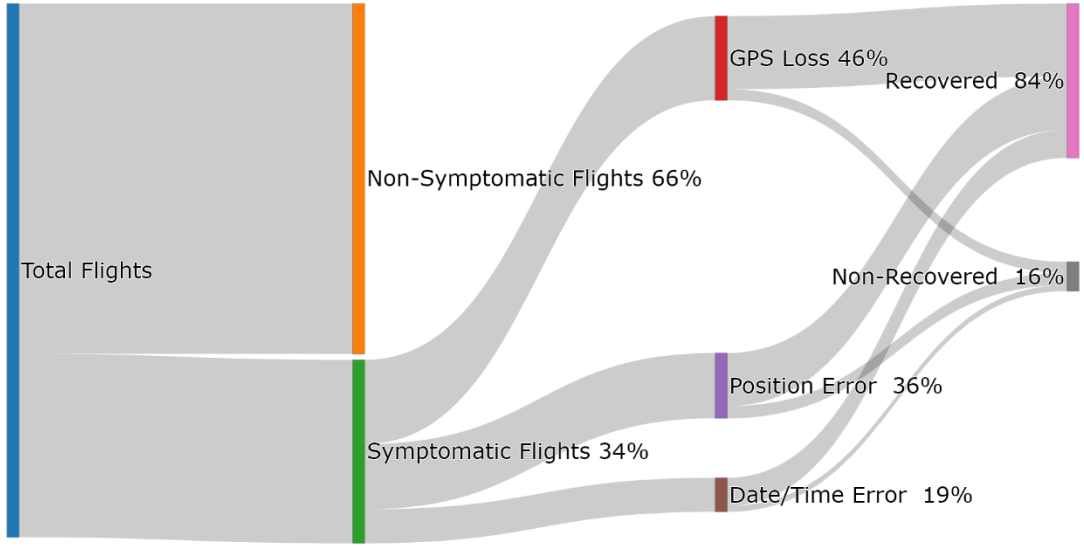
October 2025 Observations

- Data indicates heavy interference activity in the Red Sea between Jeddah and Port Sudan. Data also shows increased spoofing activity along the Northern border of Mongolia

Top 10 FIRs by Interference Occurrence Rate

1. Asmara (HHAA) - 86%
2. St. Petersburg (ULLL) – 67%
3. Ankara (LTAA) – 66%
4. Baghdad (ORBB) – 64%
5. Yangon (VYYF) – 59%
6. Moscow (UUWV) – 55%
7. Irkutsk (UIII) – 55%
8. Aktobe (UATT) – 42%
9. Minsk (UMMV) – 40%
10. Yekaterinburg (USSV) – 37%

Global Interference Trends



GNSS RFI – Boeing's Next Steps

- Continue collaborating with operators, regulators, and industry partners on strategic measures dependent on technological or regulatory advancements.
  - For example:
    - Participating in European GNSS RFI Action Plan Task Force
    - Standards Development

- Continue engaging with fleets in collecting data and identifying any new symptoms (dynamic RFI environment)

- Continue executing projects as part of Boeing's Improvement Phase

- Continue studying technologies to implement as part of Boeing's Resilient Phase

Resilient Phase: Layers of Protection