

SAFETY INFORMATION 7/2021

26 November 2021



HARMFUL INTERFERENCE TO GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) AND ITS IMPACTS ON FLIGHT OPERATIONS

Introduction

Global Navigation Satellite System (GNSS) includes navigation satellite infrastructures and constellations which provide position and timing information supporting aircraft and air traffic management operations. GNSS satellite constellations which are currently recognized by International Civil Aviation Organization (ICAO) include the US. Global Positioning System (GPS), the Russian GLONASS, the European Galileo and the Chinese BeiDou. Frequencies for GNSS signals supporting safety-of-life applications, such as aviation, are globally harmonized and legally protected under the International Telecommunication Union (ITU) Radio Regulations.

Aircraft GNSS receiver is a safety-critical equipment and the main source of position information which drives aircraft navigation system in most commercial aircraft. The GNSS receiver is the primary equipment supporting Required Navigation Performance (RNP) operations and provides position input to many aircraft avionics, such as Navigation Display (ND), Ground-Proximity Warning System (GPWS) and Automatic Dependent Surveillance (ADS). GNSS also provides timing information to some satellite communication systems. Moreover, some business aircraft are referencing GNSS for flight control and stability systems.

Impact on Aircraft Operations

Reported impacts on airline flight operations received from various airlines and airspace users include:

- a) Sustained loss of on-board GNSS functionality - [GPS-L INVALID] and/or [GPS-R INVALID] messages appear.
 - 1) Some aircraft may lose its area navigation capability, including directing to a waypoint.
- b) Decrease in navigation performance leading to RNP alert
 - 1) Through increasing aircraft horizontal position error, Actual Navigation Performance (ANP) decreases beyond RNP requirement. - [NAV UNABLE RNP] message appears.
 - 2) In some aircraft, navigation reverted to inertial (INS/IRU) or DME/DME after GNSS loss.
- c) Impact on Navigation Display - A large "map shift" was observed.

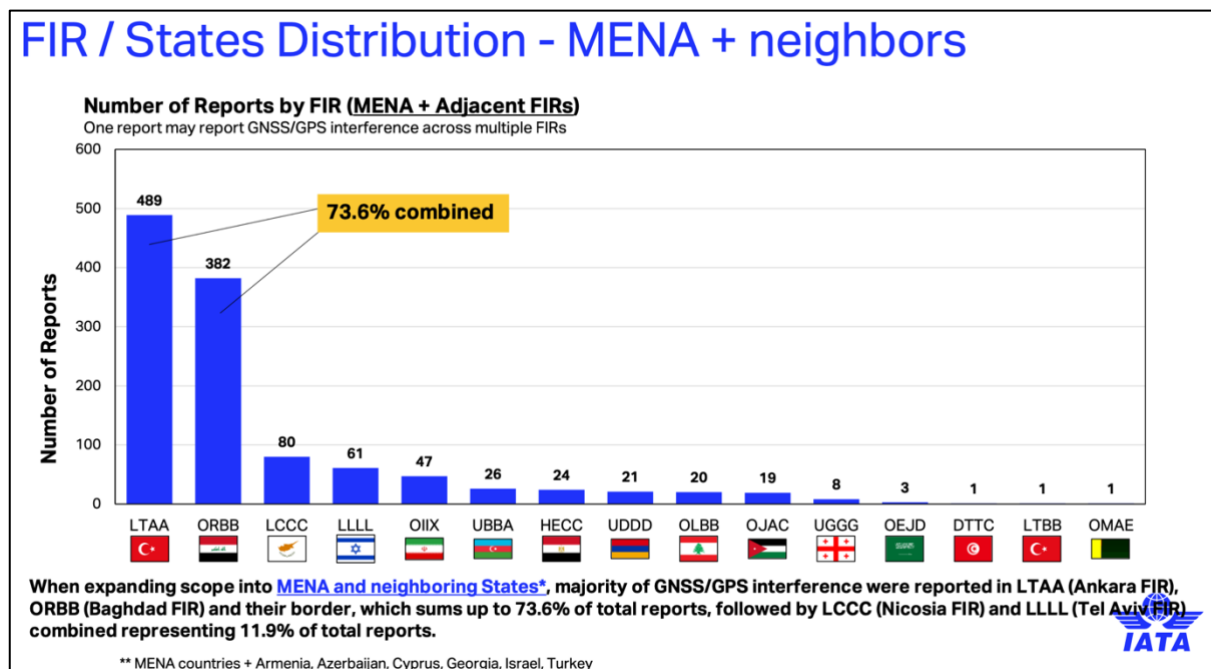
- d) Sustained loss of capabilities for GNSS-based approach and landing.
- e) Impact on GPWS - [TERR POS] and [EICAS TERRAIN POSITION] messages appear.
- f) Impact on Runway Alerting systems
- g) Loss of GNSS positioning input to ADS position reporting, ELT and PFD/MFD.

For some business aircraft which are using GNSS as a reference source for aircraft flight stability systems, the US FAA has advised that the unavailability and unreliability of GNSS may impact aircraft's Attitude and Heading Reference System (AHRS), Stall Warning Protection System (SWPS), Ventral Rudder, Yaw Damper and Auto Pilot. The interference may also generate warning messages associated with unexpected rolling and yawing oscillations (Dutch Roll) at high airspeeds.

GNSS Interference in Middle East & North Africa (MENA) Region

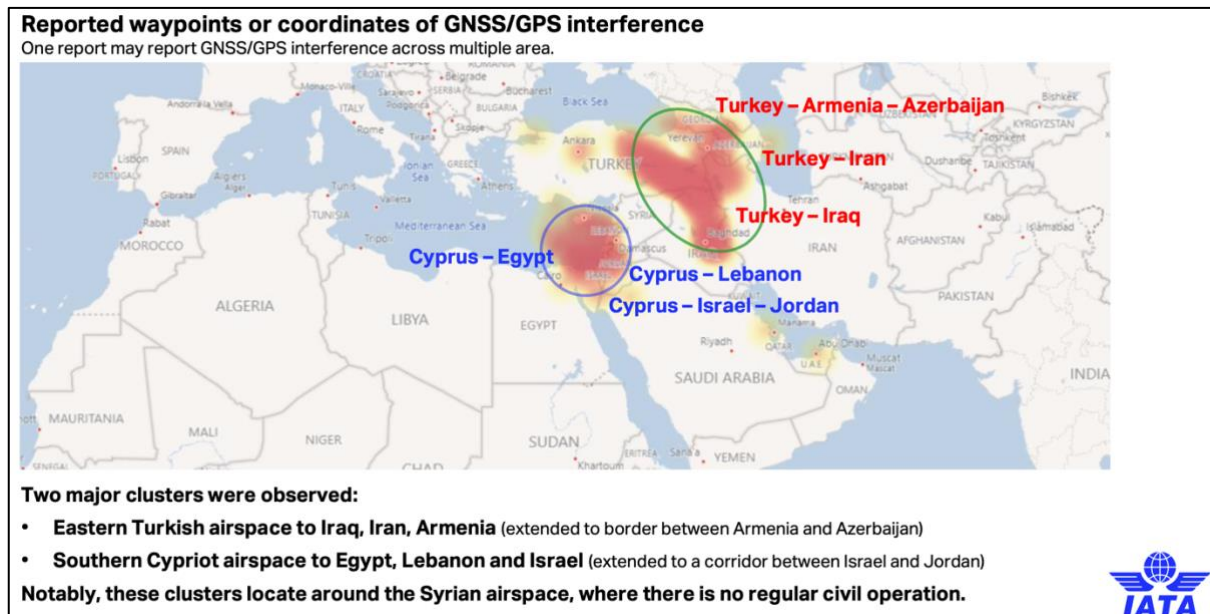
A study was conducted by International Air Transport Association (IATA) on the GNSS vulnerabilities in the MENA region from January 2019 – September 2020. The analysis reported a total of 461 GNSS jamming or suspected interference reports in MENA States and a total of 831 reports from MENA and neighbouring States.

The chart below shows the FIR/States distribution of reports according to the study.



Source: IATA GNSS/GPS Interference – Global Aviation Data Management November 11th 2020

The interference reports gathered was then overlaid on a map to display hotspots in the region, as depicted below.



Source: IATA GNSS/GPS Interference – Global Aviation Data Management November 11th 2020

Risk Assessment

Airlines intending to transit areas with reported GNSS interference to assess operational risks and limitations that may occur during loss of on-board GNSS capability. Alternative navigation capability based on INS/IRU or other conventional navigation aids can be helpful.

Reporting the Interference

Airlines and airspace users are encouraged to report harmful interference to GNSS to the appropriate frequency authorities and the CAAM

Pilot action(s) may include:

- reporting the situation to ATC as soon as practicable and requesting special handling as required;
- forwarding the aircraft call sign, location, altitude and time of occurrence to ATC; and
- forwarding information to the CAAM as soon as possible, including a description of the event (e.g. how the avionics failed/reacted during the anomaly) via the Mandatory Occurrence Report form as per CAD 1900 – Safety Reporting System.

Examples of narratives for occurrence reporting:

When transiting between Iraq and Turkey via position NINVA at FL400, we experienced failure of both GPS on the aircraft. This led to Nav unable RNP EICAS cautions followed by Terr Pos EICAS caution. Both ECL checklists actioned. DME updating selected and Navigation

performance restored. The GPS both returned to normal operation after approximately 25 minutes. Suspect GPS jamming.

Over the Eastern part of Mediterranean, from Nicosia Airspace entering into Cairo Airspace. EICAS ADS-B OUT L msg with associated status, QRH actioned. GPS lost, "Inertial" displayed on ND. GPS signal then intermittently lost for next 20 mins all the way through Cairo Airspace & Amman Airspace. GPS signal returned on entry into Saudi Airspace, no further recurrence during flight.

For further information refer to the following documents:

1. Doc 9849 – Global Navigation Satellite System Manual, 3rd edition – 2017, International Civil Aviation Organization (ICAO).
2. IATA-OSS-INFRA: Harmful Interference to Global Navigation Satellite System (GNSS) and its impacts on flight and air traffic management operations



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