

GNSS Interference

Impacts to airline operations

March 4th, 2021

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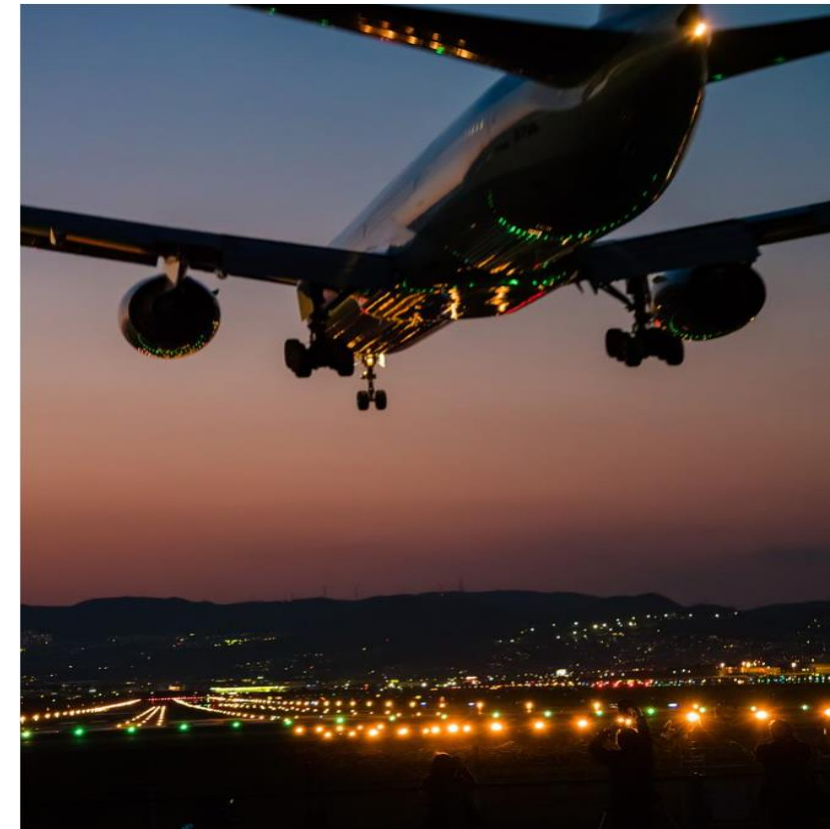
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Why GPS/GNSS is important?

Aircraft GNSS receiver is

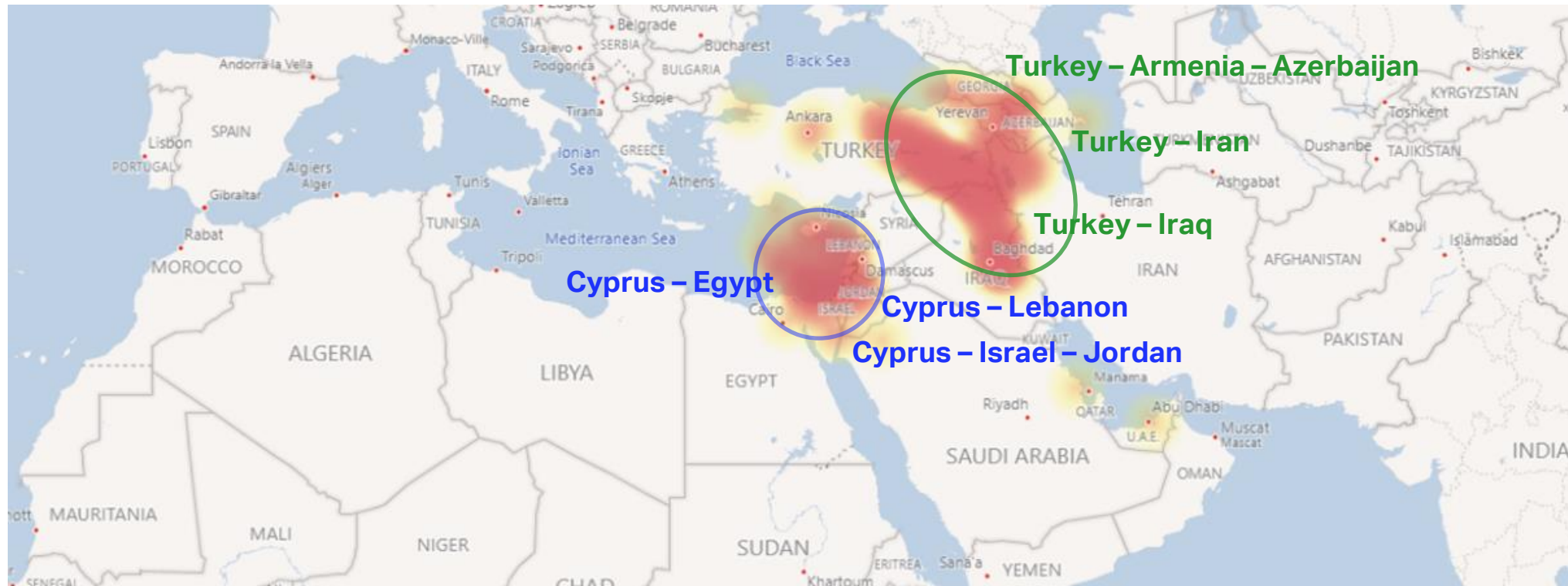
- a safety-critical equipment;
- the main position source driving aircraft navigation system;
- the primary equipment supporting Required Navigation Performance (RNP) operations; and
- the main input to many critical aircraft's safety and traffic management functions, including
 - Navigation Display (ND)
 - Ground-Proximity Warning System (GPWS)
 - Automatic Dependent Surveillance (ADS)



Some GNSS/GPS Interference Hot Spots: 2019-2020

Reported waypoints or coordinates of GNSS/GPS interference

One report may report GNSS/GPS interference across multiple area.



Two major clusters were observed:

- **Eastern Turkish airspace to Iraq, Iran, Armenia** (extended to border between Armenia and Azerbaijan)
- **Southern Cypriot airspace to Egypt, Lebanon and Israel** (extended to a corridor between Israel and Jordan)

Notably, these clusters locate around the Syrian airspace, where there is no regular civil operation.

Examples of Actual Pilot Narratives

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.

Entering Northern Iranian airspace, we experienced repeated **ADS-B OUT EICAS ADVISORY** messages, QRH actions followed and transponder changed, but advisories persisted for approx **12 minutes**. This is a common event in this area and probable cause is GPS jamming.

In cruise at FL370 over waypoint REBLO on airway P130 started at 2250z. Started in Turkish FIR, **ADS-B OUT L EICAS** message received, and checklist actioned. Same status message. **Inertial displayed on ND**. Event lasted **20 mins** before GPS recovered and displayed on ND. Lasted until Baku FIR

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 ⁴entry into Saudi Airspace, no further recurrence during flight.

On Dep from BEY, throughout climb until north of Cyprus, **multiple NAV fm/gps pos disagree and multiple GPS 1 faults**. All transient, **no apparent map shift occurred**. **Transient faults self clearing but numerous and distracting**.

Shortly after takeoff we again received **multiple gps1, gps2 & GPS/NAV disagree Ecams**. Each was FNC'd and the flight continued using raw data in VMC. Passing approx 3000' and coasting out, we received a **SINGLE "Too Low Terrain" aural warning**. Although below SSA of 4500' we had a good climb rate and would soon be above SSA, we were **in VMC On the SID with our position checked using raw data from LCA VOR on 223 radial**. **The warning was clearly spurious and most likely generated as a result of GPS jamming**. **We elected NOT to fly the "Pull Up TOGA" CFIT manoeuvre and were very quickly above SSA**.

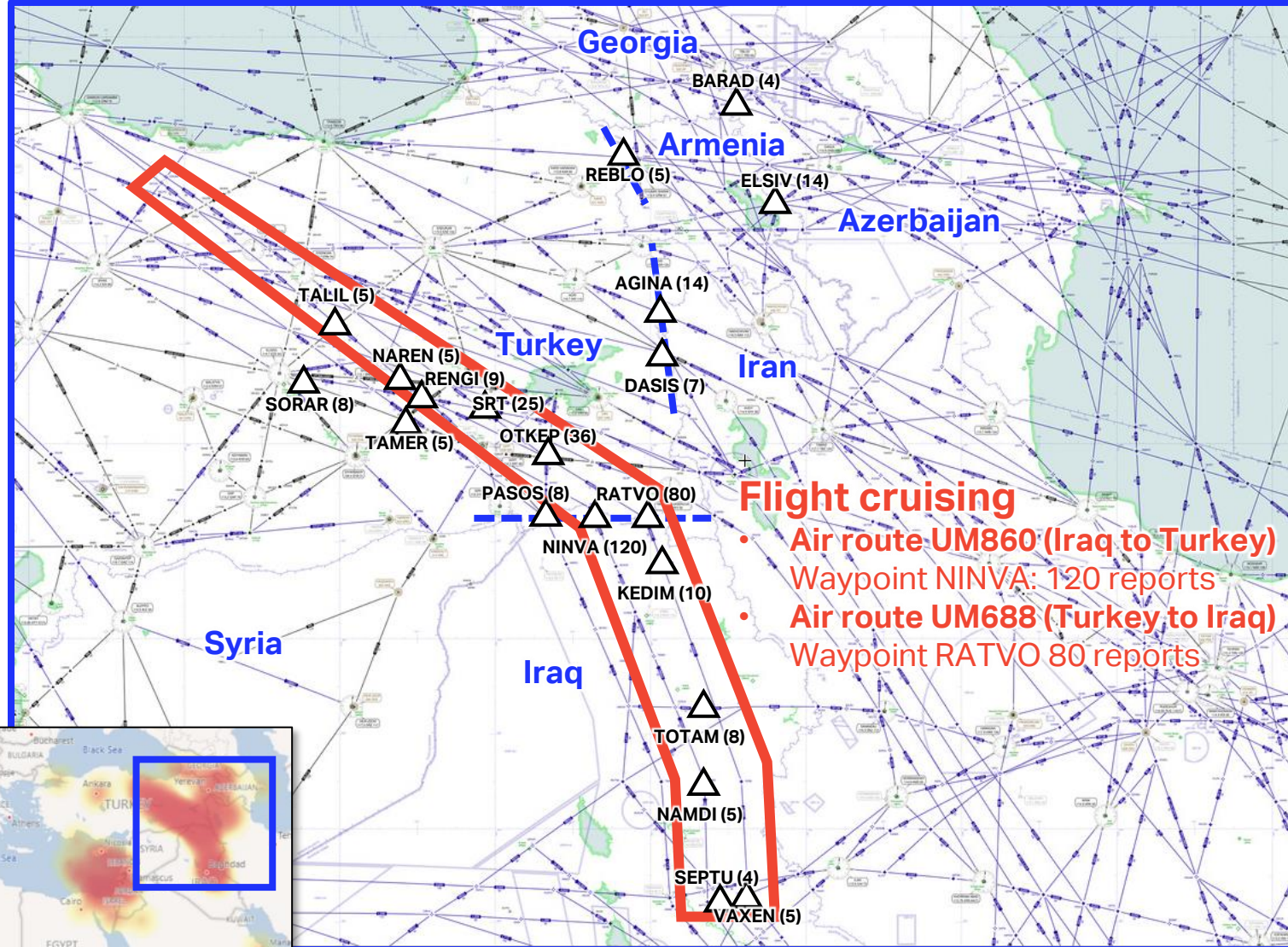
Loss of required navigation performance (RNP) during the RNP approach to Runway 30, resulting in activation of the onboard performance alert.

Path deviation while flying a straight course using LNAV.

Two false EGPWS alerts ("TERRAIN TERRAIN, PULL UP") during the ILS approach to Runway 21. In both cases, **the crew involved identified the alert as being false and continued the approach**.

Insights from Interference: En-route

Reported waypoints (number of reports)



- Flight cruising**
- Air route UM860 (Iraq to Turkey)
Waypoint NINVA: 120 reports
- Air route UM688 (Turkey to Iraq)
Waypoint RATVO 80 reports

Findings

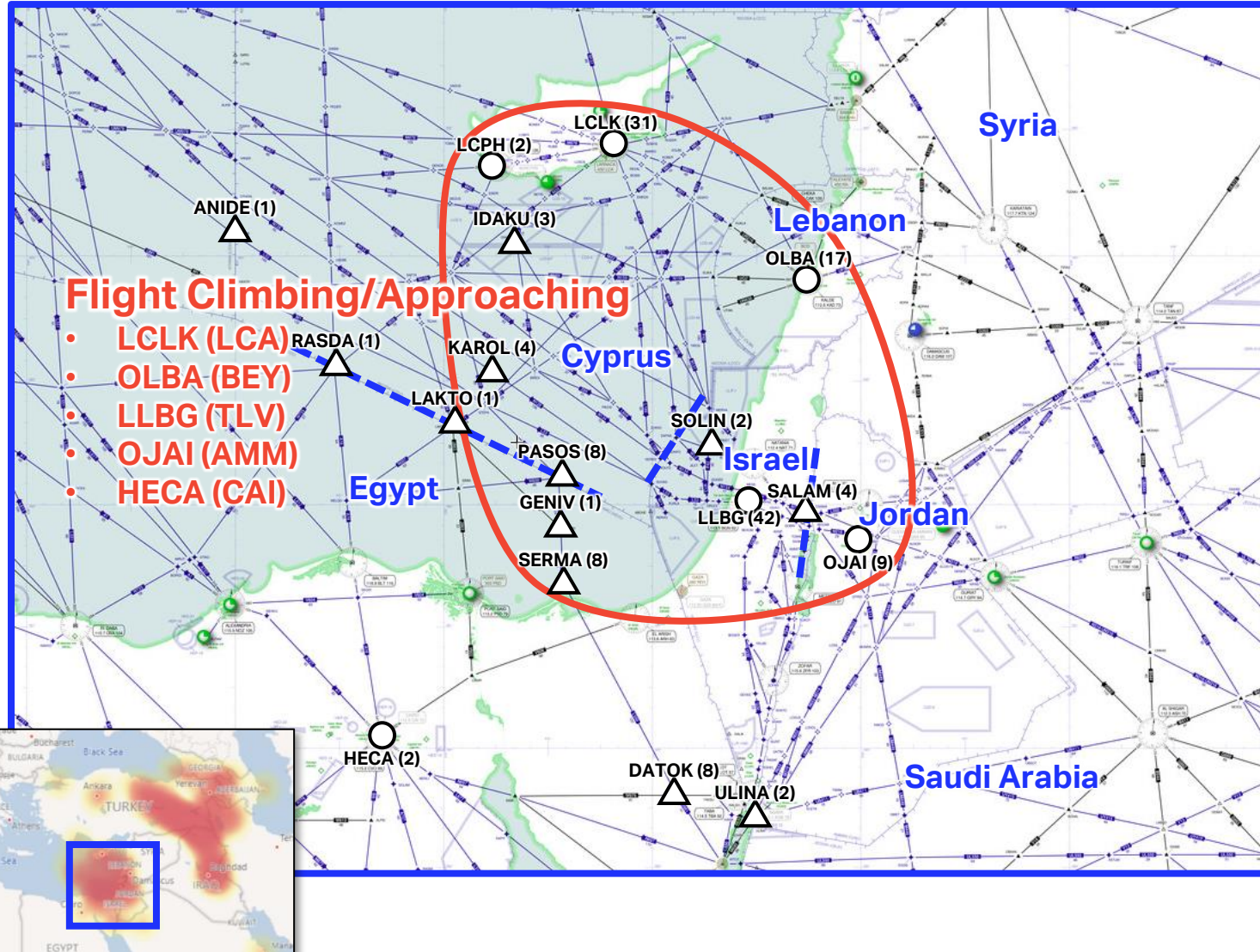
- All most all GNSS/GPS interference reported here were during the cruising phase.

Insights

- Major airlines avoid flights over Syrian airspace, and thus, numerous traffic is concentrated over air route UM680 and UM688 (e.g. routes from Europe to Persian Gulf, a.k.a Arabian Gulf, or to India).
- **GNSS interference made rerouting very difficult, particularly near conflict zones.**
- Major routes connecting Europe to Asia and the Middle East – very important for Covid-19 recovery

Insights from Interference: Terminal Area & Approach

Reported waypoints (number of reports)



Findings

- Most of the GNSS/GPS interference shown here were during the **approach, descent or climbing** phase.

Insights

- During the interference, some airlines choose to not commence or continue RNP approaches unless the reported visibility is at least 5,000 m and the reported ceiling is at least 1,500 ft.
- **ILS approaches become clear preference and necessity whenever GNSS integrity is in question.**

IATA Recommendations

1. States to implement appropriate mitigation measures as contained in ICAO GNSS Manual (Doc 9849) as a matter of high priority and to report progress and any difficulties to ICAO; and
2. States, when using GNSS jammers during military exercises and operations, to recognize the unintended impact of harmful interference to civil flight operations and to exercise caution to the maximum extent possible to protect the safety of civil aircraft during military exercises and operations; and
3. States to establish and ensure appropriate frequency regulations are in place and maintained to protect allocated GNSS frequencies from harmful interference in line with ITU Radio Regulations; and
4. States to ensure that contingency procedures are established in coordination with air navigation service providers and airspace users and that essential conventional navigation infrastructure, particularly Instrument Landing System (ILS), are retained and fully operational; and
5. National aviation authorities and Air Navigation Service Providers (ANSPs) to establish a process to detect harmful interference to GNSS and promptly notify airlines and airspace users; and

IATA Recommendations

6. Airspace users and ANSPs to inform flight crews and air traffic controllers about the impact of GNSS interference and establish effective contingency procedures and capabilities as appropriate; and
7. 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; and
8. ICAO, in coordination with manufacturers and airspace user communities, to develop a global strategy on Alternative Position, Navigation and Timing. This A-PNT strategy should aim to ensure continuity of flight and ATM operations during interruptions of GNSS and should include the increasing capabilities and roles of INS/IRU; and
9. ITU in cooperation with ICAO to analyze the reported cases of harmful interference to GNSS and establish appropriate measures to address the safety impact on aviation.