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Joint ICAO Europe and North Atlantic (EUR/NAT) and Middle East (MID) Workshop on the Global Navigation Satellite System (GNSS) Radio Frequency Interference (RFI)

(Doha, Qatar, 18-20 November 2025)

Cyprus' 2024 GNSS jamming / spoofing Experiences

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Cyprus' 2024 GNSS jamming / spoofing Experiences

- **Focusing on the unexpected cases for year 2024;**
- **Noting the "improved" picture of 2025;**

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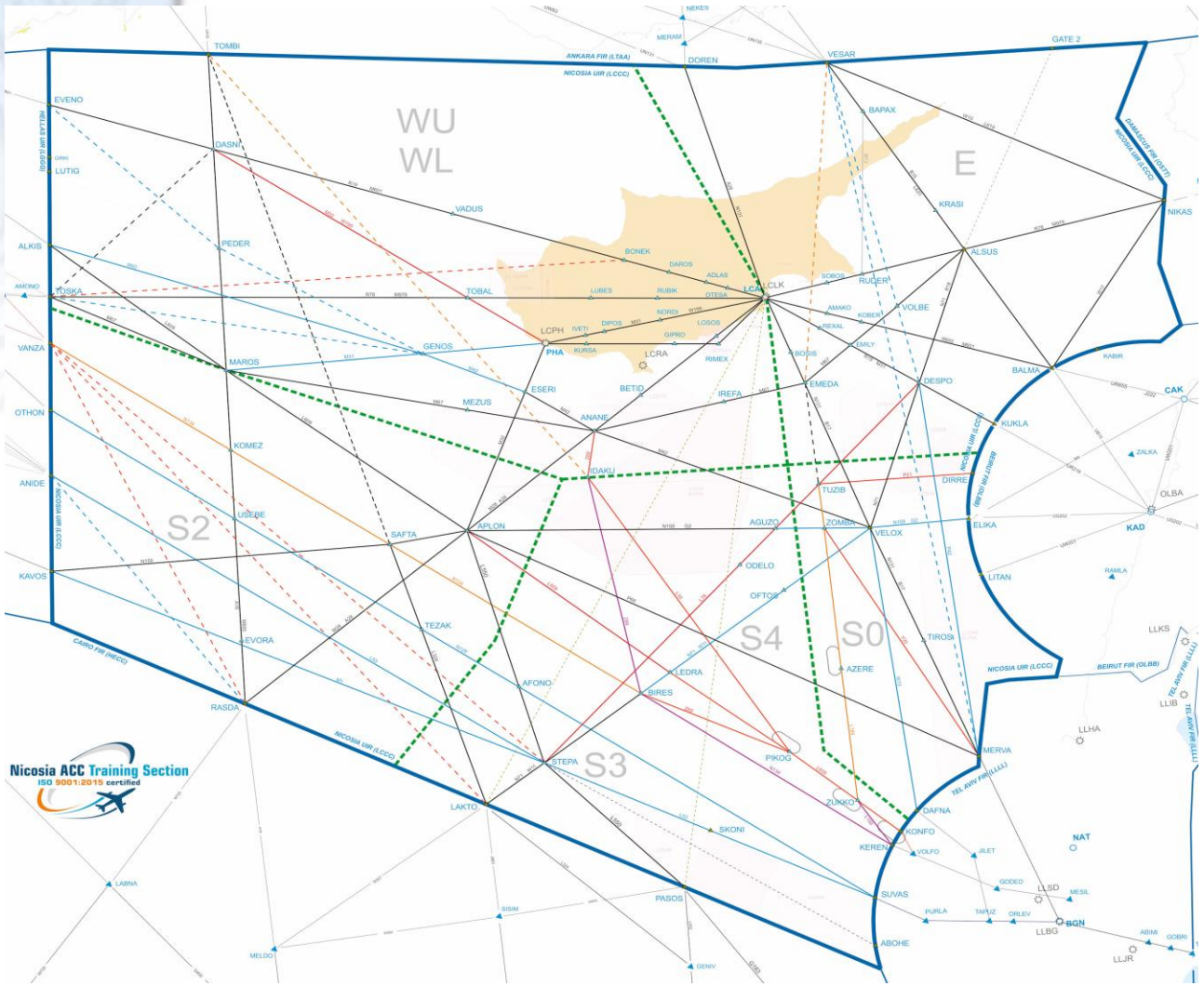
Cyprus Air Navigation Services – CYANS

Provide ATS, AIS, ATFM, ASM and FDD in the Nicosia FIR

CNS and MET provided by independent ANSPs



1. Nicosia FIR; (175,000 sq miles mostly high seas)
2. One Area Control Centre: Nicosia ACC;
   a) 411K flights in 2019;
   b) 402K flights in 2023;
   c) 379 K flights in 2024.
3. Two ATC Towers:
   a) Larnaca ATC Tower, 74K flights in 2024;
   b) Pafos ATC Tower, 30K flights in 2024;

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EU regulatory requirements regarding PBN

(EU) 2018/1048

Article 5: Exclusive use of PBN

1.Providers of ATM/ANS shall not provide their services using conventional navigation procedures… They shall only apply the PBN procedures specified in the Annex of the regulation…

Various timeframes apply, but the ultimate deadline is 2030…. **Now this is reevaluated!!**

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CURRENT SITUATION

En-Route	Conventional ATS routes	A number of conventional ATS routes kept in Nicosia FIR up to FL285
	RNAV 5 ATS routes	Nicosia FIR consists of RNAV 5 ATS ROUTES mainly from FL035 to FL660
	Free route airspace	Free route airspace operates from FL205 up to FL660 on 24 hour base. Also Cross border FRA with Greece. **This situation creates difficulties for the controller to spot an aircraft drifting from its route.**
Arrivals/Departures	Conventional STARS / SIDS	Kept the basic Conventional STARS and SIDS as back up to the RNAV ones, but last year due to the increased GPS interference we had to create more conventional SIDs and STARs to accommodate the traffic, **as pilots were refusing to use the RNAV ones.**
	RNAV 1 STARS / SIDS	RNAV 1 STARS and SIDS for all RWY ends. Since 2020 this was the main way of navigation since controllers had instructions to clear all traffic on the RNAV procedures. Since last year, due to high number of interference and increased request from pilots to use the conventional ones, **ATC went back to conventional.** **Nowadays even if the RFI is greatly reduced we still use the convectional ones.**
Approaches	VOR/DME	Kept the VOR/DME approaches for all Runway ends with different transitions as contingency to RNP APCH, **But now still are the main Approaches for the Non Precision RWY ends**
	ILS/VOR/DME	Kept the ILS/VOR/DME approaches for the precision Runway ends with different transitions as contingency to RNP APCH, **But now are the main Approaches**
	RNP TO ILS	Strategically placed RNP1 to ILS approaches, with RF leg for smooth interception with ILS. Used since 2014 with great success until recently. **Not used anymore because of GPS problems**
	RNP APP	RNP Approaches for all runway ends since 2021 with different transitions as to facilitate arriving traffic from all Directions. They were preferred for the Non precision Runways **But are Not used anymore because of GPS problems**
	RNAV TO VISUAL	Since 2014, we published an RNAV to Visual procedure due to airspace restrictions that gives 12 NM less flying distance compared to the other instrument procedures. **It was used very often until the GPS problems.**

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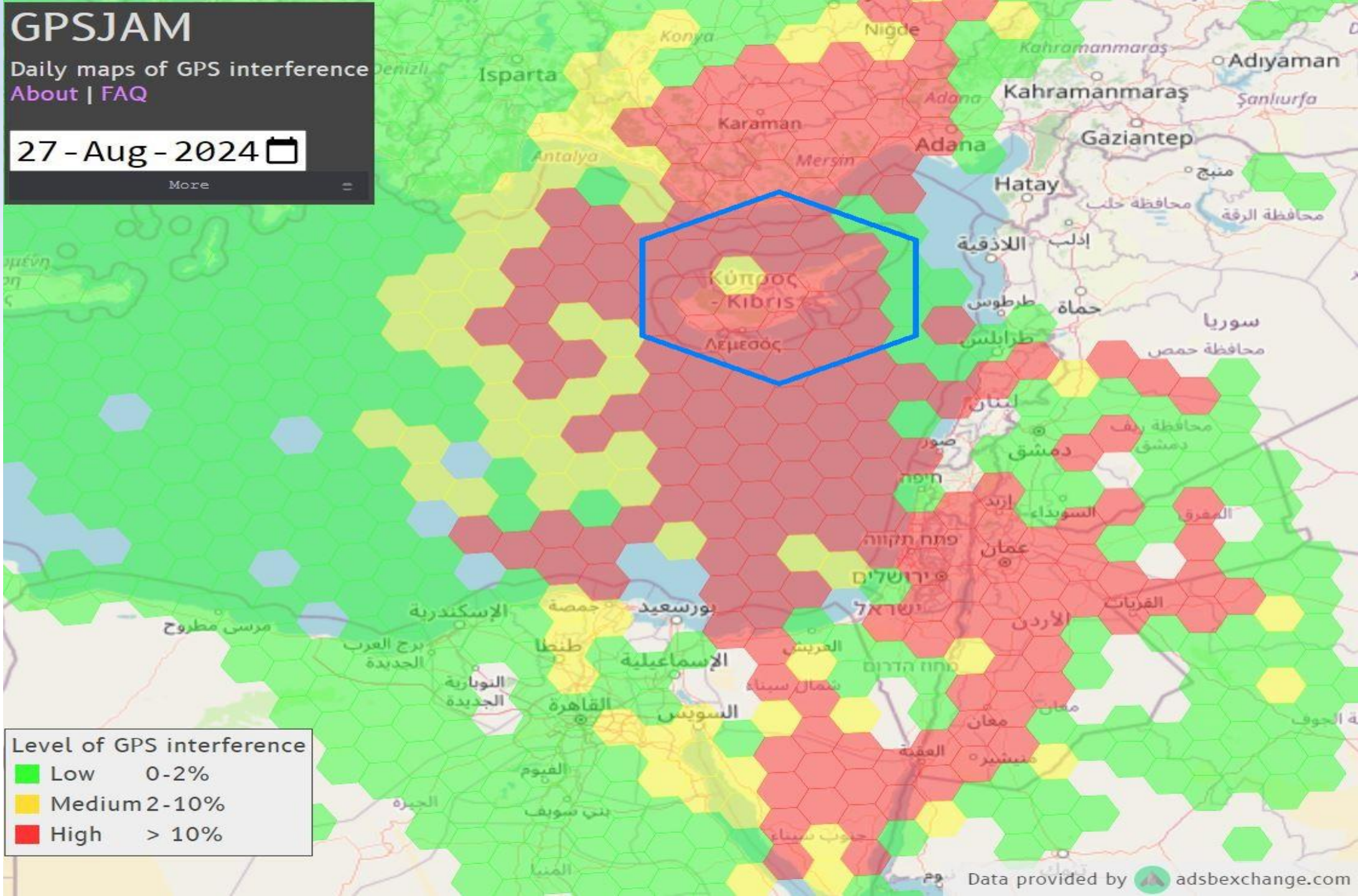

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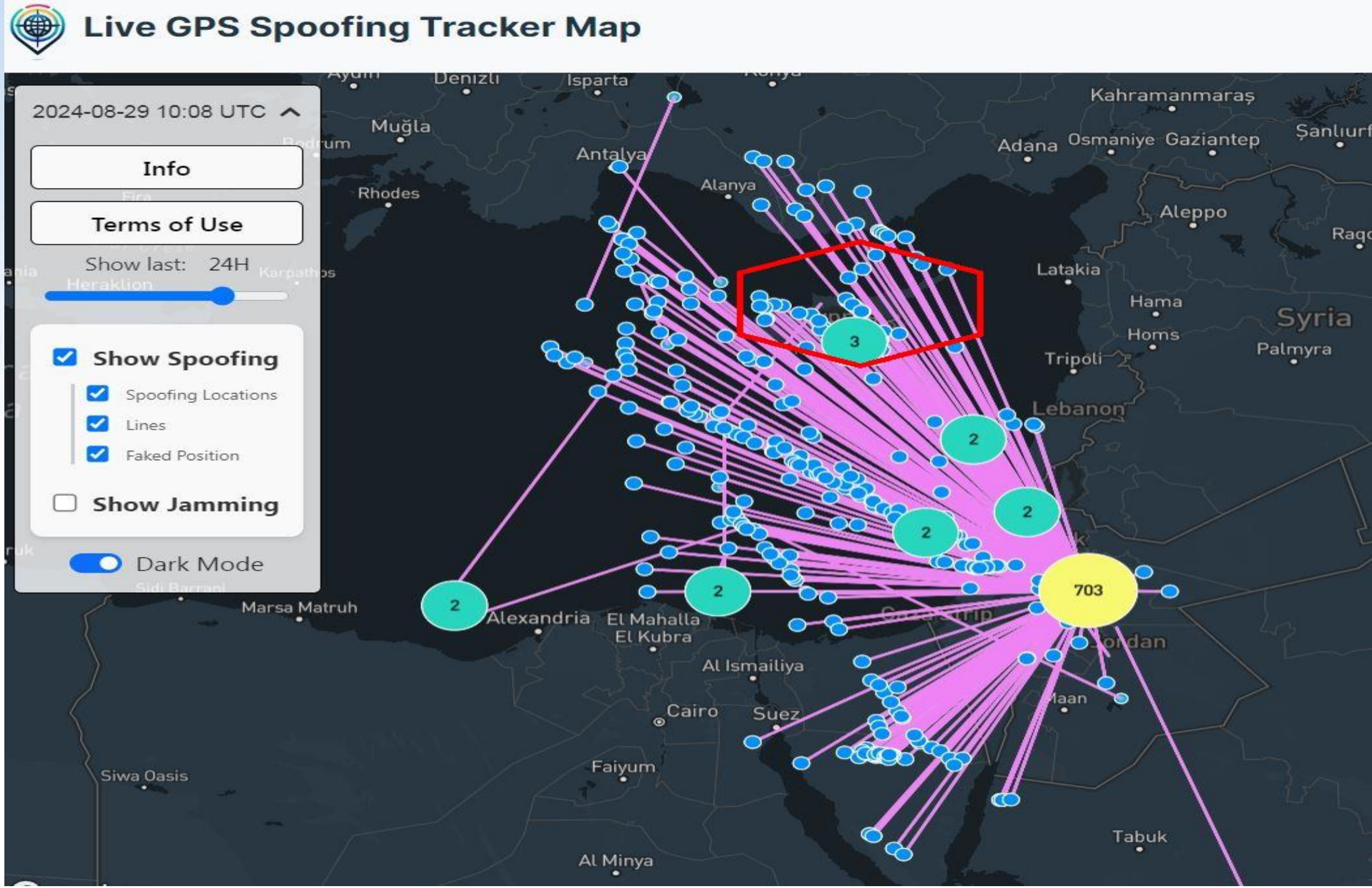

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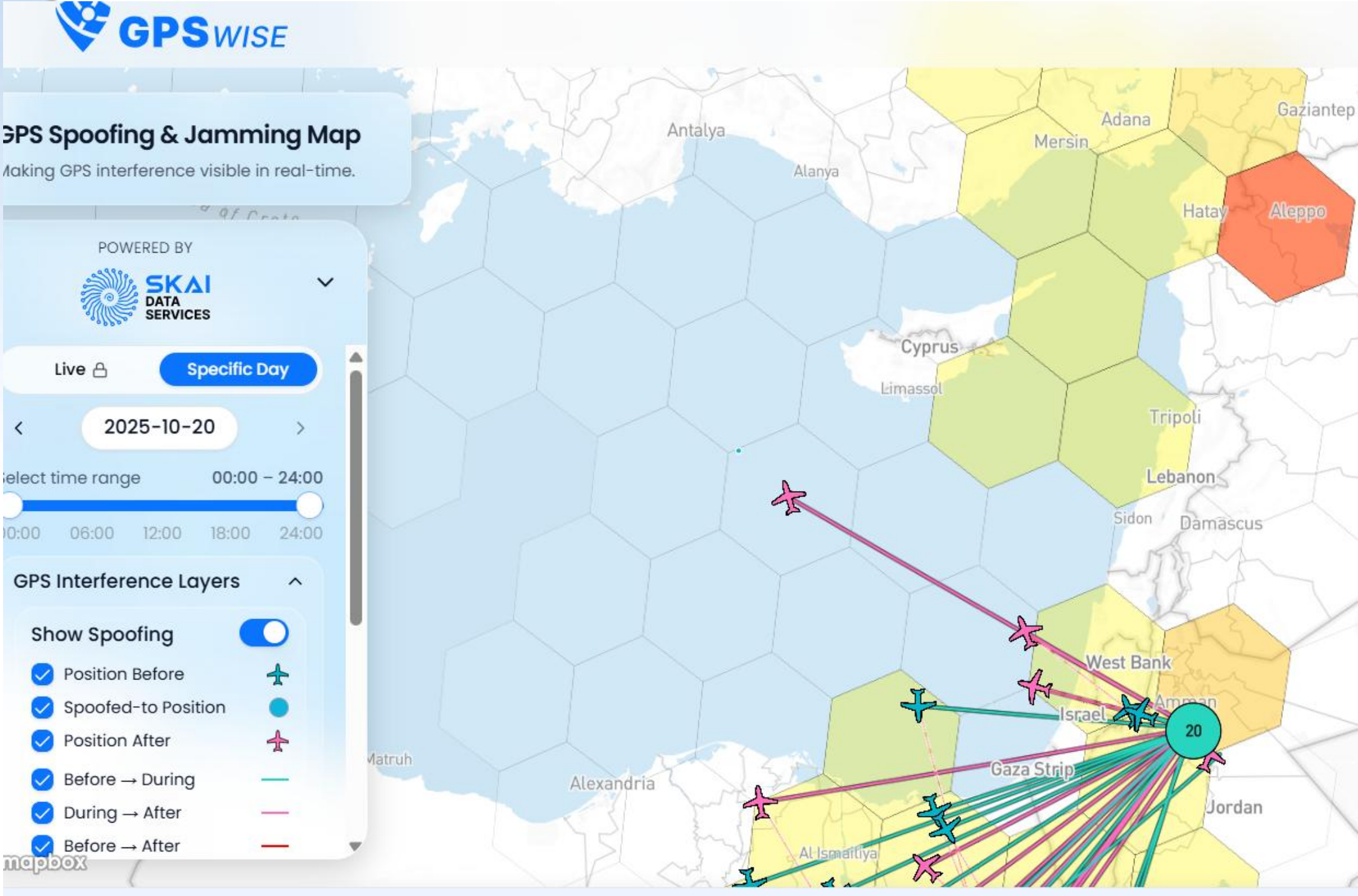

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GNSS RFI is monitored and addressed by Cyprus since 2018

A high increase of GPS Occurrences reported by flight crews (aircraft) is recorded since 2022

Since December 2023 and for the whole 2024 we notice:

a) **An exponential increase of GPS Spoofing Occurrences; and**

b) **Further impacts on aircraft performance and ATC.**

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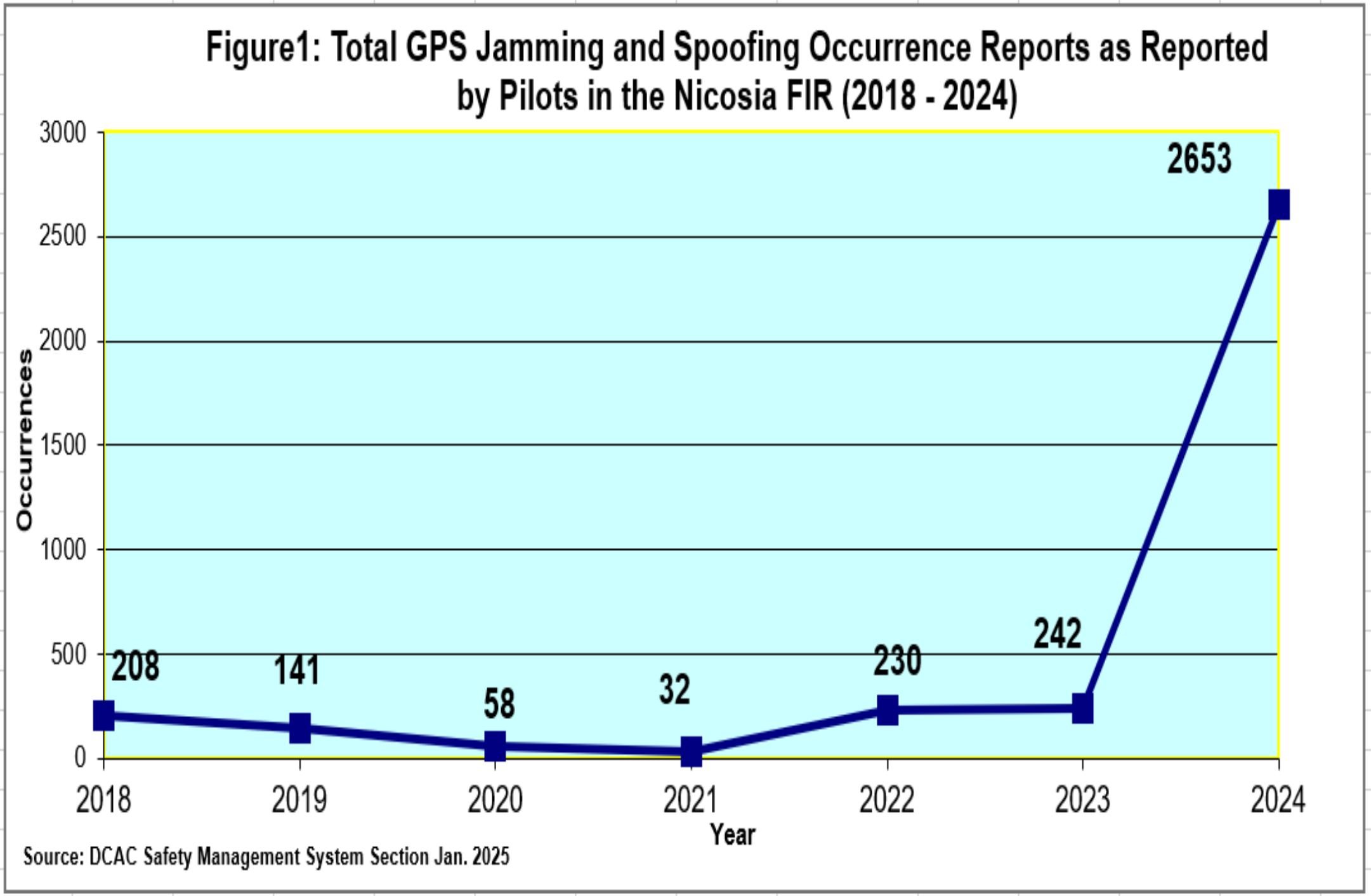

An exponential increase of GPS Spoofing Occurrence Reports since Dec. 2023

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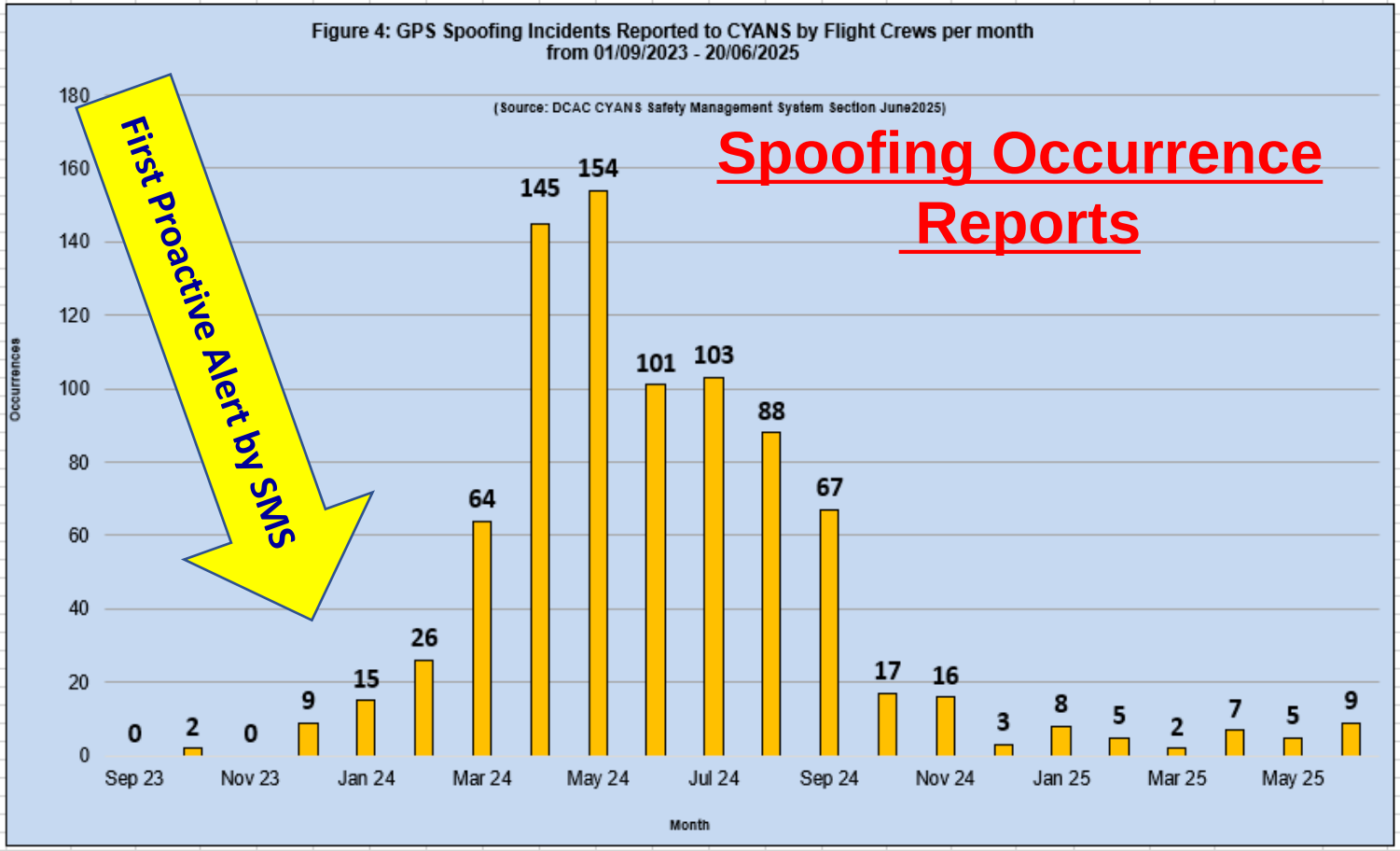
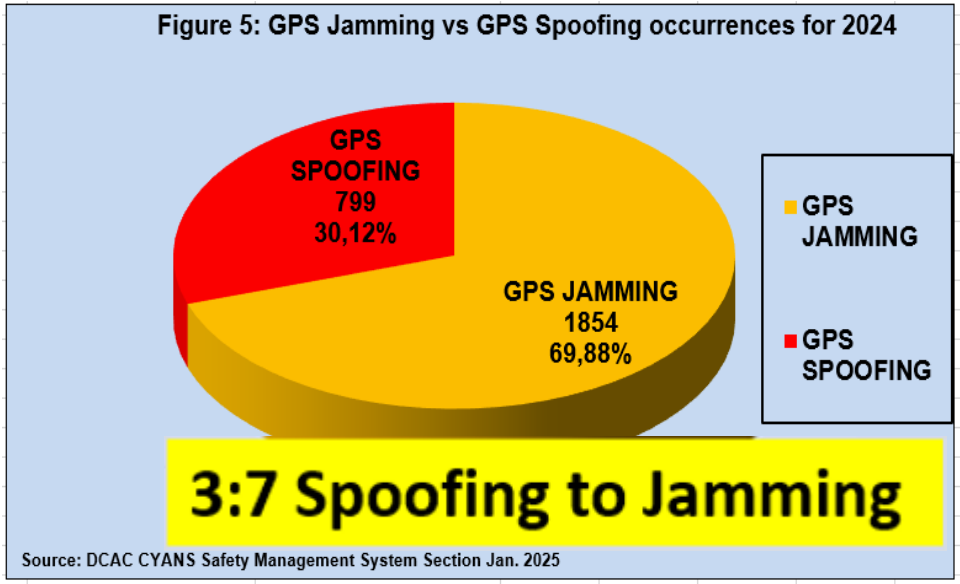
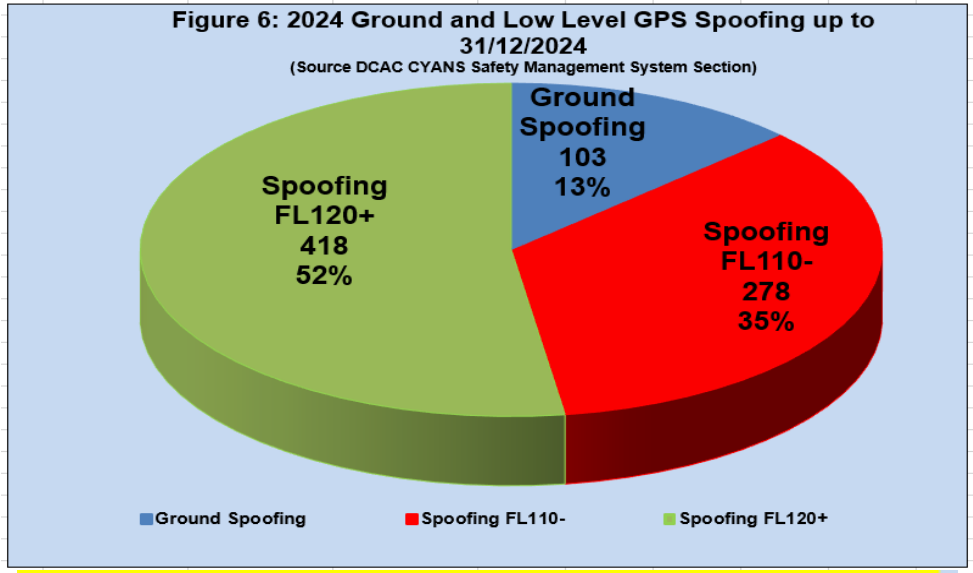
- Not all occurrences are reported by flight crews because of non-uniform airline reporting procedures
- A huge resource to administer GPS Occurrences.







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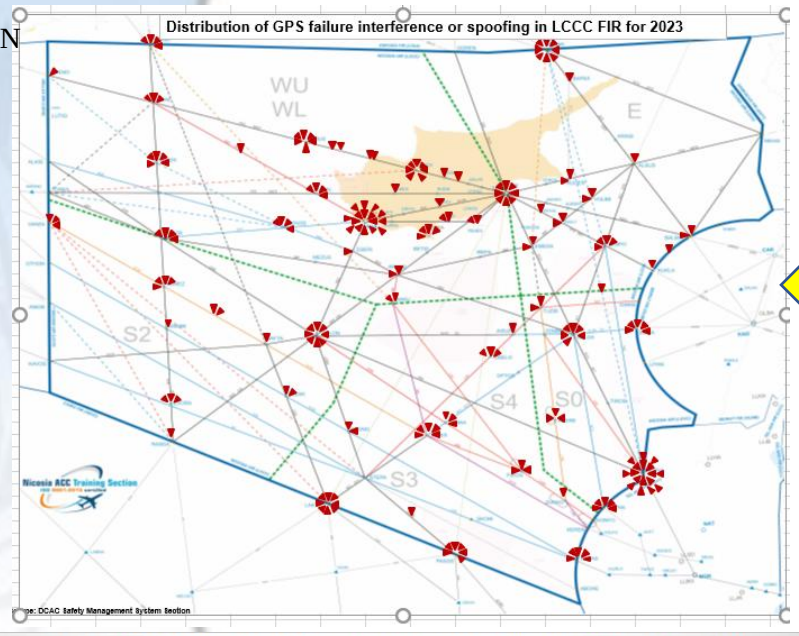
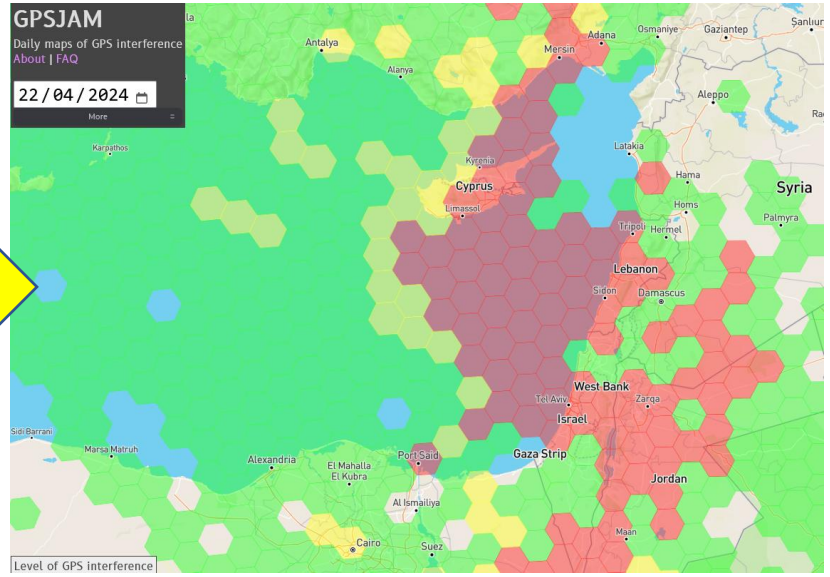
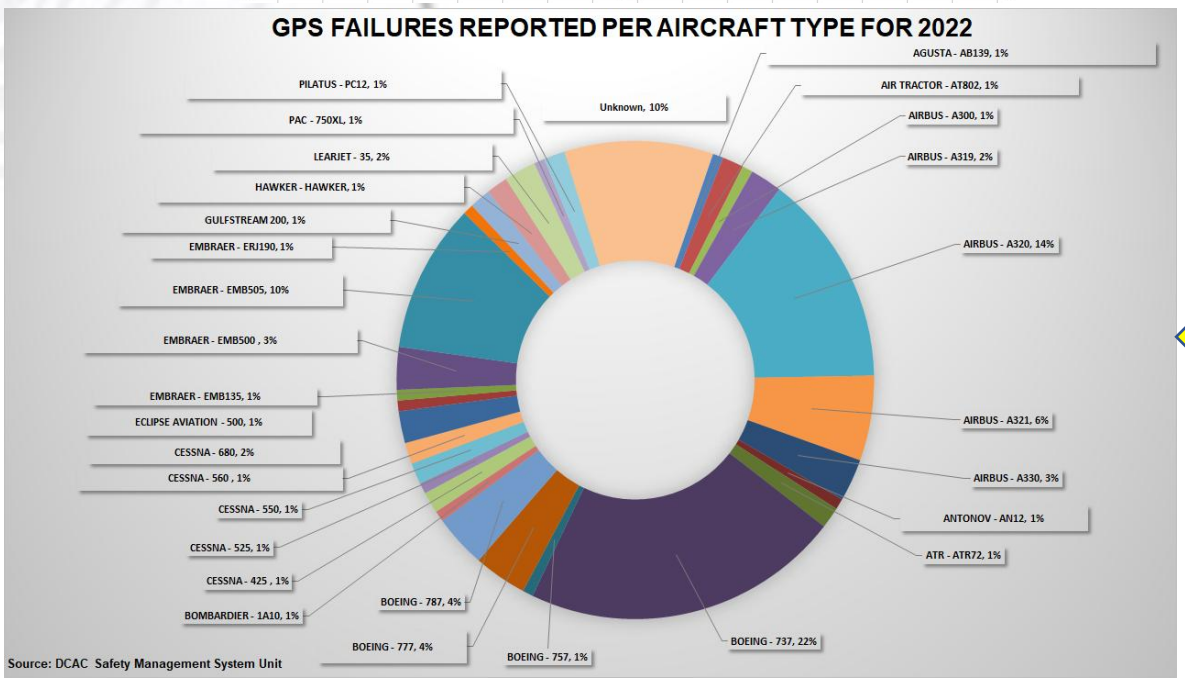
GNSS RFI occurrences' mapping, analysis and assessments indicate:



All the Nicosia FIR is affected.
East FIR more.

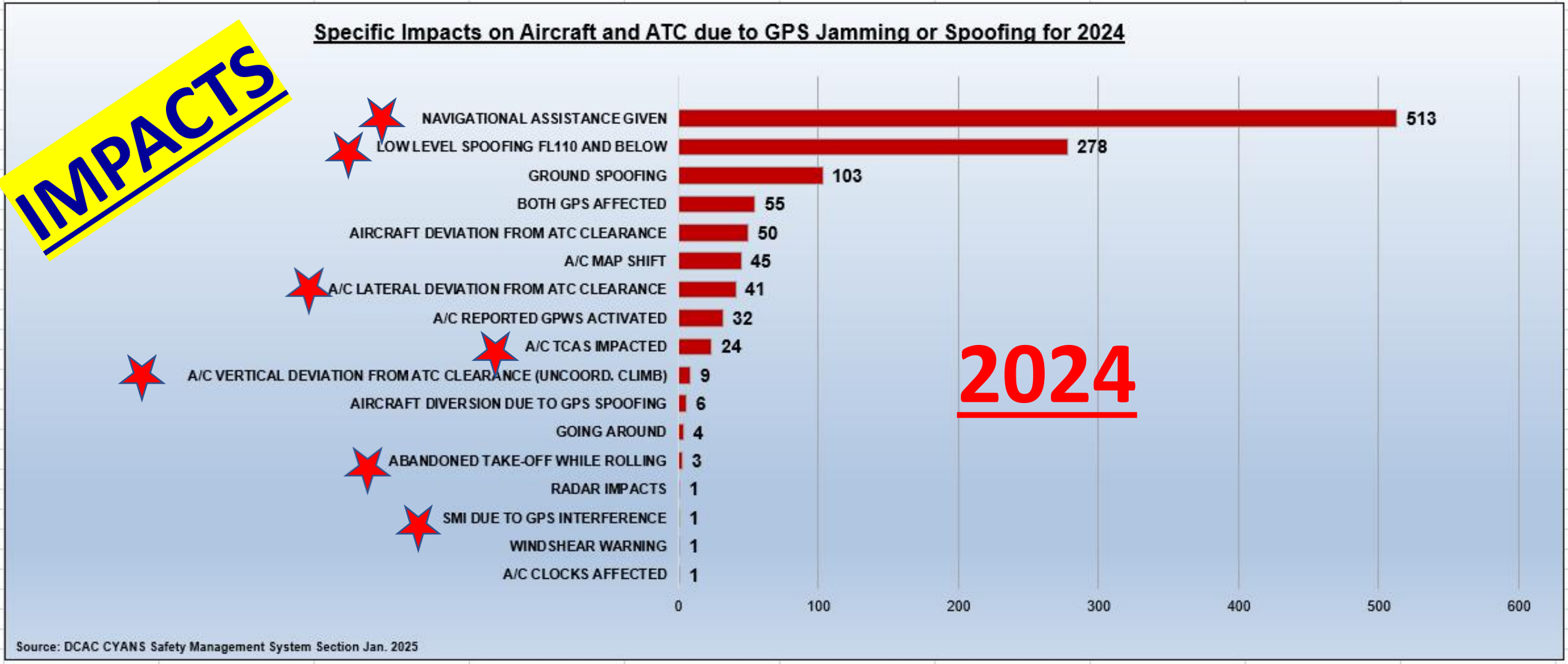




All aircraft types are affected

Occurrence Reporting verified known impacts and revealed new ones

IMPACTS



★ Including Aircraft difficulties to fly conventionally – With deviations from conventional SIDs and STARs;

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GPS Jamming / Spoofing Update
A Rising Hazard to Aviation

2024 Occurrences

Low rates but safety significant

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Incident 1

April 2024, CAVOK, A321, under Larnaca TWR on procedural control, descending through 2100 ft, turning to establish on ILS RWY 22, with clearance to land, reported “going-around” no information on altitude.

1. Aircraft was established on Localizer with RWY in sight, and Initiated **Uncoordinated Climb** due to reported GPWS alert, Without ATC clearance and without warning to ATC
2. With Very High rate of climb (≈4600ft/min)
3. Sets mode – S at 6000 ft.
4. Afterwards reported climbing to MSA 6000ft
5. Overshoots by 400ft the mode-s indication and intended altitude
6. Note : Missed Approach altitude is 2000ft,
7. A321 released back to Larnaca Approach Surveillance Service (LCA APS), vectored to final and landed safely.
8. No other traffic at time

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Incident 2

April 2024, B738 under Larnaca TWR procedural control, when at 3000ft and on the outbound leg of I/V/X RWY 22 reported "going-around" due to GPWS alert.

1. **Without ATC clearance** and without warning to ATC, while on sequence to land, The B738 initiated uncoordinated climb to 6000ft .
2. **High rate of climb** (≈4000ft/min)
3. Overshoot by 200 than mode-s indication.
4. ATC passed traffic information and assisted aircraft to land
5. Two other aircraft in the vicinity, one ahead and one behind were not affected by GPS interference.

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Incident 3

B738, under Nicosia Radar, time 16:25, approaching Larnaca for landing from the south over sea, reported GPS spoofing in the area of EMEDA while descending to FL120. Approaching FL140, initiated climb to FL150 (Uncoordinated Climb), due to GPWS.

1. Even the aircraft is climbing, on radar label there is still Indication of descent, Mode-S still indicates previous clearance (S120)
2. Pilot reported climbing FL150
3. On radar label ROC indicates 3000ft/min
4. Mode-S still indicates previous clearance.
5. The reported level was overshoot by 1400ft

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Incident 4

B738, under Pafos ATC for landing, 17:15, on first contact the B738 was cleared direct to PHA VOR for the conventional I/V/X for RWY29 but the pilot requested TOBAL 1P (RNP) and was cleared to proceed direct to TOBAL.

1. Less than two minutes after point TOBAL, on the cleared approach, the pilot reported approaching ENIAS but was seen proceeding East towards Paphos town. A/C assisted by ATC to PHA VOR for the conventional VOR/ILS X approach.
2. When on base turn Mode-C Indicates that the a/c is Climbing – no information from pilot.
3. Mode-S still indicates previous clearance
4. On radar label ROC indicates 4600ft/min
5. And level intended by a/c (as shown on mode S) is overshoot by 900ft.
6. A/C communicates and assisted by ATC for safe Landing

Incident 5

A320, after take-off Larnaca, due to GPS Spoofing instead of left towards the sea turned to the right towards, high terrain and opposite to inbound A320.

- **April 2024, 11:07, A320;**
- **Daytime, CAVOK**
- **A/C reported GPS interference before departure and requested conventional SID;**
- **Obtained Clearance for EMEDA 2B DEP which after T/O turns left over the sea;**
- **After take-off, instead of turning left, turned to the right, towards high terrain and opposite to inbound A320**
- **Conflict immediately resolved by APS (Approach Surveillance Service)**
- **From the transcript below it can be seen the confusion in the cockpit.**

11:07:39 - Pilot reported "are we proceeding to EMEDA?"
11:07:49 - Pilot reported "we lost the GPS" and that was the reason of the right turn instead of the correct left turn.
11:09:12 - Pilot reported "requesting radar vectors we are experiencing GPS interference".
11:09:12 - Pilot reported "just confirm heading takes us to the left to intercept the heading 150?, according to our FMS to intercept will be to our right".

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Incident 6

A320 - Route lateral deviation after departure. Resolved by Nicosia ACC

1. April 2024, 09:35, A320
2. After departure, a/c reported unable to follow conventional, RWY22, PAFOS 2B departure and turned to the right towards high terrain.
3. A/c was monitored and instructed to climb FL200 and to expedite passing FL090. NACC was informed.
4. After release to NACC, a/c initially requested vectors for navigation and was considering diverting back to LCA.
5. A/c requested vectoring to PHA VOR so as to update a/c's position.
6. After doing so a/c was able to resume own navigation.

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Incident 7

June 2024, 06:31 UTC

Separation Minima Infringement (SMI) in response to GPW at FL370

1. A319 near point VESAR at FL370 over the sea
2. Responded to a GPW (due to GPS spoofing)
3. Commenced climb without ATC clearance
4. Opposite direction traffic at FL380
5. Standard 1000 ft separation lost
6. NACC ATC responded by providing essential traffic information to the a/c which climbed up to FL374, before descending back to FL370.

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Incident 8
A320 Map shift on the ILS approach RWY 29 at Paphos airport daytime

Pilot comments

- Commencing ILS X RW29 after LOC capture about 8nm final the Navigation Display of the aircraft start moving to the left, ANP (Actual Navigation Performance) was exiting RNP.
- The fact that we were in VMC conditions allowed us to regain situation awareness and continue the approach to a safe landing.
- However, in case of missed approach LNAV (lateral navigation) would have been unavailable in a non-radar environment.
- Adding that there were a lot of conflicting and confusing information.

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Incident 9

Spoofing Nic FIR daytime (private jet only GNSS)

- **A/c with destination Larnaca routing via EVENO-VADUS-BONEK-LCA**

Pilot reported:

- **Started to descend into LCLK. At the start of the descent, we got an amber ADS-B out (14h02), coming on and out again 2 times. Then around VADUS point (14h07, about 80nm out of LCA), all of a sudden, we had flashing screens, and we lost our position, the plane reference was over Tel -Aviv, no more route was showing.**

Several amber messages on screen:

- **TAWS** (Terrain Avoidance and Warning System),
- **MAP FAIL,**
- **Check fuel at destination (showed 0),**
- **TAWS TERRAIN FAIL,**
- **FMS DR (Dead-Reckoning)**

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Incident 10
GPS Spoofing on Radars

1. August 2024;
2. Factual data:
   a) At West Sector, all targets on the radar screen shifted from their current position to previous position for about 5 seconds.
   b) Two targets at the FIR boundary lost.
3. Initial CNS ANSP assessment:
   a) Three of the 5 radars impacted.
   b) Identified a problem of time synchronisation (GPS clock) of the radars.
4. Mitigations:
   a) Technical solutions have been implemented immediately:
      i. Removal of GPS antennas from Radars;
      ii. Use of internal radar clock;
      iii. Manual synchronization of internal clock with other systems.
   b) System manufacturer has been informed and involved;
5. Monitored daily to confirm the measures effectiveness. It appears that, so far, these mitigations are working well.

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CONCLUSIONS - COMMON OBSERVATIONS FROM INCIDENTS:

1. A/c climbs (in response to GPW) to unknown level/altitude without any warning. Defined as "*uncoordinated climbs*" which constitute vertical deviations from ATC Clearance;
2. Rate of climb is very high;
3. As a result, a/c overshoot the level they declare they are climbing to;
4. Pilots not aware of their position, requesting navigation assistance
5. Lateral deviations from ATC Clearance (SIDs, STARs, En-route)
6. Noise and confusion in the cockpit

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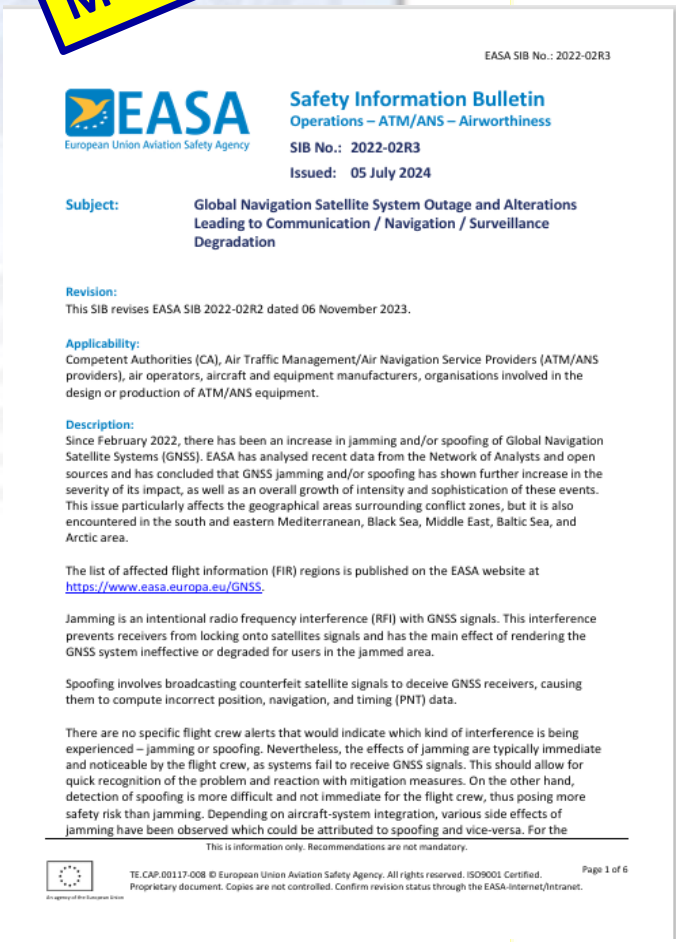
Actions and measures taken by Cyprus are based on the EASA SIBs and further proactive initiatives by Cyprus

Actions, Initiatives and Measures by Cyprus

Quick Reporting - User Consultations - Alerts



EASA SIB No.: 2022-02R3

EASA
European Union Aviation Safety Agency

Safety Information Bulletin
Operations – ATM/ANS – Airworthiness
SIB No.: 2022-02R3
Issued: 05 July 2024

Subject: Global Navigation Satellite System Outage and Alterations Leading to Communication / Navigation / Surveillance Degradation

Revision:
This SIB revises EASA SIB 2022-02R2 dated 06 November 2023.

Applicability:
Competent Authorities (CA), Air Traffic Management/Air Navigation Service Providers (ATM/ANS providers), air operators, aircraft and equipment manufacturers, organisations involved in the design or production of ATM/ANS equipment.

Description:
Since February 2022, there has been an increase in jamming and/or spoofing of Global Navigation Satellite Systems (GNSS). EASA has analysed recent data from the Network of Analysts and open sources and has concluded that GNSS jamming and/or spoofing has shown further increase in the severity of its impact, as well as an overall growth of intensity and sophistication of these events. This issue particularly affects the geographical areas surrounding conflict zones, but it is also encountered in the south and eastern Mediterranean, Black Sea, Middle East, Baltic Sea, and Arctic area.

The list of affected flight information (FIR) regions is published on the EASA website at https://www.easa.europa.eu/GNSS.

Jamming is an intentional radio frequency interference (RFI) with GNSS signals. This interference prevents receivers from locking onto satellites signals and has the main effect of rendering the GNSS system ineffective or degraded for users in the jammed area.

Spoofing involves broadcasting counterfeit satellite signals to deceive GNSS receivers, causing them to compute incorrect position, navigation, and timing (PNT) data.

There are no specific flight crew alerts that would indicate which kind of interference is being experienced – jamming or spoofing. Nevertheless, the effects of jamming are typically immediate and noticeable by the flight crew, as systems fail to receive GNSS signals. This should allow for quick recognition of the problem and reaction with mitigation measures. On the other hand, detection of spoofing is more difficult and not immediate for the flight crew, thus posing more safety risk than jamming. Depending on aircraft-system integration, various side effects of jamming have been observed which could be attributed to spoofing and vice-versa. For the

This is information only. Recommendations are not mandatory.

1. Quick GPS reporting mechanism. Daily monitoring and analyzing the GPS reporting;
2. Regular consultations and data sharing with the Local Aviation Stakeholders since 2021 (DCA Competent Authorities, ATM/ANS ANSP, CNS ANSP, Local Airlines);
3. GNSS RFI alerts in Cyprus AIP Enroute and TMA sections;
4. Jamming and Spoofing NOTAM alerts for the Nicosia FIR and the Larnaca Pafos International Airports;
5. 24/7 live ATIS alerts at the Larnaca and Pafos Airports;

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Actions and measures taken by Cyprus are based on the EASA SIBs and further proactive initiatives by Cyprus.

People – Surveillance – ATC Procedures

1. Personnel is made aware of the GPS issues via alerts, bulletins and briefings;
2. Personnel trainings with the real occurrence examples and lessons learnt;
3. ATC instructions to personnel for traffic monitoring and navigational support to aircraft;
4. Multiple Radar coverage for the Nicosia FIR. New radar into service;
5. Additional Personnel at LCA Tower when available.
6. Instruction to Nicosia ACC supervisors to reduce capacity if the incidents increase

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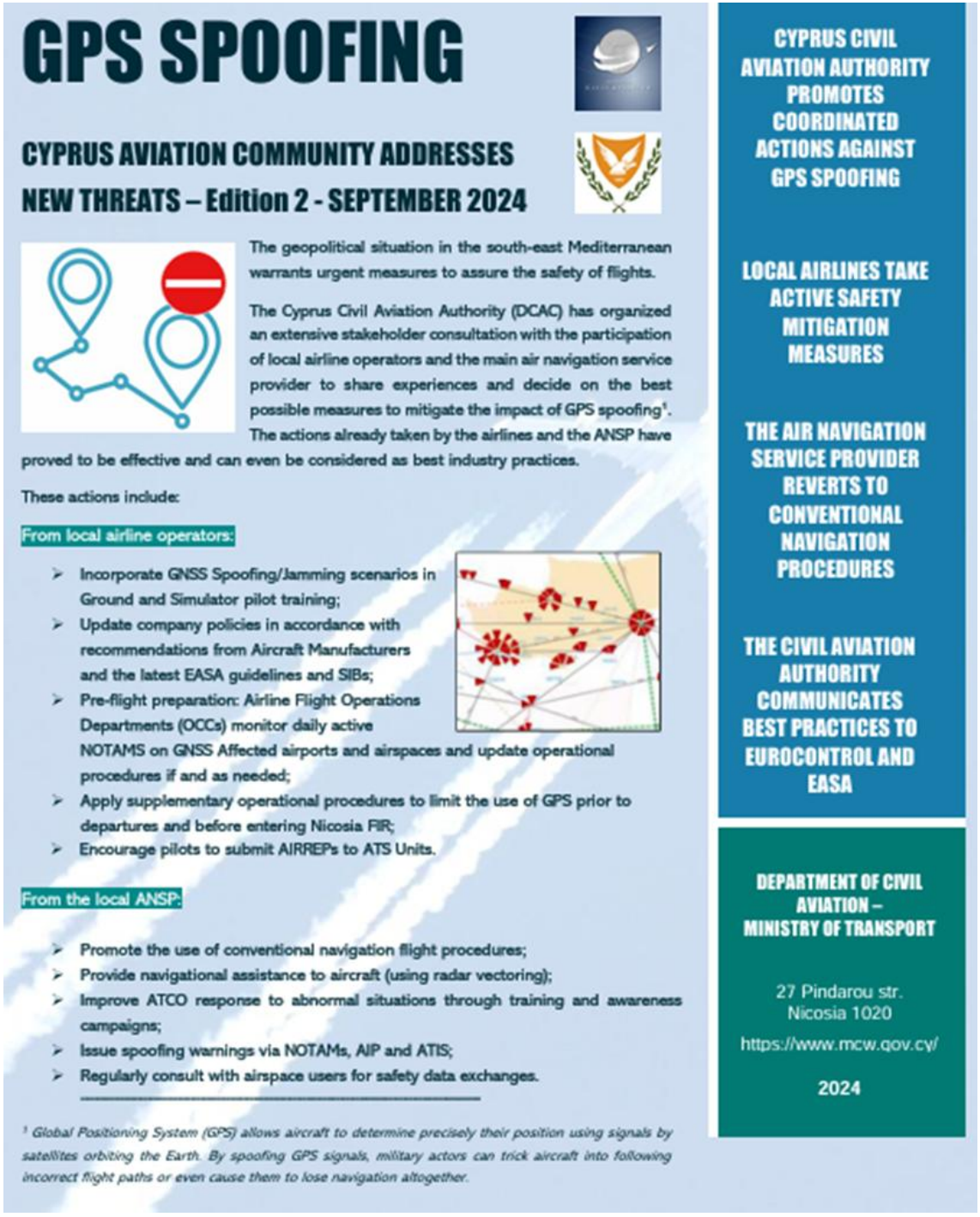
Best Practices Flyer

After a collation of the local airlines' procedures, Cyprus DCA published a best practice flyer, since the local airlines appear aware and rarely impacted.



GPS SPOOFING

CYPRUS AVIATION COMMUNITY ADDRESSES NEW THREATS – Edition 2 - SEPTEMBER 2024

The geopolitical situation in the south-east Mediterranean warrants urgent measures to assure the safety of flights.

The Cyprus Civil Aviation Authority (DCAC) has organized an extensive stakeholder consultation with the participation of local airline operators and the main air navigation service provider to share experiences and decide on the best possible measures to mitigate the impact of GPS spoofing[1]. The actions already taken by the airlines and the ANSP have proved to be effective and can even be considered as best industry practices.

These actions include:

From local airline operators:

- Incorporate GNSS Spoofing/Jamming scenarios in Ground and Simulator pilot training;
- Update company policies in accordance with recommendations from Aircraft Manufacturers and the latest EASA guidelines and SIBs;
- Pre-flight preparation: Airline Flight Operations Departments (OCCs) monitor daily active NOTAMS on GNSS Affected airports and airspaces and update operational procedures if and as needed;
- Apply supplementary operational procedures to limit the use of GPS prior to departures and before entering Nicosia FIR;
- Encourage pilots to submit AIRREPs to ATS Units.

From the local ANSP:

- Promote the use of conventional navigation flight procedures;
- Provide navigational assistance to aircraft (using radar vectoring);
- Improve ATCO response to abnormal situations through training and awareness campaigns;
- Issue spoofing warnings via NOTAMs, AIP and ATIS;
- Regularly consult with airspace users for safety data exchanges.

[1] Global Positioning System (GPS) allows aircraft to determine precisely their position using signals by satellites orbiting the Earth. By spoofing GPS signals, military actors can trick aircraft into following incorrect flight paths or even cause them to lose navigation altogether.

CYPRUS CIVIL AVIATION AUTHORITY PROMOTES COORDINATED ACTIONS AGAINST GPS SPOOFING

LOCAL AIRLINES TAKE ACTIVE SAFETY MITIGATION MEASURES

THE AIR NAVIGATION SERVICE PROVIDER REVERTS TO CONVENTIONAL NAVIGATION PROCEDURES

THE CIVIL AVIATION AUTHORITY COMMUNICATES BEST PRACTICES TO EUROCONTROL AND EASA

DEPARTMENT OF CIVIL AVIATION – MINISTRY OF TRANSPORT

27 Pindarou str.
Nicosia 1020
https://www.mcw.gov.cy/

2024

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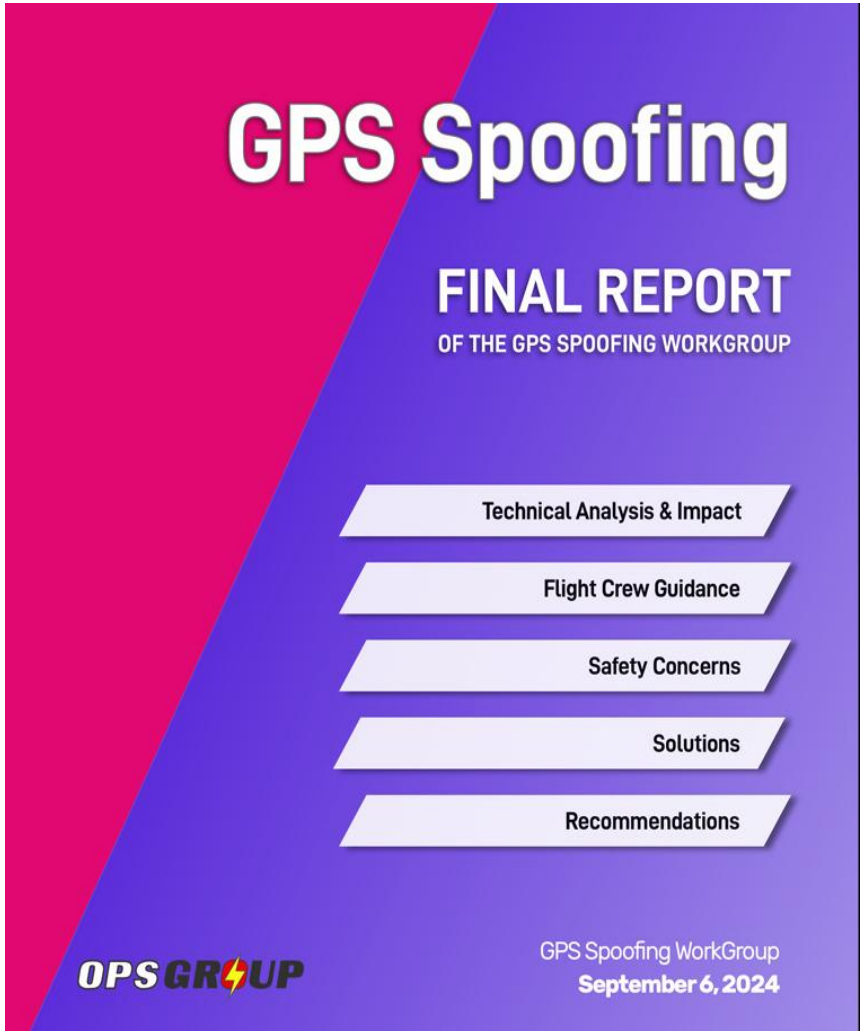
Initiatives

- **Multiple initiatives, presentations and safety data sharing with several organizations such as :**

  a) ICAO;
  b) EASA;
  c) FAA;
  d) CANSO
  e) Ops Group
  f) Other ANSPs

- **GPS safety surveys with results and guidance dissemination to personnel;**



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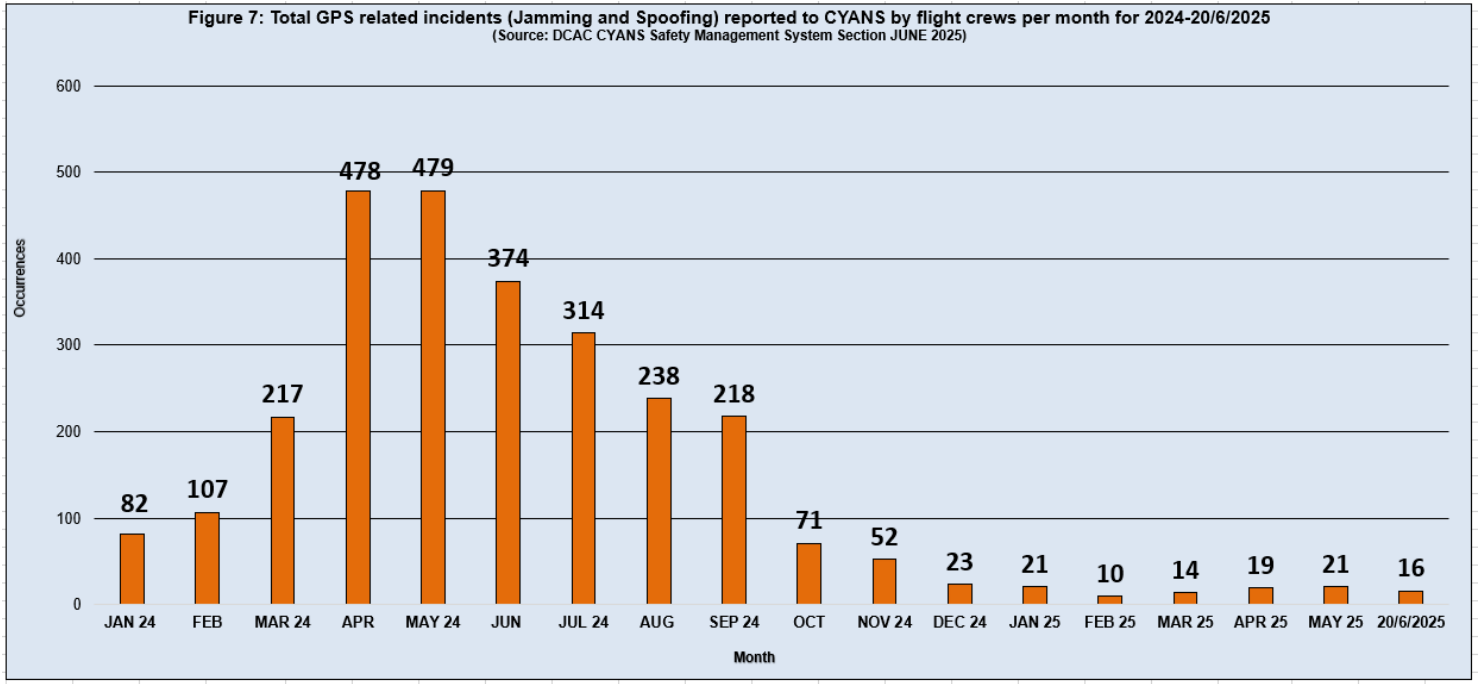
Six months on 2025 Picture: Rest Assured or Remain Concerned?



1. After the March-September 2024 peaks and impacts, the monthly occurrence reports appear reducing;
2. Reasons not yet clear and remain to be validated;
   a) Flight Crews appear more aware and prepared for GNSS RFI due to:
      i. The Cyprus' alerting and proactive measures/initiatives;
      ii. The updated EASA Safety Information Bulletins;
      iii. The recently published Airline and Aircraft Manufacturers' procedures.
   b) Are the Flight Crews used to the "new upnormal" and reduced reporting levels?
   c) Reduced GNSS RFI in the region?

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GNSS RFI Challenges

1. **Not all occurrences are reported by flight crews because of non-uniform airline reporting procedures;**
2. **Managing the thousands of GPS occurrence reports, via the current regulatory provisions and databases (ECCAIRS 2), overloads the aviation stakeholders and requires a huge resource. Need for a simplified GPS Jamming and Spoofing occurrence reporting mechanism;**
3. **Mandatory reporting GPS Jamming and Spoofing is not so clear. Occurrence reporting regulations could be enhanced and clarified;**
4. **Aircraft airmanship. Variable flight crew responses to similar occurrences;**
5. **The most severe hazard. Uncoordinated Climbs = Emergency Climbs with very high vertical speeds. Flight crew response to GPWS activation is associated with uncoordinated climb. The levels that the aircraft are climbing to, in response to "pull-up" GPWS alerts remain unknown**

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GNSS RFI Challenges

6. No standard phraseology to report and acknowledge GPS occurrences or “emergency climbs”. Do we need a TCAS equivalent regulation?

7. Contaminated aircraft GPS. How long away and how to reset in flight?

8. What indicator to use in order to withdraw Alerting GNSS RFI NOTAMs?

9. Global Solutions are needed. Beyond the current mitigations and awareness campaigns, what are the permanent solutions to the problem? Avionics (Multi-frequency and multi-constellation GNSS receivers)?? Regulations?

10. GPS Unavailability /Contamination is leading to loss of GPS Navigation Capability and in many cases leading to loss of Avionics Functionalities. Ground-based NAVAIDS (DME-DME) ?


THANK YOU FOR YOUR ATTENTION