GNSS & RWY safety

EVAIR findings

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EVAIR – ATM and GNSS outages reports

ATM trends with and without GPS
2018-2022

- No of reports without GPS
- No of occ with GPS

9139 AO/ANSPs reports

11113 GPS Outage reports
EVAIR GNSS summer and full years 2018-2022

**GPS OUTAGES 2018-2022**

- **Full years**
  - 2018: 4572
  - 2019: 3704
  - 2020: 1059
  - 2021: 430
  - 2022: 266

- **Summer seasons**
  - 2018: 2747
  - 2019: 176
  - 2020: 180
  - 2021: 2141
  - 2022: 1470

**GPS OUTAGES 2018-2022**

- **No of reports per 10,000 flights**
  - 2018: 5.35
  - 2019: 4.18
  - 2020: 0.86
  - 2021: 0.42
  - 2022: 2.75
EVAIR GNSS analysis airspace & traffic flows affected

• More than 100 FIRs affected
• Turkish airspace for the traffic to/from Europe – Middle East and the traffic to/from the East to the South East Mediterranean across Turkey
• South – East Mediterranean for the traffic to/from Europe
• Middle East – Mainly the traffic to/from Europe
• Middle East – Canada and America via Cross polar routes
• European airspace during approach to main hubs - about
• For about 20% of flights this information is not available.
EVAIR – GNSS analysis - frequent problems reported

- Failure of one or both GPS boxes
- Disagreement between GPS positions and NAV FMSs
- Inability to fly RNP and request for radar vectoring
- Wrong wind and ground speed presentations
- Loss of ADS-B L/R
- Aircraft clocks L/R/both failed or began to count backwards
- Terrain warnings – pull up requests.

[Graphs and charts showing data related to GPS activation and phases of flight.]
EVAIR EXAMPLES OF PILOTS’ NARRATIVE

04/03/2023 Jamming event in Turkish airspace, en route to VADEN (between 60 nm to 30 nm southeast) led to AMBER CAS ADS-B OUT, SVS FAIL CYAN CAS, and GNSS NOT AVAILABLE notifications.

08/03/2023 GPS L/R invalid signal encountered from waypoint ABKAL until SOBIL. DME update in FMC manually switched from OFF to ON in order to keep ANP below 1.00. Uneventful continuation of flight

10/03/2023 During initial climb out, before passing 2000 feet, ADS-B RPTG 1 than 2 failed, followed by GPS 1 than 2 failing. Systems didn’t recover until flight completion.

14/03/2023 When passing FL290 we got ECAM message “NAV ADS-B RPTG 1(2)FAULT” at the same time we lost all three GPS. The GPS MONITOR page in MCDU showed only dashes and no info were available. However, we had GPS PRIMARY and accuracy HIGH indicated on the PROG page. No indications of any navigation failures or problems. All three GPS came back again when passing FL 100 descending. During climb out another crew experienced the same thing in approximately the same area.

01/02/2023 Crew reported GPS FAILURE. ACFT position: W part of LUKK TMA – SEC 1, Radial 220 Distance 8NM from KIV VOR, FL60.

24/02/2023 During cruise in Turkish Airspace, under control of Ankara Frequency 127.925, were cleared to proceed direct to waypoint OTKEP. On the CDU legs page OTKEP was selected and transferred to L1 PSN on page 1. Prior to executing the change, observed the following 1. The FMA indication from SPD/LNAV/VNAV PTH, with the Autopilot engaged changed to SPD/LNAV/VNAV PTH with associated AMBER line across the pitch and roll mode, indicating the degraded mode of the Pitch and Roll mode. 2. Both L and R CDU displays temporary became BLANK for approx. 3-5 seconds. 3. Upon recovery of both CDUs, observed the legs pages were no longer active, indicated by CYAN on the ND displays. Some performance data were observed to be missing; ZFW, Reserves, COST INDEX and CRZ ALT. 4. Reverted to basic modes by selecting HDG and FLCH on the MCP with associated FMA SPD/HDG/ALT 5. CDU data were entered, validated and verified, prior to Executed. LNAV an VNAV were reengaged, and flight continued to DOH without any further events. 6.N.B. Prior to the incident, GPS interference were also affecting the Navigation of the aircraft, as this is a normal occurrence in Turkish Airspace.

20/01/2023 GPS 1 fault with ADSB REPORTING 1 and 2 fault on UR660 from DASIS to ERZ UL704 to SONAD UL746 to ODERO.
Pilot feedback and requirements

- Impact on operations
  - Workload increase especially if you are not used to fly in regions having GNSS problems
  - More critical during landing or take-off
  - Brake To Vacate unavailability
  - ADS-C unavailability causing increased separation in NAT airspace
- Pilot statement: “We would like to have information on GNSS problems within a particular area pre-flight. The information could be provided either by ANSP or Airline OCC in a map form.”
Pilot feedback and requirements collected by NAV

- There is no GPS JAMMING light

- Multiple systems affected making failure analysis difficult

Conclusions

**GNSS signal interference**

- Flight deck effects not easily tied to GPS jamming
- Flight crew workload increased
- Negates PBN operations. Often not only for the duration of the outage.
- Warrants solid contingency procedures
- A/C navigation performance depends on available DMEs
- DME grid necessary as Minimum Operating Network

Our mitigations

- High level of flight crew awareness
- Flight crew contingency procedures
- Flight crew simulator training with GNSS PVT degradation
- Airbus configured with multi-constellation MMR (less susceptible to jamming)
Ground Requirement

### On-ground problems

- Loss of some **surveillance** capabilities (ADS-B, ADS-C)
- Possible loss of **communication** CPDLC
- **ATC workload** increase
- Capacity reduction

- **2014: Preparation for EU PBN Implementing Rule:**
  - ATC Human in the Loop Impact Studies for impact assessment including GPS Loss
  - Budapest simulation, high level of “GPS-only for PBN” traffic (20%)
  - ATCO Statement: “I can deal with GPS RFI, just tell me when it starts, how many sectors are affected, and when it ends”

- **Validated OPS Requirement through EUROCONTROL NETOPS**
  - **NETOPS Conclusion 23/10:** NETOPS agreed the following recommendations:
    - **b)** With reference to paragraph 3.2: *confirm the Operational need to be aware of the geographic area of GPS outages and that they (ATC) intend to use this information in the context of contingency operations.*

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Summary Report Twenty-third Meeting (NETOPS/23) Brussels, 28 Feb - 1 March 2019, NETOPS/24 WP02
AWARENESS - GNSS weekly updates: NOTAMs & EASA SIB

LTBB - ISTANBUL FIR

EN-ROUTE
- FLIGHT PLANNING TIPS:
- NOTAMs & EASA SIB
- IMPORTANT LOCAL & NATIONAL NOTAMs
- PROFICIENT FLIGHT PLANNING
- FROM: 06 JUN 2023 04:00 UTC - 07 JUN 2023 12:00 UTC

LFMM - MARSEILLE

EN-ROUTE
- INTERFERENCE OF GPS SENSORS (OSM/GA100) FROM DIFFERENT SITES
- GPS SENSORS IN INTERFERENCE: VARIOUS VEHICLES & COMMUNICATIONS
- FROM: 09 JUN 2023 04:00 UTC - 10 JUN 2023 12:00 UTC

LTAA - ANKARA FIR

EN-ROUTE
- AI LFAR
- LFAR VOR/DME 116.95 MHZ/216.9 MHz, VOR LFAR CALIBRATION
- LFAR LFAR RECIPROCAL CHRA-lj SICHELI/FL 230/22
- FROM: 05 JUN 2023 21:00 UTC - 06 JUN 2023 21:00 UTC

LFBB - BORDEAUX

EN-ROUTE
- POSSIBLE GNSS DISTURBANCE OF THE SIGNAL RECEIVED BY OGS RECEIVERS IN THE "CAPITOL" AREA, POSSIBLE 360 DEGREES INTERFERENCE OBSERVATION.
- FROM: 06 JUN 2023 07:00 UTC - 07 JUN 2023 14:00 UTC

LCCC - NICOSIA FIR

EN-ROUTE
- GNSS SIGNAL INTERFERENCE REPORTED NORTHERN CYPRUS FIR.
- PROCEDURE FOR REPORTING INTERFERENCE
- FROM: 06 JUN 2023 22:06 UTC - 07 JUN 2023 22:06 UTC

EPWW - WARSZAWA FIR

EN-ROUTE
- PRECIPITATION - GNSS SIGNAL INTERFERENCE CAN BE EXPECTED IN THE EAST-EAST AND EAST PART OF WAR. ACES CARS ARE ADVISED TO PHANTOM AND INITIATE INTERFERENCE REPORTING.
- FROM: 13 JUN 2023 12:16 UTC - 14 JUN 2023 23:19 UTC

EASA SIB No.: 2022-02R1
Revision: This SIB revises EASA SIB 2022-02 dated 17 March 2022.
Ref. Publications: None.
Applicability: National Aviation Authorities (NAAs), Air Navigation Service Providers (ANSPs) and air operators.
Description: Since February 2022, there has been an increase in jamming and or possible spoofing of Global Navigation Satellite Systems (GNSS). This issue particularly affects the geographical areas surrounding conflict zones but is also present in the eastern Mediterranean, Baltic Sea and Arctic area.

EASA has analysed data from the Network of Analysts and open sources, and has concluded that GNSS jamming and or spoofing has intensified in recent months. The main affected flight information regions (FIRs) are:

- The Black Sea area:
  - FIR Istanbul LTBB, FIR Ankara LTAA
  - Eastern part of FIR Burundai LBBB, FIR Soz IA
  - FIR Trabzon LUGG, FIR Yurum LUGD, FIR Balik LHAB

- The southeastern Mediterranean area, Middle East:
  - FIR Nicosia LCCC, FIR Beirut OBLB, FIR Damascus OTS, FIR Turan LLLL, FIR Amman QIAC, northeastern part of FIR Cairo HCC
  - Northern part of FIR Baghdad ORBB, northeastern part of FIR Tehran DXIX
  - Northern part of FIR Tripoli HILL

- The Baltic Sea area (FIR surrounding FIR Kaliningrad LMMK):
  - Western part of FIR Vinnits EYVL, northeastern part of FIR Warszawa EPWW, southwestern part of FIR Riga EVUR

- Arctic area:
  - Southern part of FIR Helsinki FFIN, northern part of FIR Polars EORN
AWARENESS - NM information communication

- 1st step
  - Weekly updates via the public NOP portal
- Next step: Integrated NM B2B service
  - providing real-time network situational awareness and supporting collaborative decision making (CDM) processes
  - SWIM compliant
  - Request/Reply or Publish/Subscribe
  - Accessible 24 hours a day, 7 days a week

The following section contains the latest information available on GNSS operational status across the network. It shows where aircraft avionics have reported a degraded or unavailable GNSS position. The most common cause for such degradations is radio frequency interference. An update is provided on a weekly basis in the following link: GNSS update
Target audience and objectives:
The course provides strategies and tools for those who wish to implement mitigation measures against GNSS interferences or those who wishes to obtain a broad understanding of GNSS interference and its effects on aviation. It will also include a group work/discussion to focus on the main problems the audience is facing with regard to GNSS interferences.

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DAY/TIME | 09:00 | 12:30 | 13:30 | 17:00
---|---|---|---|---
DAY 1 | Introduction | GNSS vulnerabilities | Sources of GNSS interferences | Impact of GNSS interferences
DAY 2 | Impact of GNSS interferences | GNSS interference mitigation | GNSS interference mitigation | Debrief

Location
Aviation Learning Centre, Luxembourg

Dates
7-8 June 2023
EVAIR Runway Incursion findings
EVAIR Runway Incursion 2018-2022

![Graph showing the number of runway incursions per 10,000 flights from 2018 to 2022. The graph indicates a peak in 2019 with 0.060 reports, followed by a decline to 0.034 in 2020, and a slight increase to 0.038 in 2022.](image-url)
Runway Incursion Contributory factors

- Spoken comm. 25.31%
- Oper. Comm. Issue 18.78%
- Mistakes 9.39%
- Lapses 5.71%
- Traffic information 9.80%
- Traffic and Airspace problems 5.31%
- Meteorological conditions 6.12%
- Go-around 7.76%
- Coordinations Issues 0.82%
- Ground-ground communication 2.45%
- Documentation and Procedures 2.86%
- Airport data 1.22%
- Runway configuration 1.22%
- ATC clearance/instruction related item 2.45%
- Failure of COMMUNICATION function 0.41%
- Un-authorised penetration of airspace 0.41%
- Meteorological conditions 6.12%
- Go-around 7.76%
States, locations and AOs affected or participating in Runway incursion 2018-2022
EUROCONTROL activities and plans

Continuous monitoring and information data collection
• Daily information/incident provision to EVAIR and upload into the DB
• Publication of analysis – EVAIR Bulletin and customized analysis
• Survey with ANSPs of A and B risk severity Runway Incursion occurrences as part of the Top 5 EUROCONTROL safety concerns
• Publication of report

Preparation of the Global Action Plan for the Prevention of Runway Incursion (GAPPRI)
• Coordination and discussion with all SHs including IATA
• Inventory of the European Action Plan and its improvement
• Consolidation of proposals and publication of the Global Action Plan
• Kick of meeting 30 Mar 2023
GAPPRI Expectations from AO

EUROPEAN ACTION PLAN FOR THE PREVENTION OF RUNWAY INCURSIONS

RECOMMENDATIONS

1. General principles
2. Aerodrome operator issues
3. Communications
4. Aircraft operator issues
5. Air navigation service provider issues
6. Data collection and lesson sharing
7. Regulations issues
8. Aeronautical information management
9. Technology
10. Civil military
11. Future work

1.4 AIRCRAFT OPERATOR

<table>
<thead>
<tr>
<th>#</th>
<th>Recommendation</th>
<th>Action</th>
<th>Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4.1</td>
<td>Provide training and assessment for pilots regarding Aerodrome signage, markings and lighting.</td>
<td>Aircraft Operator (suad).</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.2</td>
<td>Pilots shall not cross illuminated red stop bars when lining up or crossing a runway (or on a taxiway where present), unless contingency procedures are in force, e.g. to cover cases where the stop bars or controls are unserviceable.</td>
<td>Aircraft Operator.</td>
<td>Appendix A</td>
</tr>
<tr>
<td>1.4.3</td>
<td>Ensure that flight deck procedures contain a requirement for explicit clearance to cross any runway.</td>
<td>Aircraft Operator.</td>
<td>Appendix A</td>
</tr>
<tr>
<td>1.4.4</td>
<td>Flight Crew should not enter a runway for departure if not ready to take off. Flight Crew must advise Air Traffic Control on time contact with the Tower in addition time on the runway is required for operational reasons.</td>
<td>Aircraft Operator, Air Navigation Service Provider.</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.5</td>
<td>Operate, significantly early, flight operations should confirm with ATC the line-up/take-off or crossing clearance when approaching the runway holding position.</td>
<td>Aircraft Operator, Air Navigation Service Provider.</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.6</td>
<td>Flight crew should consider conferring landing clearance on short final, if ATC issued it 15 more than 5 nautical miles from touch down.</td>
<td>Aircraft Operator, Air Navigation Service Provider.</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.7</td>
<td>Promote best practices in flight deck procedures while taxiing and during final approach - to include the “Starke flight deck” concept.</td>
<td>ICAO (ideal), ECA/ILPA (support).</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.8</td>
<td>Promote best practices for pilots planning of ground operations.</td>
<td>ICAO (ideal), ECA/ILPA (support).</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.9</td>
<td>Ensure a means to indicate except of landing / line-up / take off / crossing clearance to the pilot.</td>
<td>Airframe Manufacturer, Aircraft Operator.</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.10</td>
<td>Pilots are advised to switch on forward facing lights when in receipt of a take-off clearance and when forward facing lights on the approach.</td>
<td>Aircraft Operator.</td>
<td>Appendix D</td>
</tr>
<tr>
<td>1.4.11</td>
<td>Pilots must be made aware of current safety significant airport information.</td>
<td>Aircraft Operator.</td>
<td>Appendix H</td>
</tr>
<tr>
<td>1.4.12</td>
<td>During test for departure or during approach, pilots should not accept a runway change proposal if time to reprogramme the FMS / return is not sufficient. This includes a change of departure intersection.</td>
<td>Aircraft Operator, Air Navigation Service Provider.</td>
<td>Appendix D</td>
</tr>
</tbody>
</table>

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Many Thanks for your Attention!

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www.eurocontrol.int/articles/eurocontrol-voluntary-atm-incident-reporting-evair