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AVIATION

PBN SG 9 – GNSS interference mitigation

Hamdi NASSER

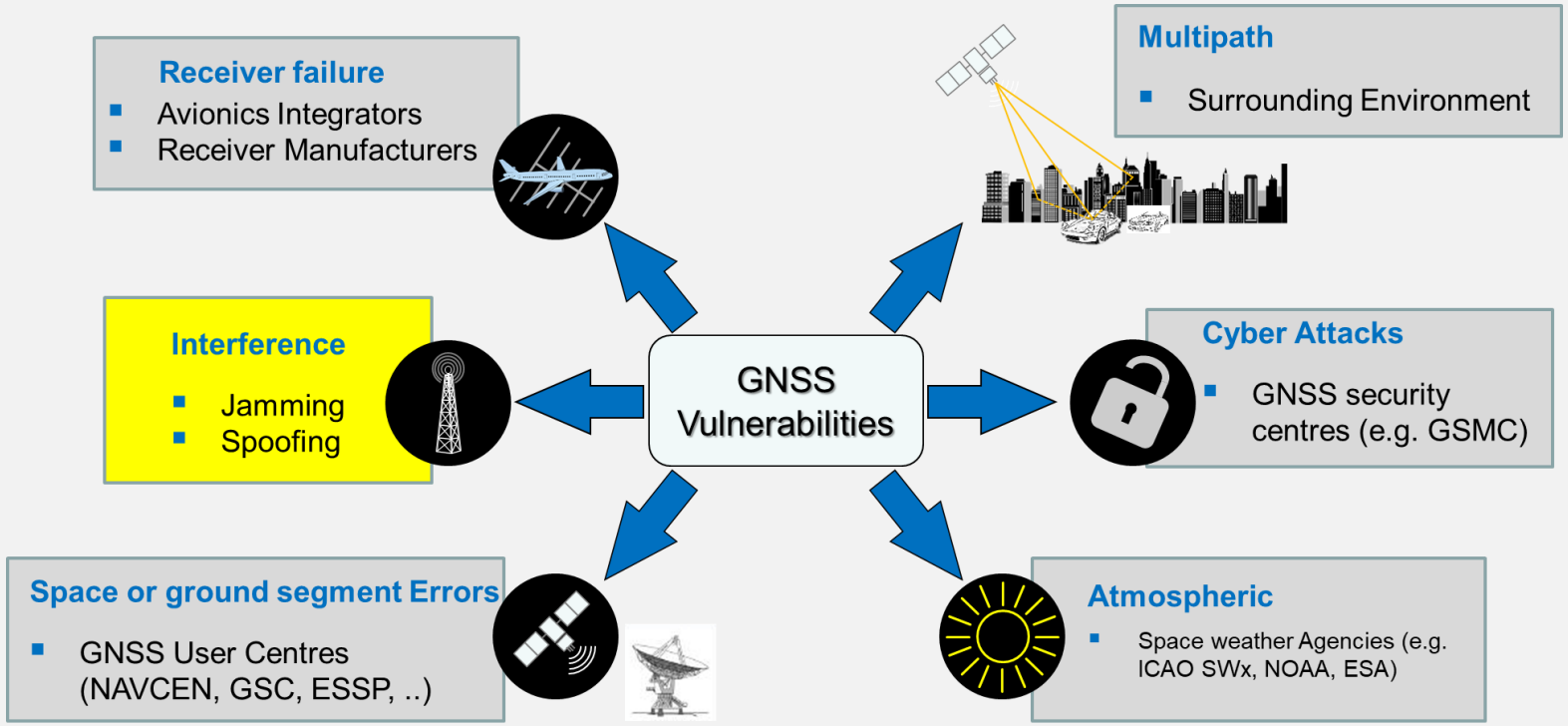
NMD/INF/CNS

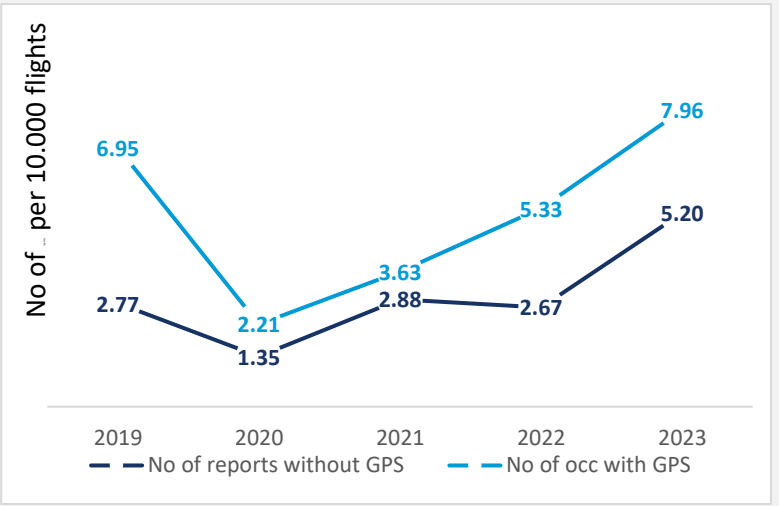
CONSORTIUM COORDINATOR sesar DEPLOYMENT MANAGER

FOUNDING MEMBER sesar JOINT UNDERTAKING

NETWORK MANAGER

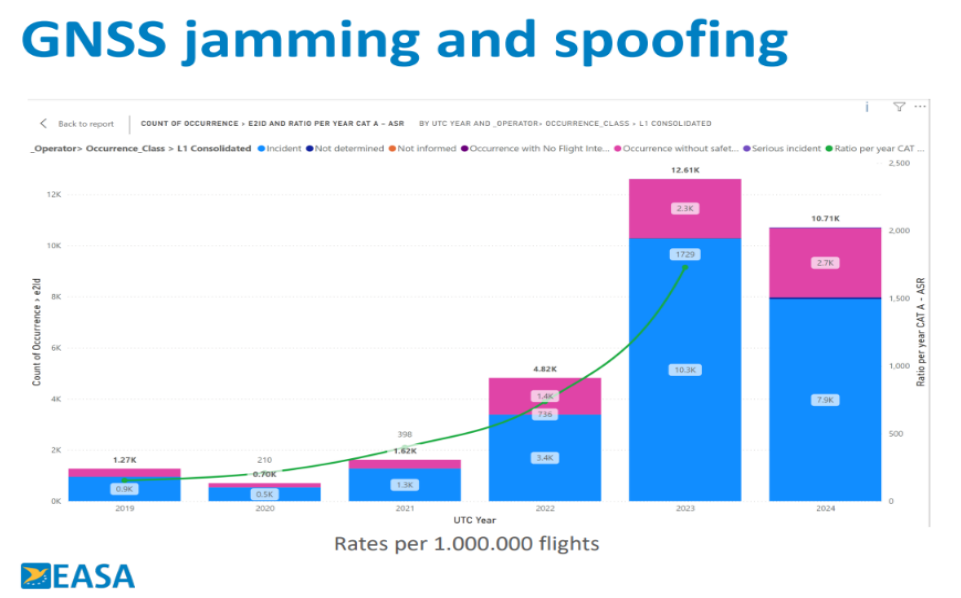
GNSS Vulnerabilities

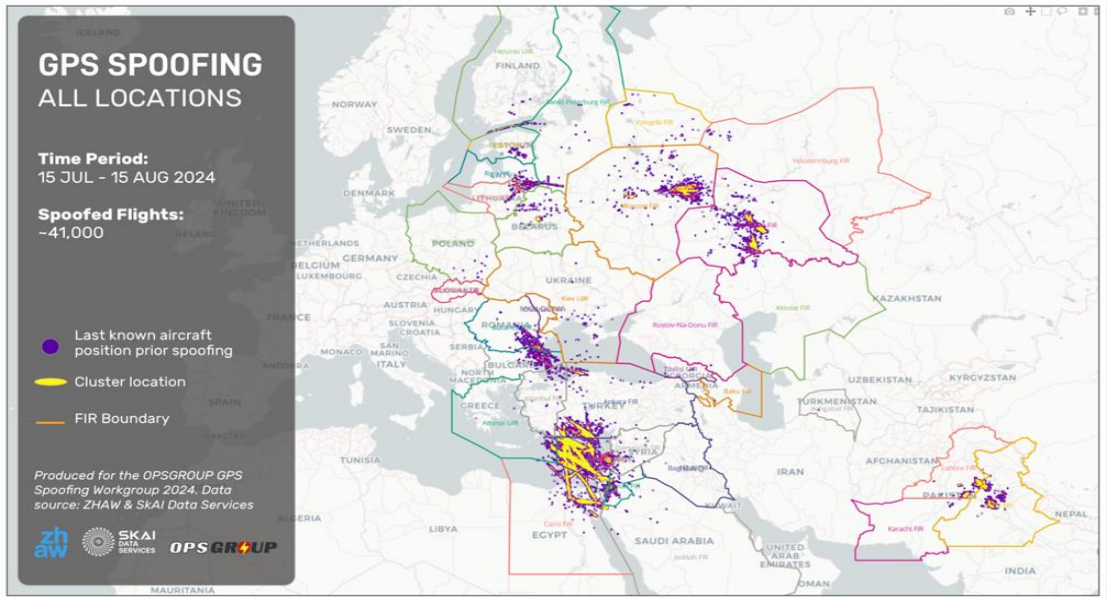


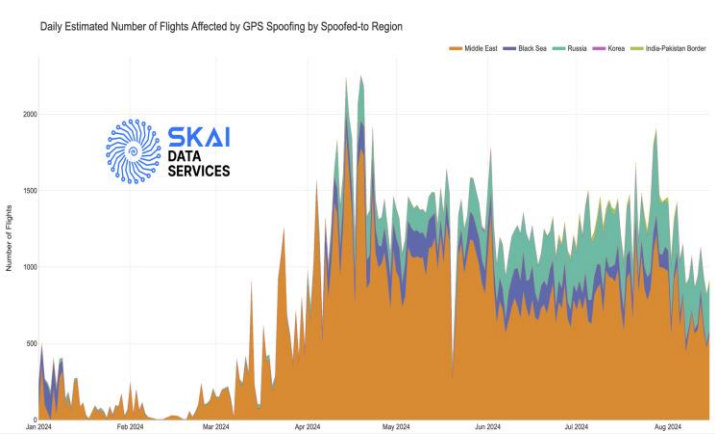


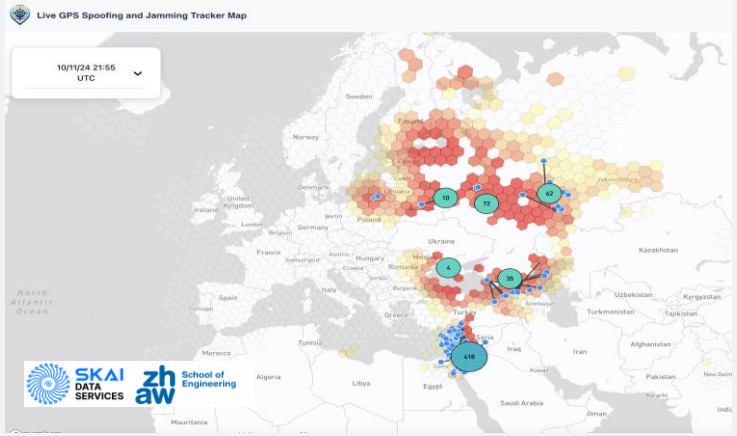
EVAIR

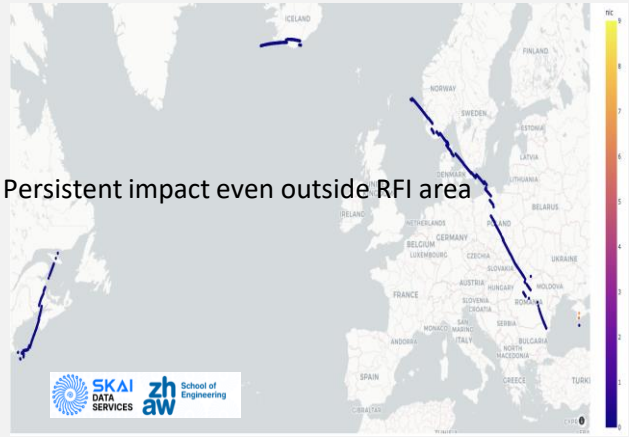
Growing trend and a new realty











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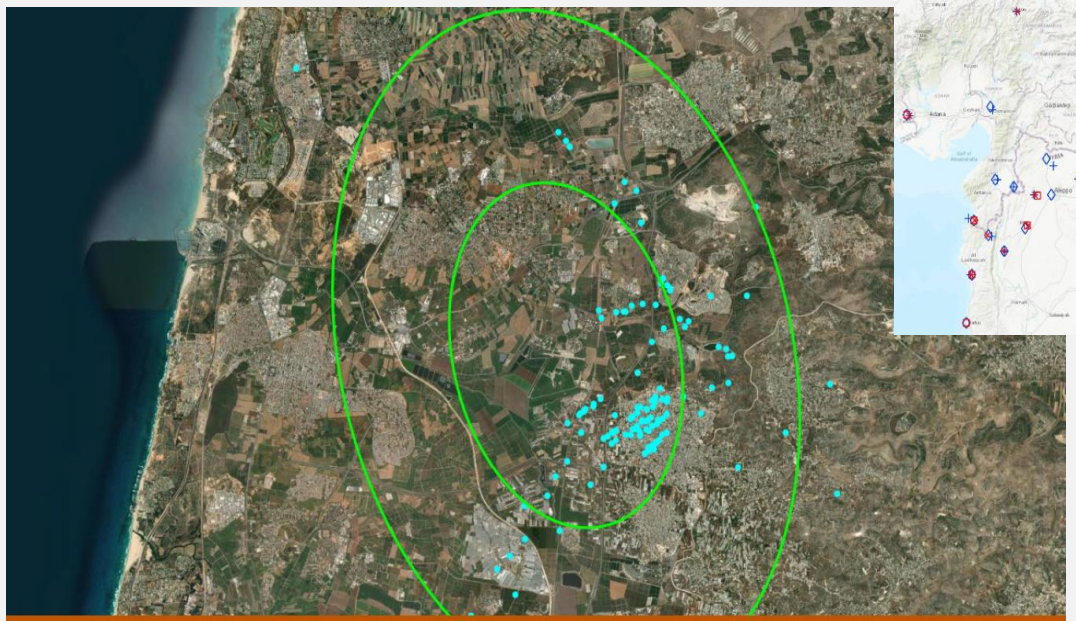
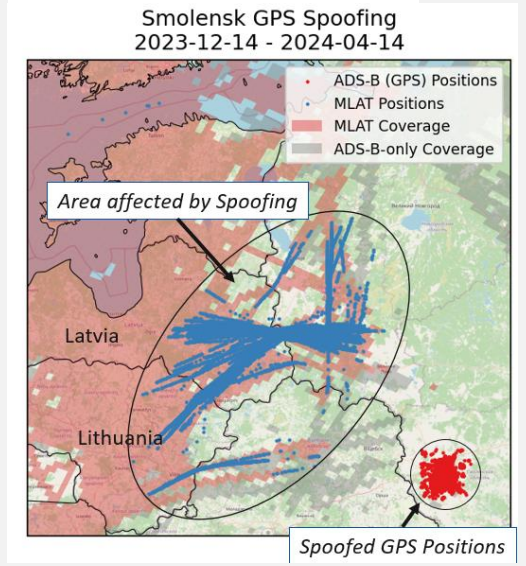
Spoofing detected sources



Jan. 2024: GNSS spoofing has gone mainstream:
Source of spoofing over Israel is an IDF airbase.

EW and its Civil Spillover Effects, Todd Humphreys
ENC @ ESTEC | May 23, 2024
https://insidegnss.com/pinpointing-gnss-interference-from-low-earth-orbit/

> 2500 flights affected (as of April 14, 2024)



Sero Systems

Regularly discovering new cases from pilot reports

- GPS Receiver, FMS , Clock fail
- EGPWS failure
- Comms failures (CPDLC, SatCom)
- Weather Radar failure
- ADS-B, ADS-C
- Synthetic Vision System (SVS) failure
- Runway Protection Systems failure
- Emergency Locator (ELT) incorrect rep
- Wind Display (ND) failure
- Navaid tuning failure
- Map shifts

- Inability to fly RNP and request for radar vectoring (Pilot/ATC workload)
- EGPWS false alerts, Uncoordinated climb
- Go-Arounds in unexpected positions
- Non recovery of systems, Aircraft grounded pending reset of GPS
- Cascading system failures, high workload approaches
- Risk to enter segregated military areas

EUROCONTROL voluntary ATM incident reporting (EVAIR) |

https://ops.group/blog/gps-spoofing-final-report/

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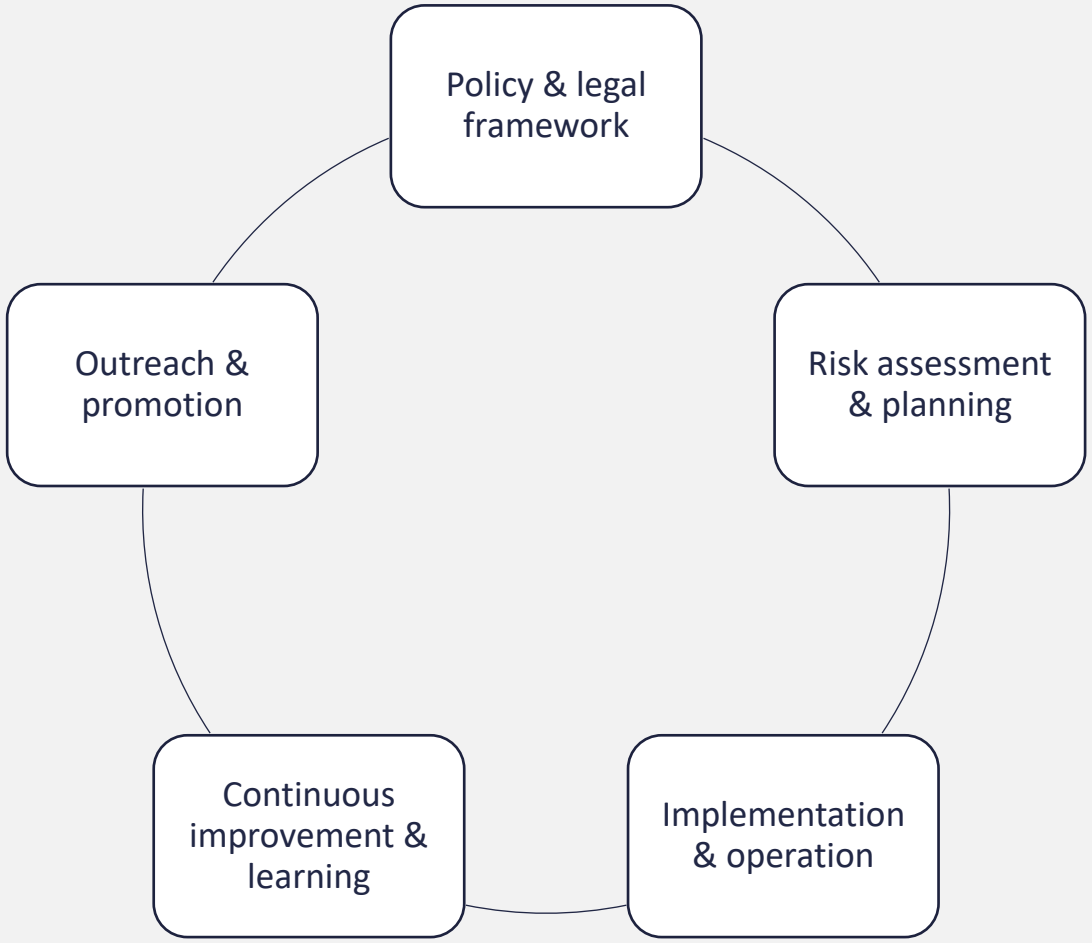
GNSS interference mitigation



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Policy and legal framework

GNSS RFI – Europe WPs (WP/61 and WP/63) and Industry WP/76, Japan WP/78 Singapore WP/118, Cameroon WP/120, Korea WP/151)

WP/61 called to evaluate whether non-GNSS navigation systems can be removed from the aviation system

WP/118 called for ICAO to set up a global repository of RFI occurrences. Development of a global solution

WP/63 called to condemn GNSS harmful interferences that are not clearly justified by security or defense needs posing significant risks to the safety of air transport and continuity of civil aviation operations;

- ***States**:*

  a. *ensure that effective GNSS RFI mitigation measures are implemented, based on measures developed by ICAO and industry, including the need to maintain a **sufficient network of conventional navigation aids** to ensure operational safety as well as sufficient **airspace capacity** during times of GNSS **interference**;*

  b. *through the mechanism of the planning and implementation regional groups, **develop regional GNSS reporting mechanisms** to raise operational awareness of affected **geographical areas***

  c. *work with industry to identify means to make **aircraft systems** more **resilient** to RF interference events, and to provide guidance on **detecting** GNSS **jamming or spoofing** and maintaining safe and efficient aircraft operation in case of GNSS anomalies;*

- ***ICAO**:*

  a. *continue to **assess** the **impact** of GNSS interference on **aviation safety and continuity of civil aviation operations** and define adequate **mitigation** measures, while **reminding States** of their **obligations**;*

  b. *develop a **standardized implementation package** to **assist** and guide **States** in implementing effective GNSS RFI **mitigation** measures, including optimization and rationalization of conventional navigation aids, commensurate with their local conditions, to ensure continuity in the provision of air navigation services;*

  c. *develop **guidance** on GNSS interference **information exchange and civil-military coordination** in relation to harmful interference to GNSS originated or detected by military authorities; and*

  d. *develop **recommendations** for globally harmonized **minimum aircraft equipage lists** to ensure that provided navigation infrastructure can be used by airspace users in line with available air traffic services.*

World Radiocommunication Conference (WRC-23)
Dubai, 20 November - 15 December 2023

ITUWRC DUBAI2023

PLENARY MEETING	**Document 456-E**
B34	**11 December 2023**

Prevention and mitigation of harmful interference to the radionavigation-satellite service in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz

resolves to urge administrations

- to apply necessary measures to avoid the proliferation, circulation and operation of unauthorized transmitters that cause or have the potential to cause harmful interference to RNSS systems and networks operating in the frequency bands 1 164-1 215 MHz and 1 559-1 610 MHz, including possible measures that might need to be taken with respect to *recognizing j)*;
- to encourage **collaboration** between **spectrum regulators**, **enforcement authorities** and **RNSS stakeholders**, in particular in the aeronautical and maritime domains;
- to encourage cooperation **between aeronautical, maritime and security** authorities, as well as spectrum regulators, as appropriate, to address interference risks to RNSS systems that may stem from the activities of these security authorities;
- **to report cases**, as the affected administration deems appropriate, of harmful interference to RNSS in accordance with Article **15**,

instructs the Director of the Radiocommunication Bureau

to provide, on request, assistance to administrations in accordance with No. **13.2**,

instructs the Secretary-General
to bring this Resolution to the attention of ICAO and IMO.

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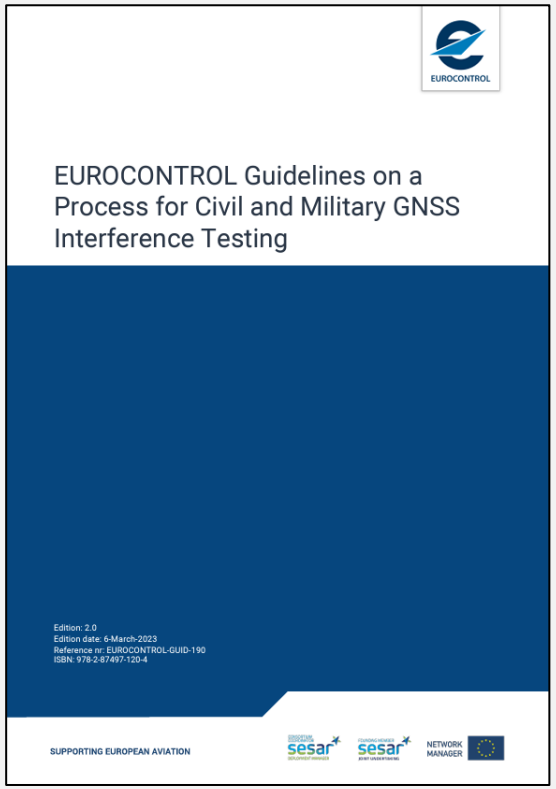
Civil Military Coordination of State Authorized Events



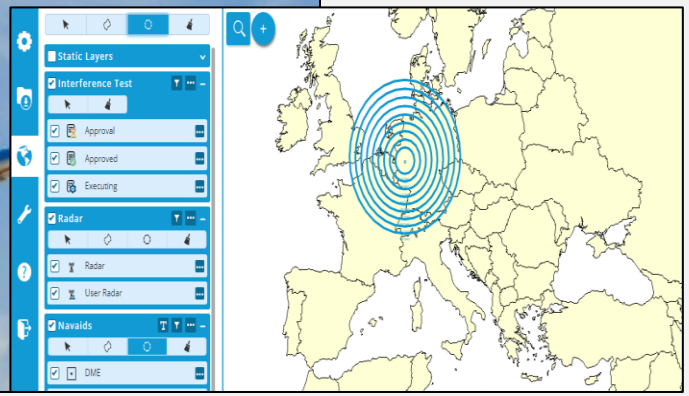
https://www.eurocontrol.int/publication/eurocontrol-guidelines-process-civil-military-gnss-interference-testing

Objectives

- **Document** and facilitate sharing of **best practices** between states.
- Reinforce **coordination** and collaboration between authorities
- Put in place a process to mitigate the risk of planned GNSS RFI exercises and to maintain the level of safety for airspace users.

Main elements

- **Coordination** and mutual assistance between the concerned parties
- **Planning** of the GNSS testing and **impact assessment** (area, duration, how to act in case of unforeseen effects)
- **Notification** to minimize the impact on airspace users
- Being aware of impacted systems and **contingency procedures**



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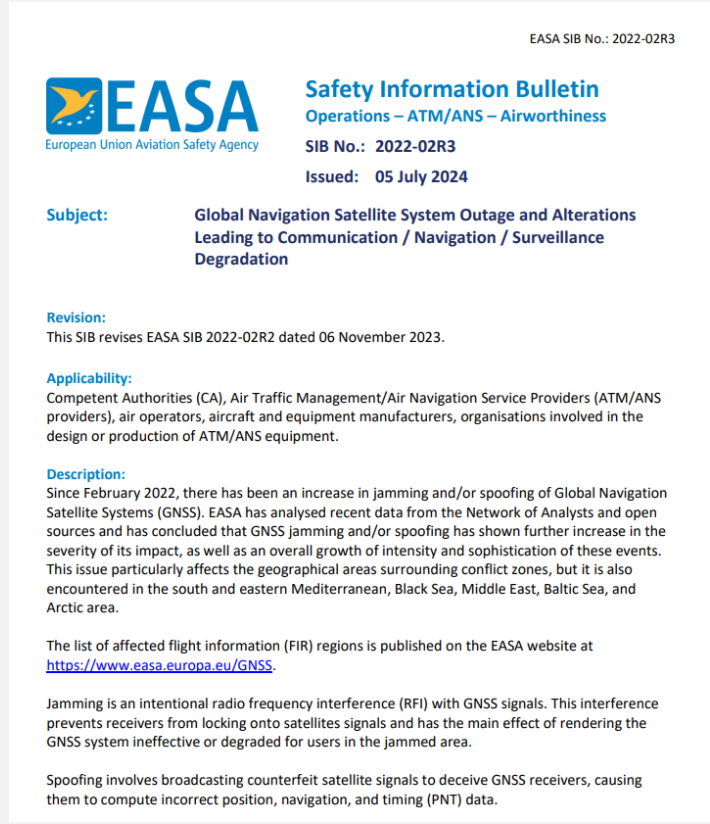
EASA SIB

EASA updates SIB on GNSS Outage & Alterations

GNSS jamming and spoofing has shown increase in terms of both intensity and severity in recent years. This was the conclusion following an analysis conducted by EASA based on recent data from the Network of Analysts as well as open sources.

https://www.easa.europa.eu/en/newsroom-and-events/news/easa-updates-sib-gnss-outage-and-alterations

https://www.easa.europa.eu/community/topics/global-navigation-satellite-system-outage



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.

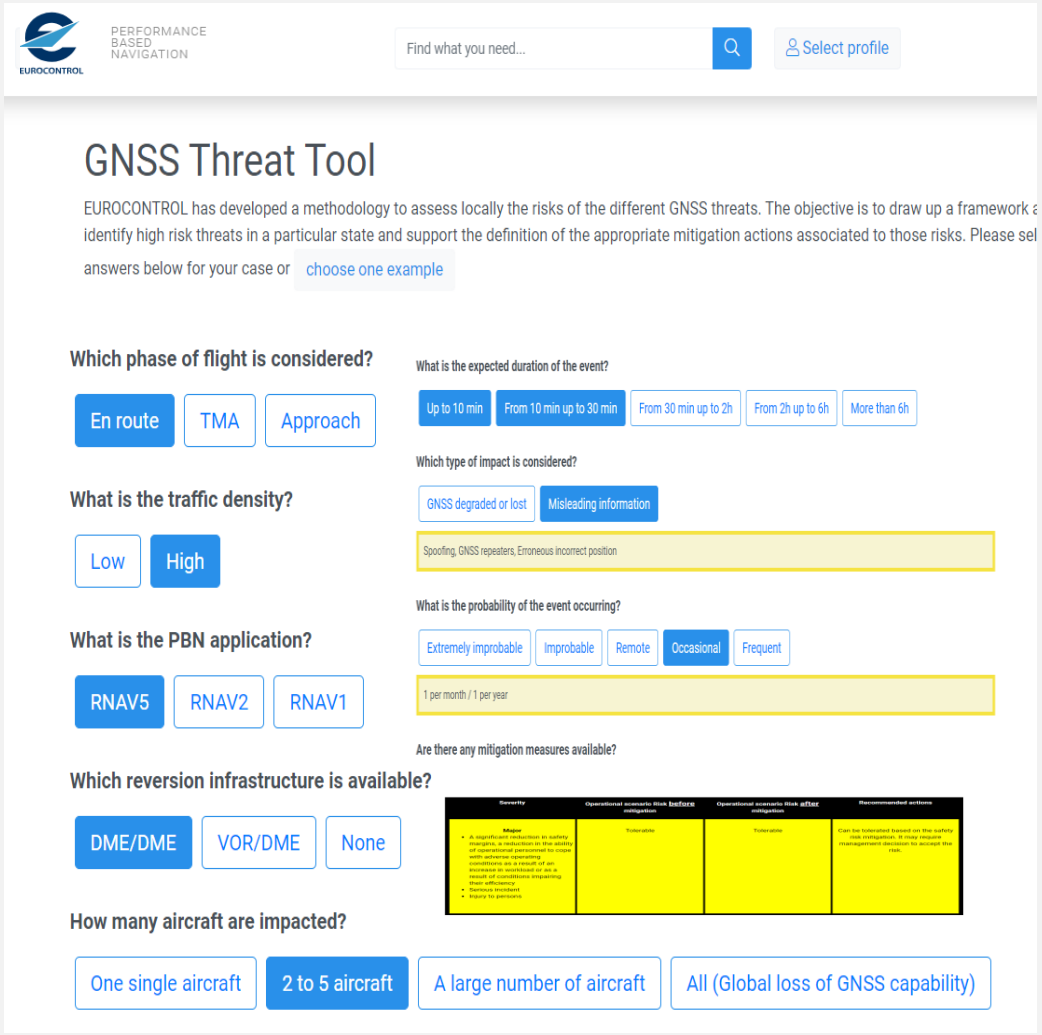
The list of affected flight information (FIR) regions is published on the EASA website at https://www.easa.europa.eu/GNSS.

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.

EASA Safety Publications Tool (europa.eu)

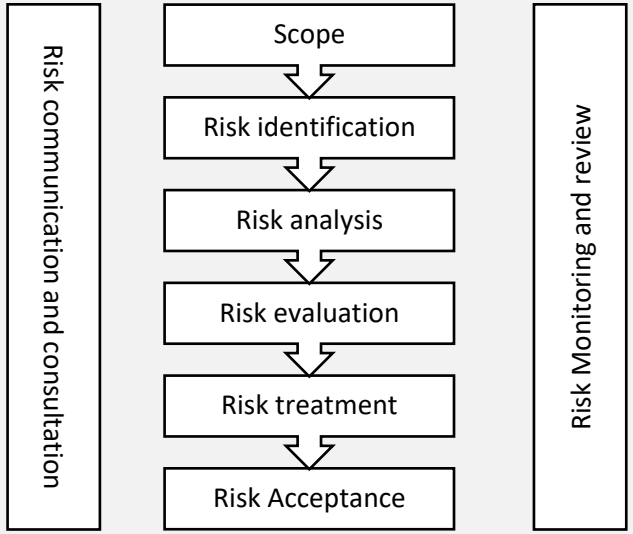
Risk assessment



https://pbnportal.eu/epbn/main/PBN-Tools/GNSS-Threat.html

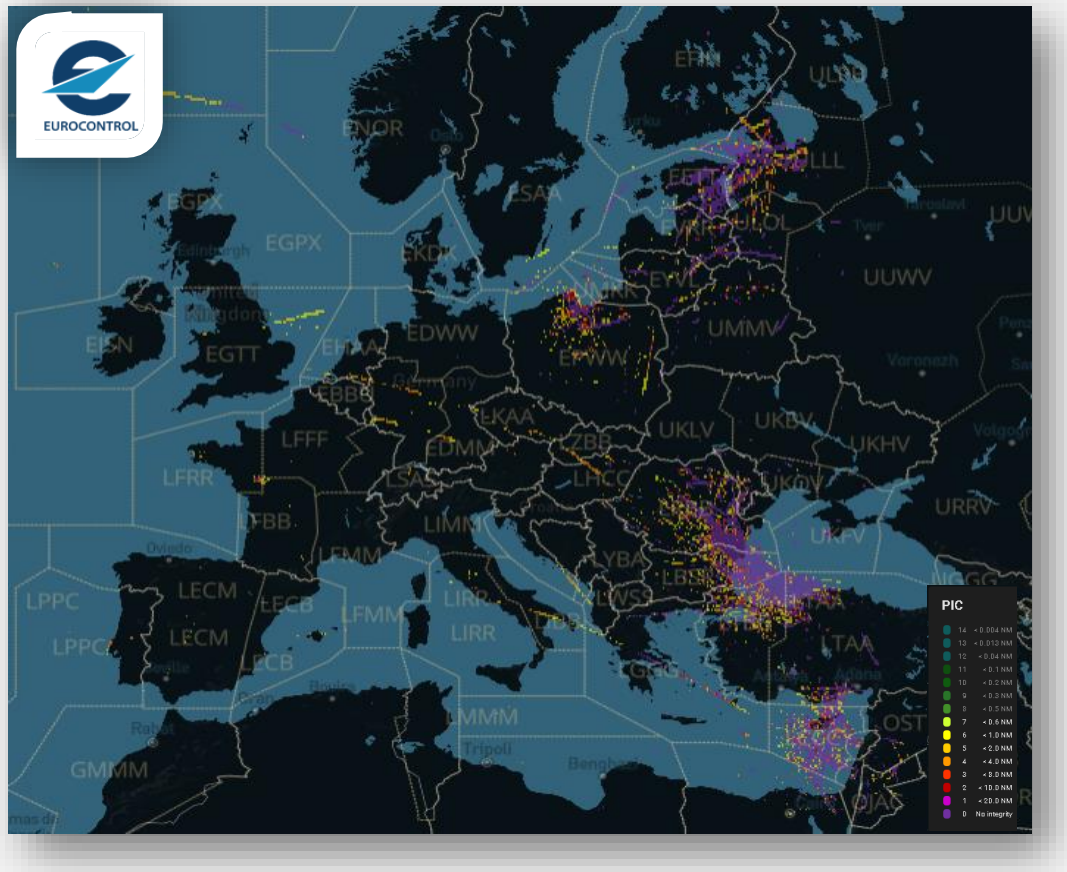
Risk Probability	Risk Severity				
	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely Improbable 1	1A	1B	1C	1D	1E

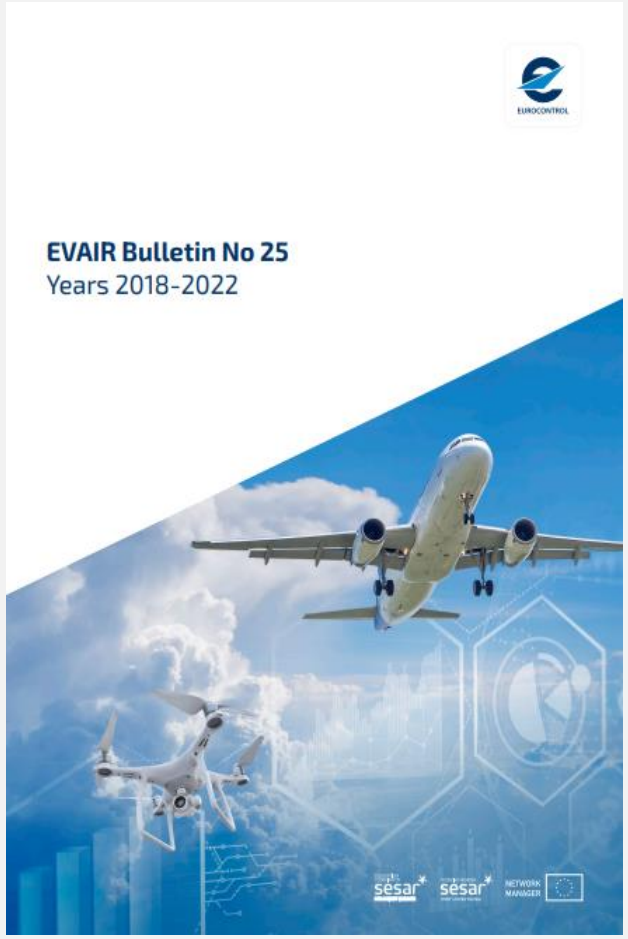
ICAO safety risk assessment



ISO 27005

Monitoring





EUROCONTROL voluntary ATM incident reporting (EVAIR)

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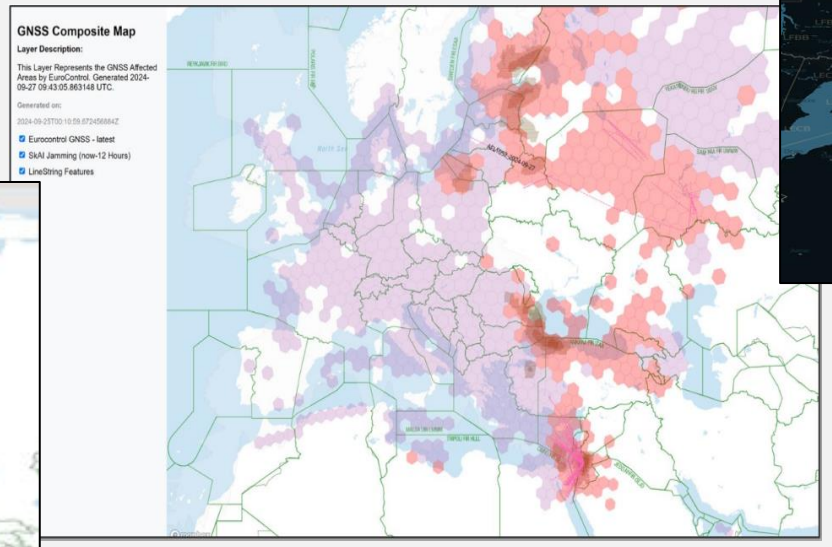
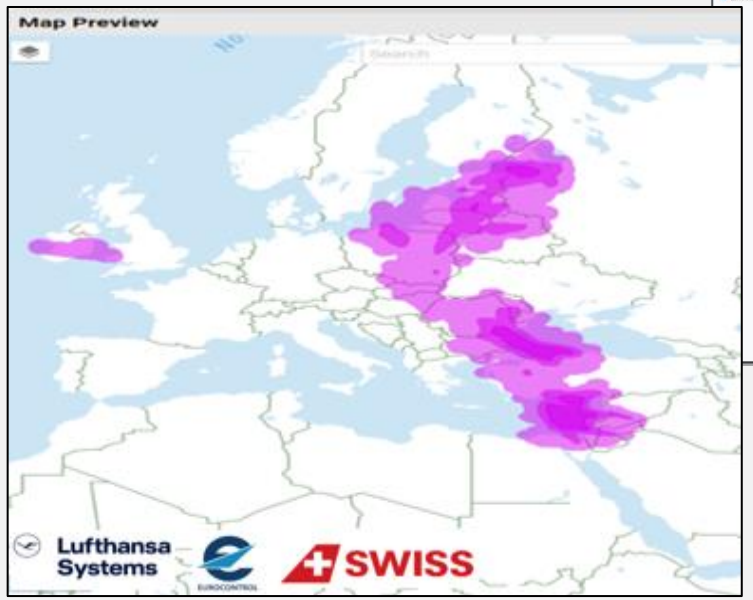
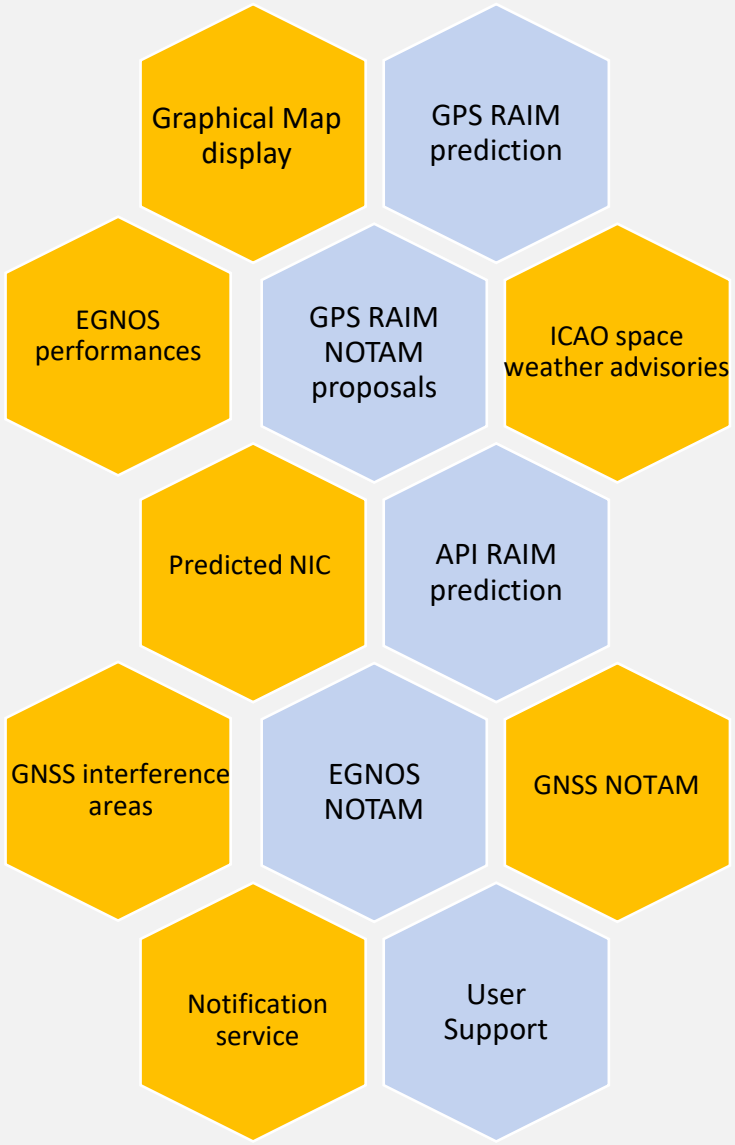
NM B2B service - GNSS interference monitoring

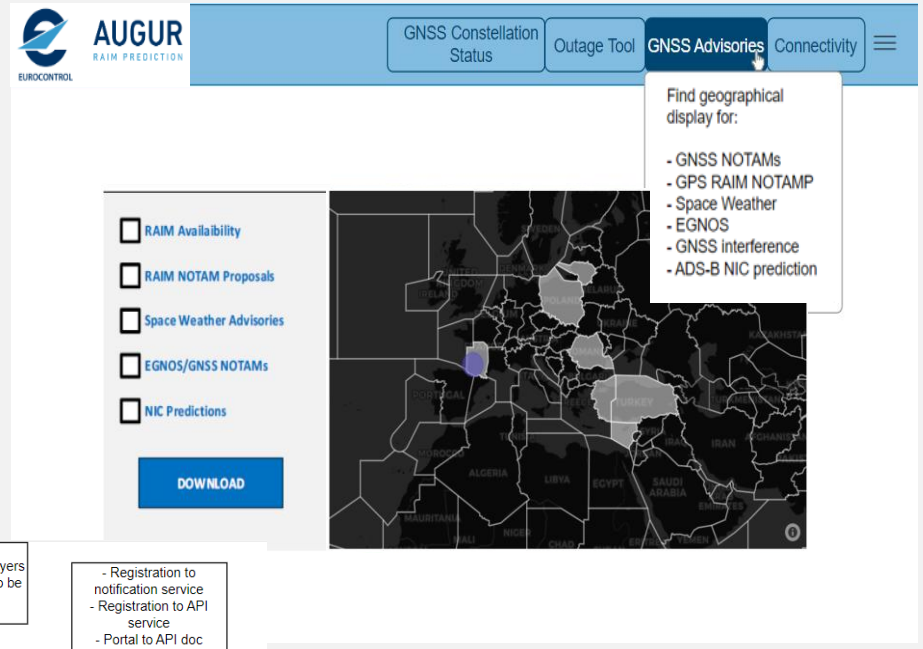


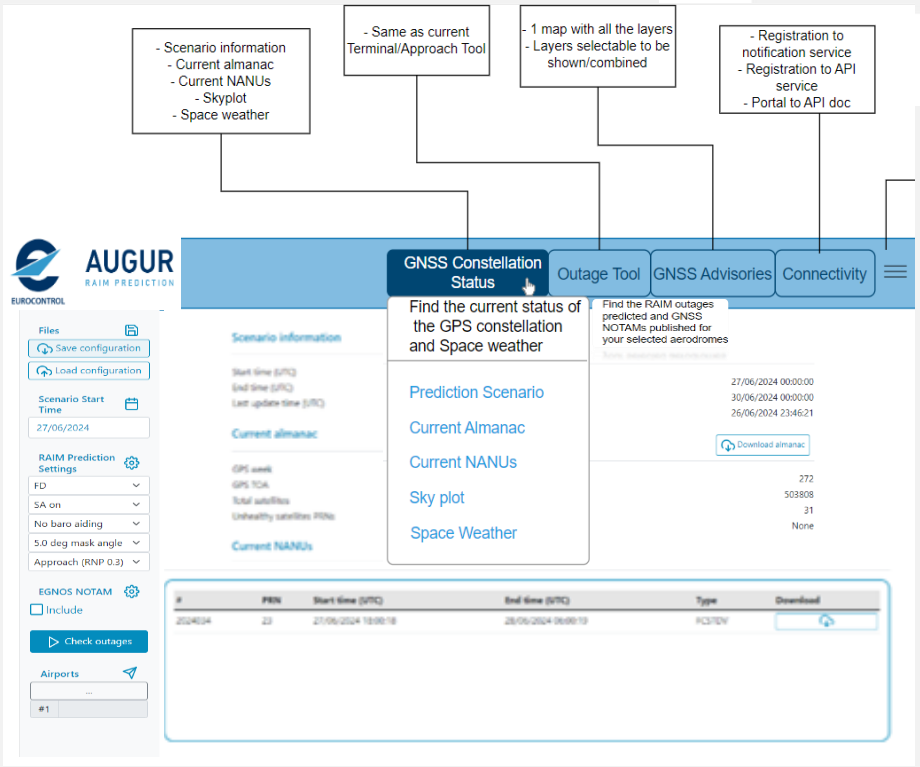


Integrated GNSS monitoring



[AUGUR - GNSS Monitoring](#) service





New features are expected to be deployed in March 2025

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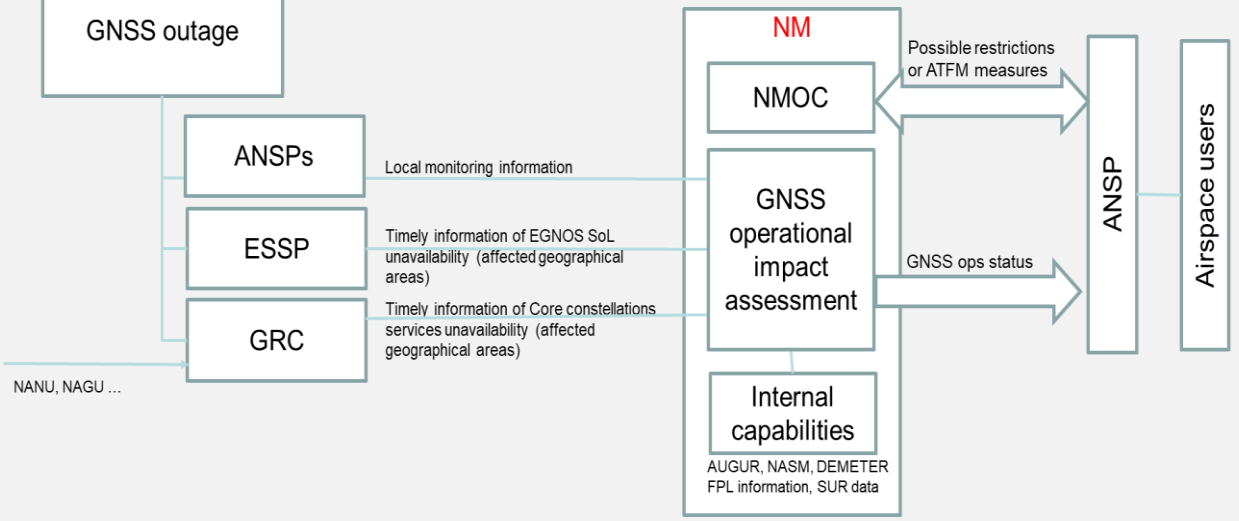
Implementation and operation

Incident Management



EU GNSS monitoring CONOPS

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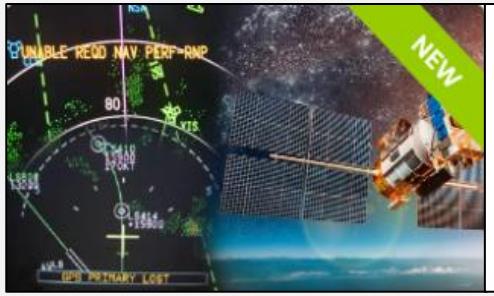
Enhancing operational readiness

Scenario :

- Simulated wide area jamming affecting major airports and airspaces
- Simulated wide area spoofing affecting major airports and airspaces

Training - GNSS interference course - [NAV-GNSS-RFI]

Learning Zone



GNSS Radio Frequency Interference [NAV-GNSS-RFI]

Classroom Course

Course available

Classroom Course EUROCONTROL Aviation Learning Centre

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.

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

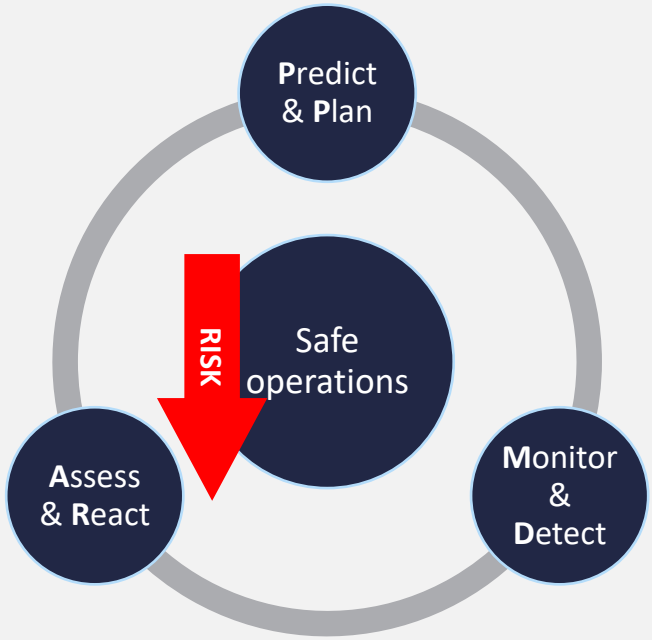
Location
Aviation Learning Centre, Luxembourg

Dates
27-28 May 2025

Registration and info :
https://learningzone.eurocontrol.int/ilp/pages/description.jsf#/users/@self/catalogues/896269/coursetemplates/17804270/description

Summary

- GNSS situation today
  - Some parts of the world experience interference on a daily basis
  - Spoofing is becoming a new realty
  - Impact on MON
- Leverage the current capabilities
  - Global Awareness
  - GNSS monitoring and coordination tools
  - Handbooks / Guidelines / Trainings
- Need for a structured and harmonised approach to tackle the issue
  - Holistic impact assessment
  - Harmonisation of operational contingency procedures
  - Automated notification and impact prediction
- Work on-going on strengthening receiver resilience
  - Integration of jamming / spoofing requirements in next generation standards (DFMC GNSS MOPS)



Incident Management

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Further reading & watching

- GNSS RFI risk assessment: EUROCONTROL Think Paper #9 https://www.eurocontrol.int/publication/eurocontrol-think-paper-9-radio-frequency-interference-satellite-navigation-active
- GNSS risk assessment: https://pbnportal.eu/epbn/main/PBN-Tools/GNSS-Threat.html
- GNSS RFI reporting: https://www.eurocontrol.int/service/eurocontrol-voluntary-atm-incident-reporting
- GNSS monitoring: https://augur.eurocontrol.int/status/
- GNSS contingency procedures: https://www.eurocontrol.int/publication/european-gnss-contingency-reversion-handbook-pbn-operations
- GNSS contingency : https://pbnportal.eu/epbn/main/PBN-Tools/GNSS-Outage-Strategic-Decisions.html
- EUROCONTROL Guideline on GNSS Interference Testing (enables coordination for those willing to coordinate) https://www.eurocontrol.int/sites/default/files/2023-03/eurocontrol-gnss-interference-testing-guide-v2-0.pdf
- Crew guidance: https://ops.group/blog/gps-spoofing-final-report/
- GNSS RFI Mitigation Plan: GNSS Manual, ICAO Doc 9849
- Training: https://learningzone.eurocontrol.int/ilp/pages/course-description.jsf?courseId=20758176&catalogId=896269&isTemplate=true

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ACTION BY THE MEETING

The meeting is invited to :

a) Take note Eurocontrol GNSS interference mitigation and monitoring; and

b) discuss any relevant matters as appropriate.

SUPPORTING
EUROPEAN
AVIATION

Thank you!

hamdi.nasser@eurocontrol.int

www.eurocontrol.int

CONSORTIUM COORDINATOR sesar DEPLOYMENT MANAGER

FOUNDING MEMBER sesar JOINT UNDERTAKING

NETWORK MANAGER