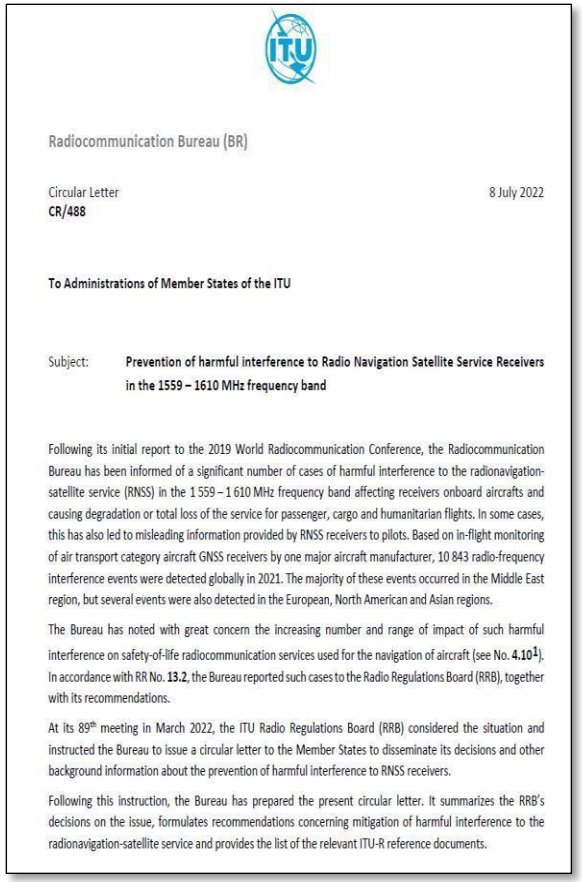
GNSS RFIupdate Reference to PBNC TF/7 &NSG/34

EUROCONTROL

GNSS RFI: a global problem



Radiocommunication Bureau (BR)

Circular Letter
CR/488

8 July 2022

To Administrations of Member States of the ITU

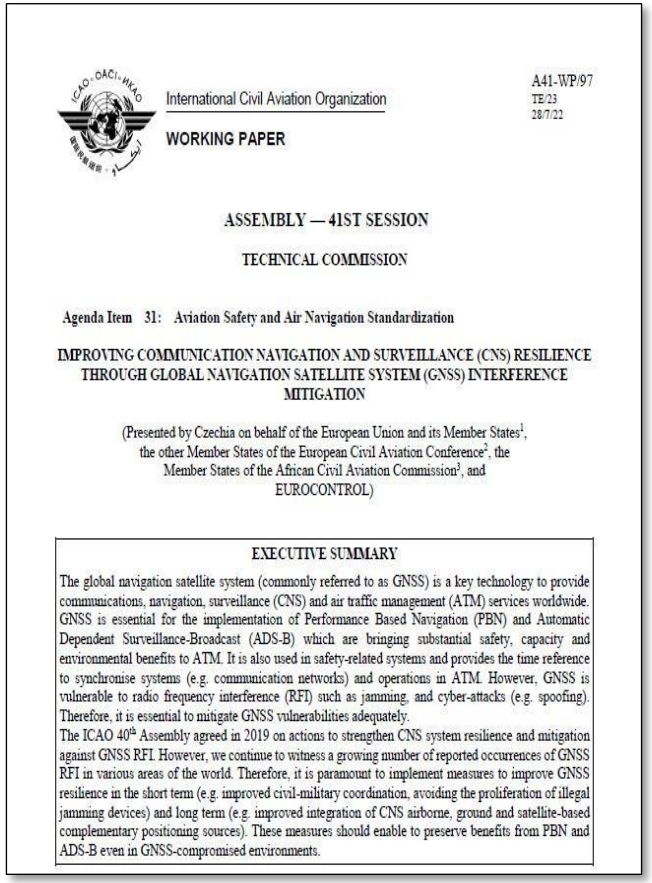
Subject: **Prevention of harmful interference to Radio Navigation Satellite Service Receivers in the 1559 – 1610 MHz frequency band**

Following its initial report to the 2019 World Radiocommunication Conference, the Radiocommunication Bureau has been informed of a significant number of cases of harmful interference to the radionavigation-satellite service (RNSS) in the 1 559 – 1 610 MHz frequency band affecting receivers onboard aircrafts and causing degradation or total loss of the service for passenger, cargo and humanitarian flights. In some cases, this has also led to misleading information provided by RNSS receivers to pilots. Based on in-flight monitoring of air transport category aircraft GNSS receivers by one major aircraft manufacturer, 10 843 radio-frequency interference events were detected globally in 2021. The majority of these events occurred in the Middle East region, but several events were also detected in the European, North American and Asian regions.

The Bureau has noted with great concern the increasing number and range of impact of such harmful interference on safety-of-life radiocommunication services used for the navigation of aircraft (see No. **4.10**[1]). In accordance with RR No. **13.2**, the Bureau reported such cases to the Radio Regulations Board (RRB), together with its recommendations.

At its 89th meeting in March 2022, the ITU Radio Regulations Board (RRB) considered the situation and instructed the Bureau to issue a circular letter to the Member States to disseminate its decisions and other background information about the prevention of harmful interference to RNSS receivers.

Following this instruction, the Bureau has prepared the present circular letter. It summarizes the RRB's decisions on the issue, formulates recommendations concerning mitigation of harmful interference to the radionavigation-satellite service and provides the list of the relevant ITU-R reference documents.



International Civil Aviation Organization

WORKING PAPER

A41-WP/97
TE/23
28/7/22

ASSEMBLY — 41ST SESSION

TECHNICAL COMMISSION

Agenda Item 31: Aviation Safety and Air Navigation Standardization

IMPROVING COMMUNICATION NAVIGATION AND SURVEILLANCE (CNS) RESILIENCE THROUGH GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) INTERFERENCE MITIGATION

(Presented by Czechia on behalf of the European Union and its Member States[1], the other Member States of the European Civil Aviation Conference[2], the Member States of the African Civil Aviation Commission[3], and EUROCONTROL)

EXECUTIVE SUMMARY

The global navigation satellite system (commonly referred to as GNSS) is a key technology to provide communications, navigation, surveillance (CNS) and air traffic management (ATM) services worldwide. GNSS is essential for the implementation of Performance Based Navigation (PBN) and Automatic Dependent Surveillance-Broadcast (ADS-B) which are bringing substantial safety, capacity and environmental benefits to ATM. It is also used in safety-related systems and provides the time reference to synchronise systems (e.g. communication networks) and operations in ATM. However, GNSS is vulnerable to radio frequency interference (RFI) such as jamming, and cyber-attacks (e.g. spoofing). Therefore, it is essential to mitigate GNSS vulnerabilities adequately.
The ICAO 40th Assembly agreed in 2019 on actions to strengthen CNS system resilience and mitigation against GNSS RFI. However, we continue to witness a growing number of reported occurrences of GNSS RFI in various areas of the world. Therefore, it is paramount to implement measures to improve GNSS resilience in the short term (e.g. improved civil-military coordination, avoiding the proliferation of illegal jamming devices) and long term (e.g. improved integration of CNS airborne, ground and satellite-based complementary positioning sources). These measures should enable to preserve benefits from PBN and ADS-B even in GNSS-compromised environments.

EASA SIB No.: 2022-02

EASA
European Union Aviation Safety Agency

Safety Information Bulletin
Operations – ATM/ANS
SIB No.: 2022-02
Issued: 17 March 2022

Subject: **Global Navigation Satellite System Outage Leading to Navigation / Surveillance Degradation**

Ref. Publications:
None.

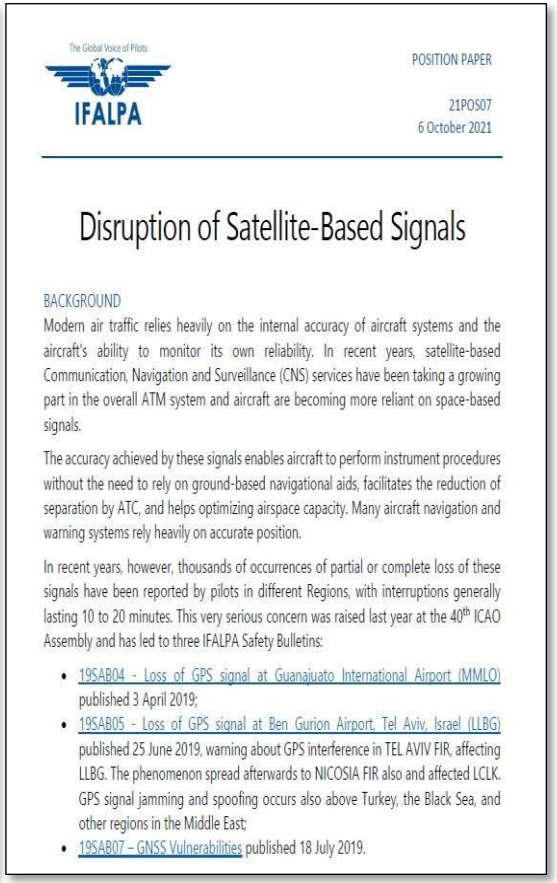
Applicability:
National Aviation Authorities (NAAs), Air Navigation Service Providers (ANSPs) and air operators.

Description:
In the current context of the Russian invasion of Ukraine, the issue of Global Navigation Satellite Systems (GNSS) jamming and/or possible spoofing has intensified in geographical areas surrounding the conflict zone and other areas.

Eurocontrol, Network of Analysts and open-source data reports analysed by EASA indicate that since 24 February 2022, there are four key geographical areas where GNSS spoofing and/or jamming has intensified, namely:

- Kaliningrad region, surrounding Baltic sea and neighbouring States;
- Eastern Finland;
- The Black Sea; and
- The Eastern Mediterranean area near Cyprus, Turkey, Lebanon, Syria and Israel, as well as Northern Iraq.

The effects of GNSS jamming and/or possible spoofing were observed by aircraft in various phases of their flights, in certain cases leading to re-routing or even to change the destination due to the inability to perform a safe landing procedure. Under the present conditions, it is not possible to predict GNSS outages and their effects. The magnitude of the issues generated by such outage would depend upon the extent of the area concerned, on the duration and on the phase of flight of the affected aircraft.



The Global Voice of Pilots
IFALPA

POSITION PAPER

21POS07
6 October 2021

Disruption of Satellite-Based Signals

BACKGROUND

Modern air traffic relies heavily on the internal accuracy of aircraft systems and the aircraft's ability to monitor its own reliability. In recent years, satellite-based Communication, Navigation and Surveillance (CNS) services have been taking a growing part in the overall ATM system and aircraft are becoming more reliant on space-based signals.

The accuracy achieved by these signals enables aircraft to perform instrument procedures without the need to rely on ground-based navigational aids, facilitates the reduction of separation by ATC, and helps optimizing airspace capacity. Many aircraft navigation and warning systems rely heavily on accurate position.

In recent years, however, thousands of occurrences of partial or complete loss of these signals have been reported by pilots in different Regions, with interruptions generally lasting 10 to 20 minutes. This very serious concern was raised last year at the 40th ICAO Assembly and has led to three IFALPA Safety Bulletins:

- 19SAB04 - Loss of GPS signal at Guanajuato International Airport (MMLO) published 3 April 2019;
- 19SAB05 - Loss of GPS signal at Ben Gurion Airport, Tel Aviv, Israel (LLBG) published 25 June 2019, warning about GPS interference in TEL AVIV FIR, affecting LLBG. The phenomenon spread afterwards to NICOSIA FIR also and affected LCLK. GPS signal jamming and spoofing occurs also above Turkey, the Black Sea, and other regions in the Middle East;
- 19SAB07 – GNSS Vulnerabilities published 18 July 2019.

- Ops contingency procedures
- Retain essential CNS infra
- Coordination between authorities
- Monitoring and reporting
- Legal framework
- Better integration and resilience of airborne systems

GNSS Threatassessment

- Threats
  - Jamming
  - Spoofing
  - Non-RFI
- Types of impact
- Risk
  - Severity taking into consideration the operational scenario and the types of impact
  - Likelihood based on past experience
  - Mitigation score
    - Currently deployed measures

- The proposed methodology is a framework to assess GNSS threats risks and to define the appropriate mitigation actions.
- **Excel file can be made available uponrequest**

Residual Risk = Severity * Operational scenario coefficient * Mitigation score * Likelihood

Severity					
	GNSS degraded or lost				
	number AC / Duration	From 2h up to 6h	From 30 min up to 2h	from 10 min up to 30 min	Up to 10 min
	All (Global loss of GNSS capability)	Major [C]	Hazardous [B]	Hazardous [B]	Major [C]
	large number of aircraft	Minor [D]	Major [C]	Major [C]	Minor [D]
	one to few aircraft	Negligible [E]	Minor [D]	Minor [D]	Negligible [E]
	One single aircraft	Negligible [E]	Negligible [E]	Negligible [E]	Negligible [E]
	Misleading information				
	number AC / Duration	From 2h up to 6h	From 30 min up to 2h	from 10 min up to 30 min	Up to 10 min
	All (Global loss of GNSS capability)	Hazardous [B]	Hazardous [B]	Hazardous [B]	Hazardous [B]
	large number of aircraft	Major [C]	Hazardous [B]	Hazardous [B]	Major [C]
	one to few aircraft	Major [C]	Major [C]	Major [C]	Major [C]
	One single aircraft	Minor [D]	Major [C]	Major [C]	Minor [D]

Operational scenario

Scenario #	Type of Traffic	Traffic density	PBN application	APNT (infra only)	Operational scenario coefficient
1	TMA	Low	RNAV1	DME/DME	0.25
2			RNP1	None	0.75
3		High	RNAV1	DME/DME	0.25
4			RNP1	None	1

Mitigation Score	
	[1] no mitigating measures available
	[0.75] mitigation has a limited scope (many important aspects are not covered)
	[0.5] mitigating measures are generally in place, but they may be immature or only partially effective
	[0.25] mitigation measures effective and are in widespread use

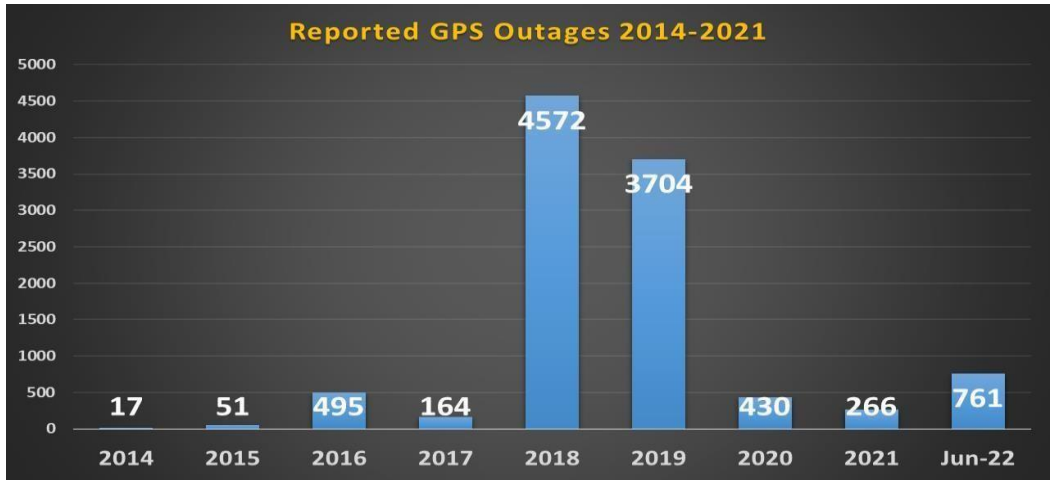
ICAO safety manual

Safety Risk Index Range	*Safety Risk Description*	*Recommended Action*
5A, 5B, 5C, 4A, 4B, 3A	INTOLERABLE	Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventative controls are in place to bring down the safety risk index to tolerable.
5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	TOLERABLE	Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
3E, 2D, 2E, 1B, 1C, 1D, 1E	ACCEPTABLE	Acceptable as is. No further safety risk mitigation required.

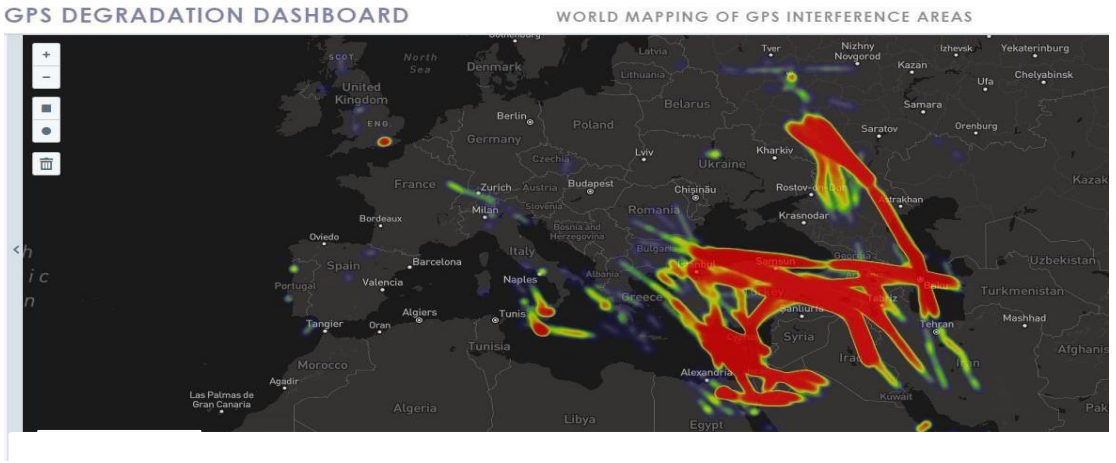
Safety Risk	Severity				
Probability	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	1E

EVAIR: Collecting Pilot Reports of ATM incidents

- EUROCONTROL Voluntary ATM Incident Reporting (EVAIR)
- 250 Participating Aircraft Operators
  - Coverage: Europe, Middle East, Northern Africa
  - Detail reports subject to confidentiality



2018 / 2019 trend: average of 10 GPS reports DAILY
2020/2021 decrease due to reduced flights (COVID) and reporting
2022: increase due to the war in Ukraine (main peak in March/April)

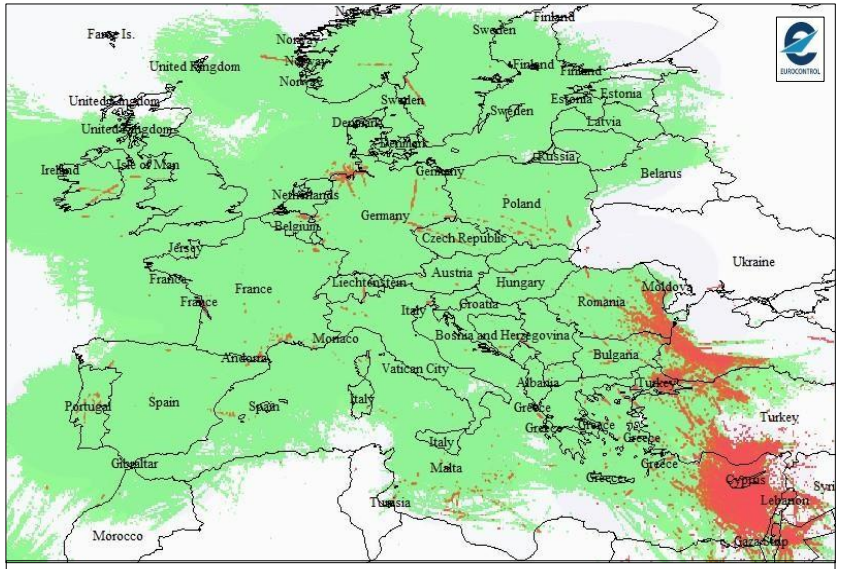


2021: 10843 events detected worldwide
RFI continues despite reduced pilot reports

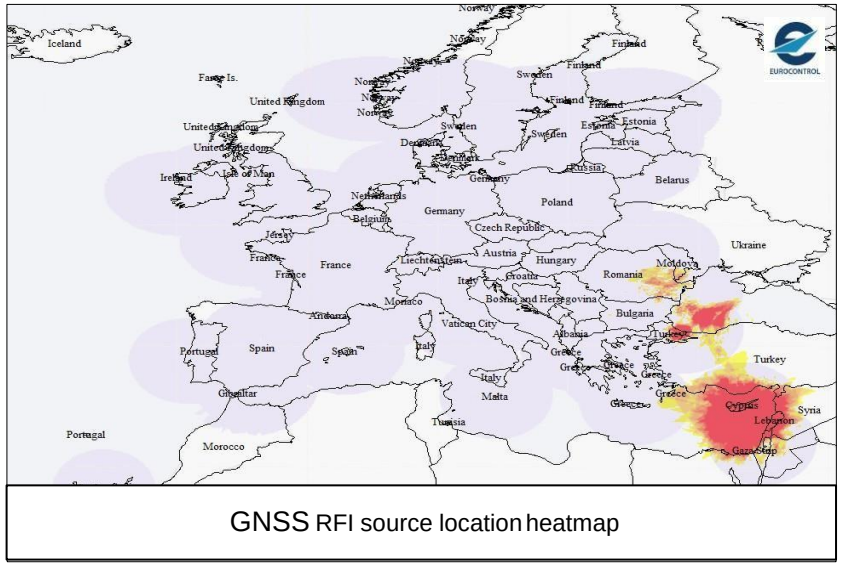
The number of reports gives a small indication but does not reflect the full picture (dependent on the willingness to report)

- Important to report cases to justify actions and make political pressure
- Need for a tool allowing automatic detection and reporting of GNSS RFI

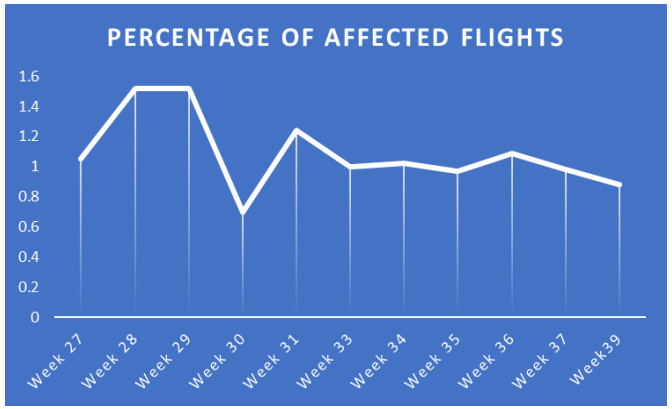
Navigation status monitoring (NASM) – IOC and weekly update



GNSS quality indicators reported through ADS-B

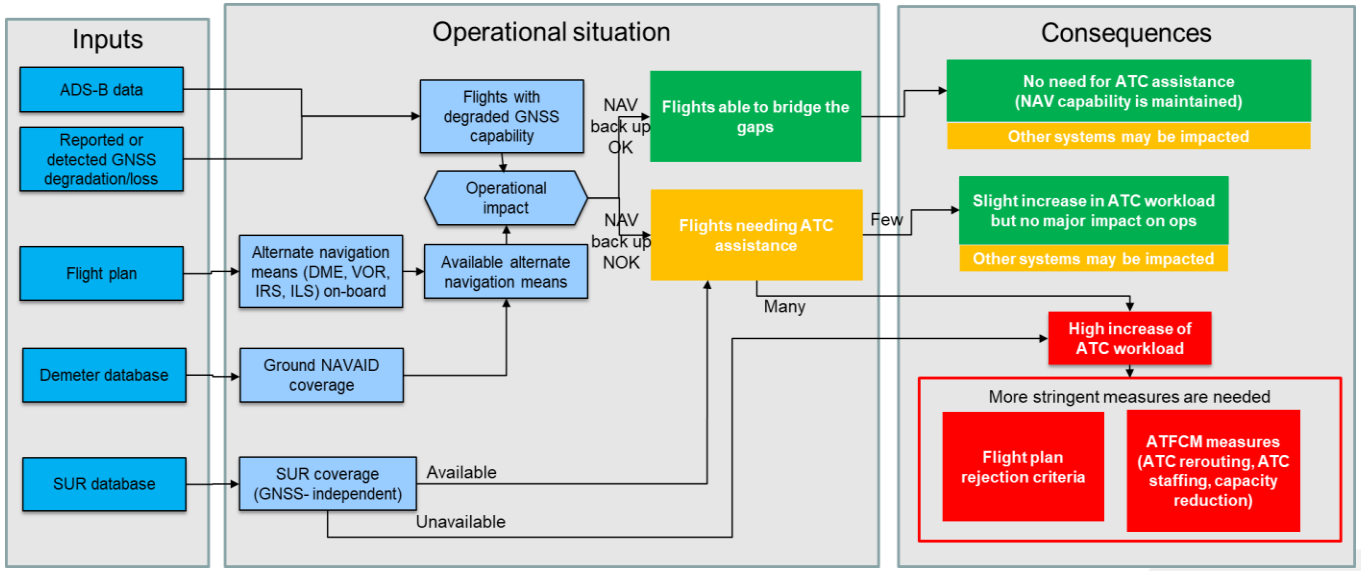


GNSS RFI source location heatmap



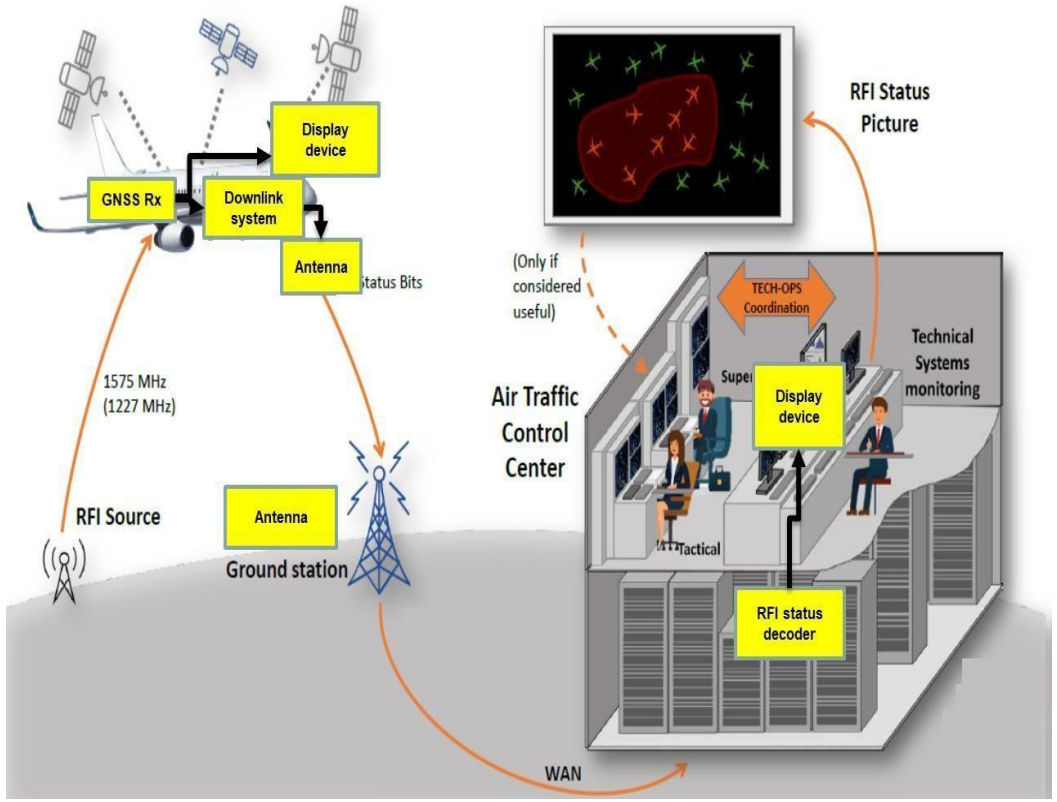
***Tactical:* Near real time capability**
Ensure that there is a timely reaction to a significant event, allowing to identify affected flights, inform all concerned actors and implement appropriate mitigation measures (such as reducing certain traffic through an impacted airspace).

Operational impact assessment

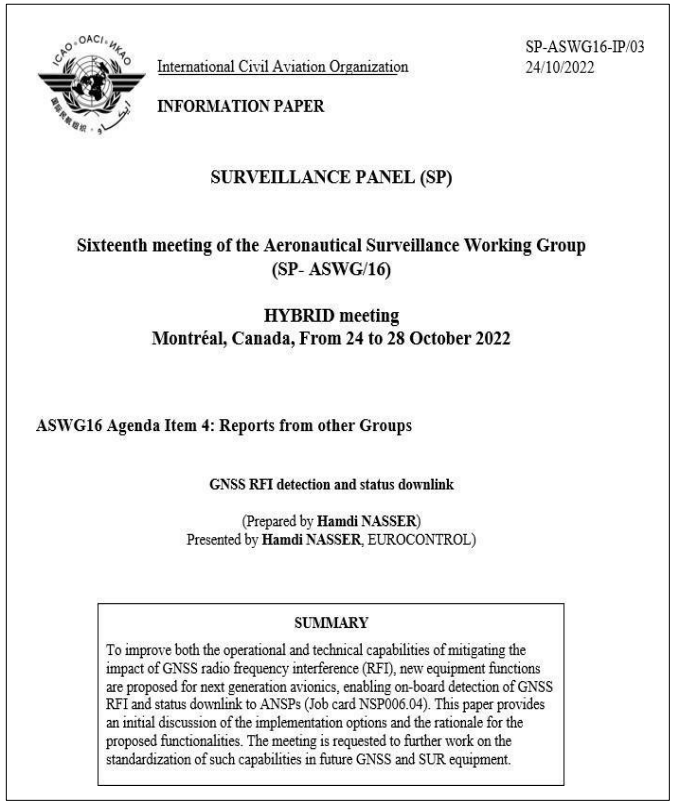


Envisioned Next Generation RFI Mitigation Function

Functional architecture



➔ ***Work in progress***



International Civil Aviation Organization

SP-ASWG16-IP/03
24/10/2022

INFORMATION PAPER

SURVEILLANCE PANEL (SP)

Sixteenth meeting of the Aeronautical Surveillance Working Group (SP- ASWG/16)

HYBRID meeting
Montréal, Canada, From 24 to 28 October 2022

ASWG16 Agenda Item 4: Reports from other Groups

GNSS RFI detection and status downlink

(Prepared by **Hamdi NASSER**)
Presented by **Hamdi NASSER**, EUROCONTROL)

SUMMARY

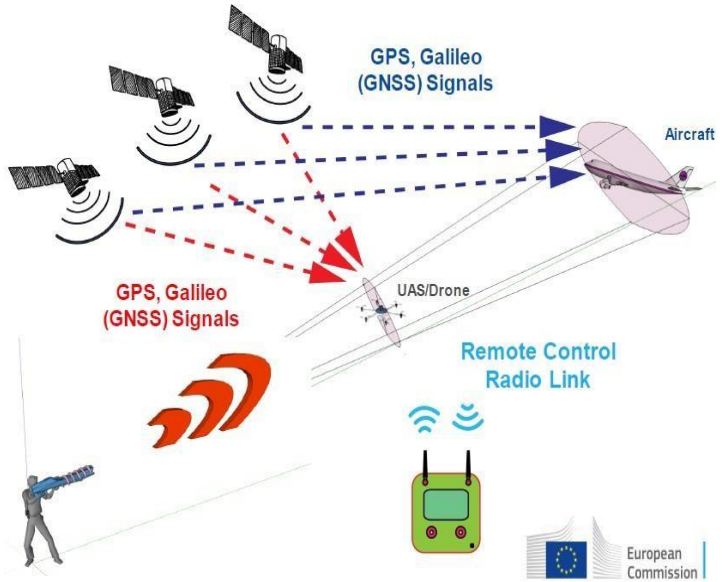
To improve both the operational and technical capabilities of mitigating the impact of GNSS radio frequency interference (RFI), new equipment functions are proposed for next generation avionics, enabling on-board detection of GNSS RFI and status downlink to ANSPs (Job card NSP006.04). This paper provides an initial discussion of the implementation options and the rationale for the proposed functionalities. The meeting is requested to further work on the standardization of such capabilities in future GNSS and SUR equipment.

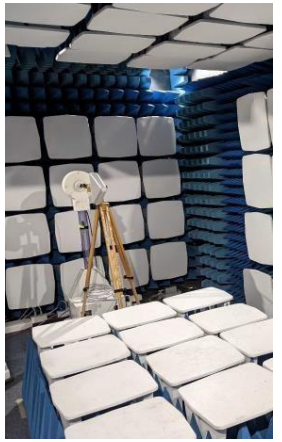
Standards

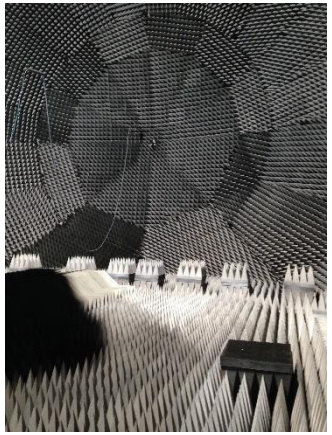
- ICAO NSP agreed job card to work on “GNSS RFI detection and status Downlink”
- RTCA SC159 / EUROCAEWG62 is working on the **inclusion of an RFI detection function in next generation GNSS standards**
- ADS-B is the most suitable link due to commonality of interest (use of GNSS)
- Work on going with the SUR community to define the downlink message

C-UAS

- An **ad hoc group** composed of representatives from EUROCONTROL, EDA, NATO, EC JRC and European police forces/frequency regulators/military
- **Objective**: Determine possible collateral risks to the use of C-UAS jammers
  - i.e. possible risks to non-participating GNSS receivers, including receivers in civil aviation aircraft
  - Risk assessment as a basis for authorizing the safe use of C-UAS
- **Planned activities**: Test plan, Test campaign at JRC (Measure of the 3D radiation pattern of commonly used CUAS), Report including recommendations on the use of state authorized CUAS.
  - Technical characteristics and mitigation: on going in JRC, Results expected in Q4 2022.
  - operational/tactical mitigation planned for 2023
- **Expected outcome**: Risk mitigation measures to ensure the safe use of CUAS capabilities







Summary

- GNSS RFI is a widespread problem (ITU CR, EASA SIB, ICAO assembly paper, …)
- Pilot reports (EVAIR) and Aircraft collected data (Airbus skywise) confirm that GNSS RFI is still a problem affecting aviation operations
  - The number of reports gives a small indication but does not reflect the full picture (dependent on the willingness to report)
  - Need for a tool allowing automatic detection and reporting of GNSS RFI
- EUROCONTROL is developing monitoring capabilities
  - IOC and weekly updates: RFI detection and localisation using ADS-B
  - Objective is to move to a near real time tool and to combine with other data in order to assess impact on ATM ops
- Standards: Work on going to define the “GNSS RFI detection and status downlink” functions
- EUROCONTROL guidelines on a process for Civil-military GNSS interference testing– Coordination of state authorized GNSS RFI testing
  - CUAS study could feed the guidelines with recommendations related to the safe use of CUAS (unplanned events).