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INTERNATIONAL CIVIL AVIATION ORGANIZATION

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ICAO WRC-27 Preparatory Workshop
Agenda item: GNSS Interference

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Presentation Overview

01 Background

02 Potential Issues

03 ICAO Position

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01 Background

GNSS Interference definitions (Source: ICAO NSP/5 IP/26 - Montréal, 6-15 November 2018)

Intentional interference is generally referred to as interference whose purpose is to disrupt signal reception. Most effects of interferers on air navigation services are collateral and can be due to conflict zones, sensitive areas, personal privacy devices

The International Telecommunication Union (ITU) Radio Regulations (Vol 1, Art I, Sect VII) [24] define interference as
"The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy".

01 Background

GNSS Interference definitions (Source: ICAO NSP/5 IP/26 - Montréal, 6-15 November 2018)

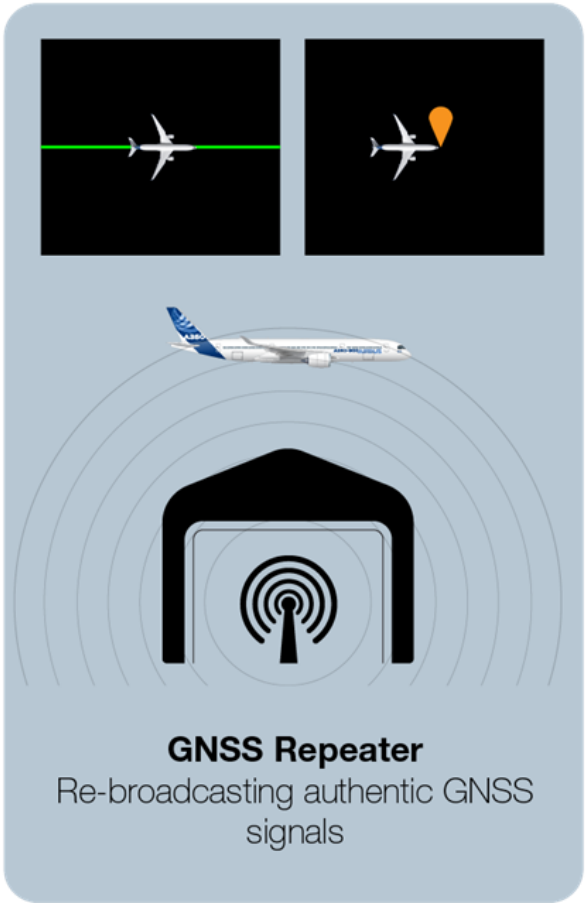
ITU classifies interference as permissible, accepted or harmful, where harmful interference is defined as "Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations".

The proposed top-level types of harmful interference threats are Jamming and Spoofing, where:

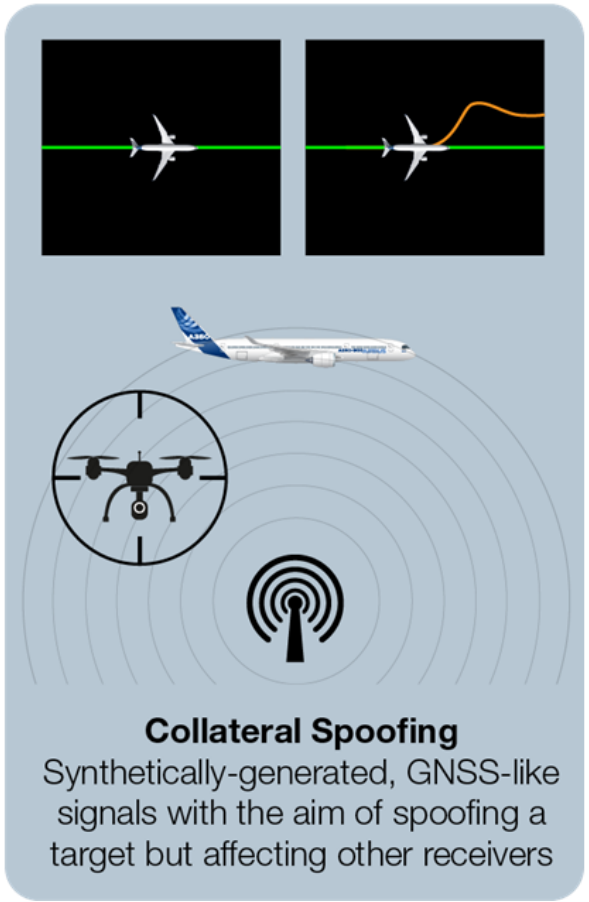
- Jamming denotes emissions that do not mimic GNSS signals, but rather interfere with the receiver’s ability to acquire and track GNSS signals.
- Spoofing denotes emissions of GNSS-like signals that may be acquired and tracked in combination with or instead of the intended signals.

01 Background

Types of GNSS interferences affecting Aviation Services



GNSS Repeater
Re-broadcasting authentic GNSS signals

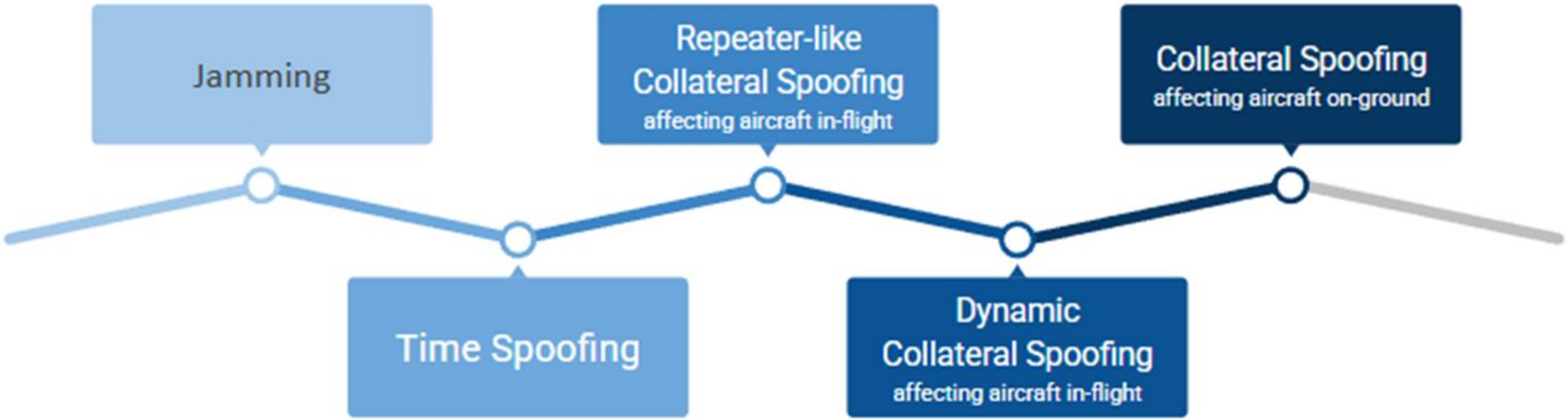


Collateral Spoofing
Synthetically-generated, GNSS-like signals with the aim of spoofing a target but affecting other receivers

Targeted Spoofing
GNSS-like signals based on real-time reception of authentic signals aiming to spoof a target

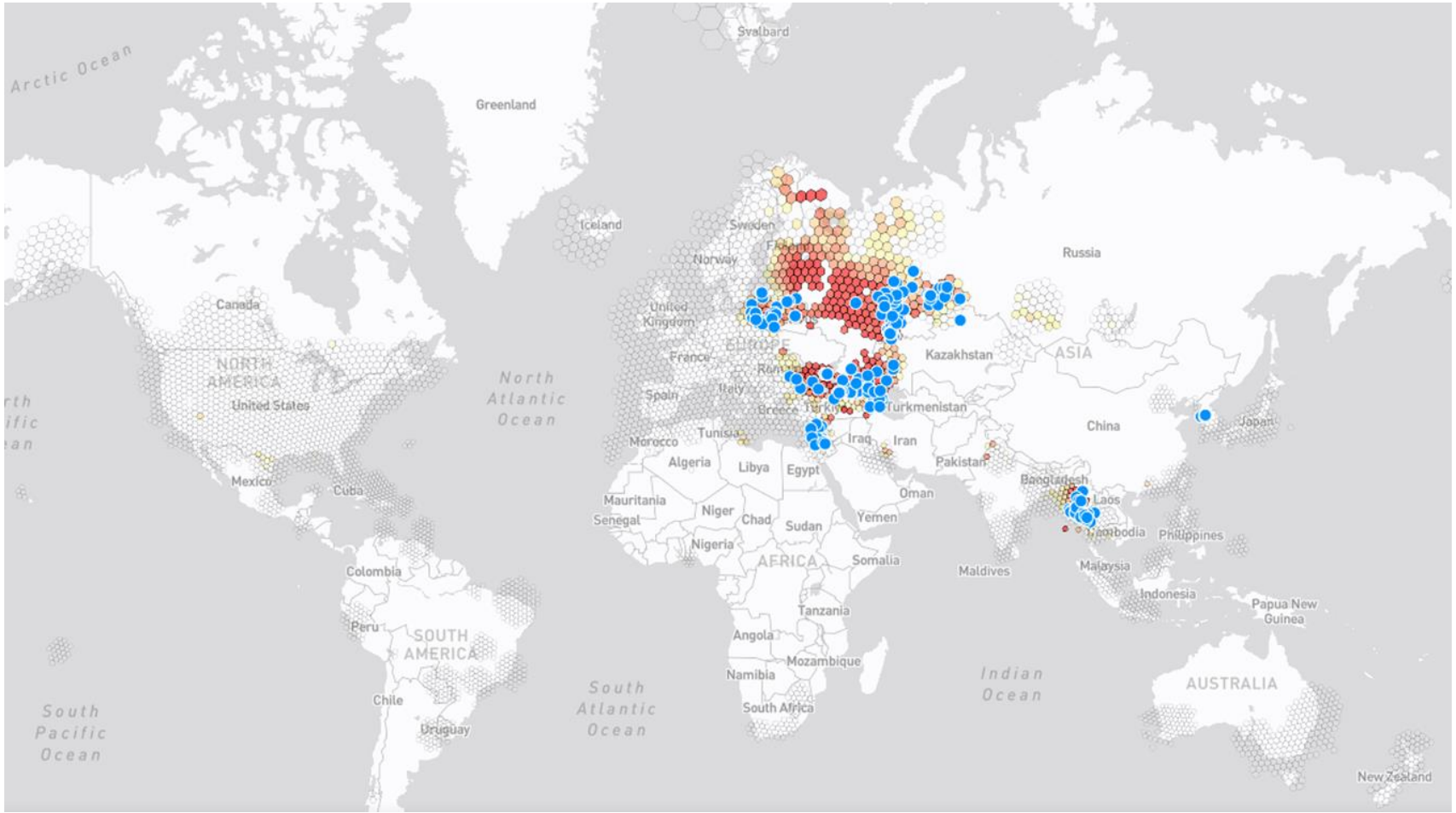
02 Potential issues

GNSS Interference evolutions near conflict zones

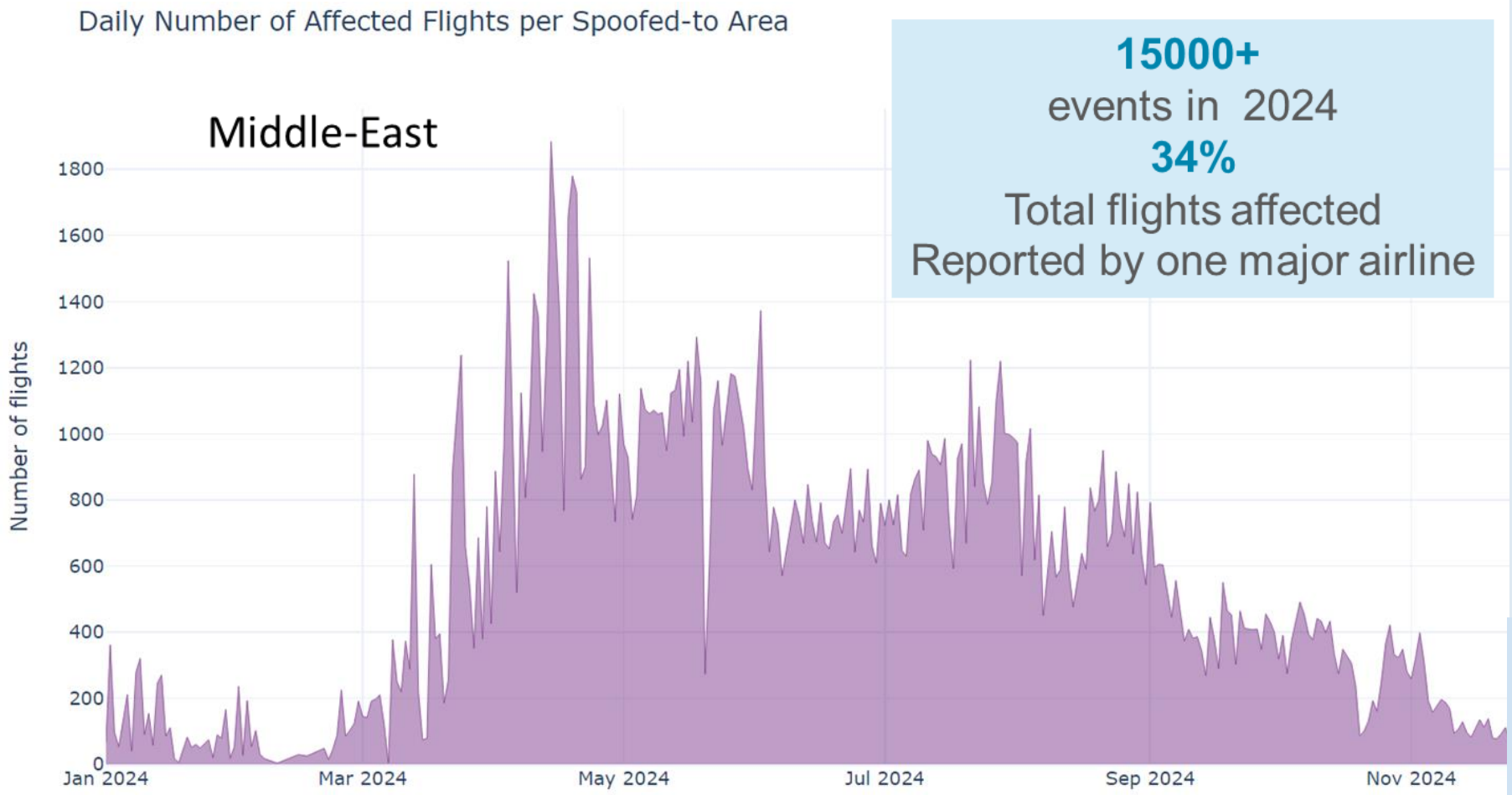


02 Potential issues

GNSS Interference jamming and spoofing zones



02 Potential issues



15000+
events in 2024
34%
Total flights affected
Reported by one major airline

AIRCRAFT IMPACTS

TERRAIN
Loss or
Nuisance alerts

Temporary or permanent loss of GPS-based Navigation

TRAFFIC, WEATHER Loss

Incorrect Aircraft Position & Timing

Example: oceanic operations adversely affected

Risk of **Crew considering valid cockpit alerts as spurious ones** leading to **non-application of emergency procedures in case of real alerts**

02 Potential issues

Possible effects of GNSS interferences (Sources: EASA SIB 2022-02R3 - 05 July 2024)

- Loss of or misleading surveillance function (corrupted Automatic Dependent Surveillance-Broadcast (ADS-B), TAWS, TCAS, ACAS;
- Loss of or misleading information on a Synthetic Vision Systems (SVS), weather uplink functions, predictive wind shear, and other surface functionalities;
- Inconsistent flight guidance possibly resulting in route divergence, uncommanded turns, and deviations from the ATC clearances or instructions received, which could potentially lead to airspace infringements, loss of traffic separation, insufficient terrain/obstacle clearance, etc.;
- Inconsistent, or potentially misleading aircraft position, GNSS altitude, and calculated ground or wind speed on the navigation display or on the Electronic Flight Bag (EFB);
- Inconsistent, or potentially misleading aircraft position and/or GNSS altitude, later in the flight after having exited the affected area, e.g., during approach;
- Loss or misleading time and/or date dependent systems (e.g., clock, fuel computation system, flight management system, discarded Controller Pilot Data Link Communication (CPDLC) messages)

03 ICAO Position

ICAO 14th Air Navigation Conference Recommendations

Recommendation 2.2/2 – Addressing global navigation satellite system interference and contingency planning

That States:

ensure that effective global navigation satellite system radio frequency interference 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 global navigation satellite system interference;

through the mechanism of the planning and implementation regional groups, develop regional global navigation satellite system reporting mechanisms to raise operational awareness of affected geographical areas, to the extent feasible, as described in the *Global Navigation Satellite System (GNSS) Manual* (Doc 9849);

work with industry to identify means to make aircraft systems more resilient to radio frequency interference events, and to provide guidance on detecting global navigation satellite system jamming or spoofing and maintaining safe and efficient aircraft operation in case of global navigation satellite system anomalies; and

review aircraft minimum equipage lists to ensure compatibility with States' implemented minimum operational networks.

03 ICAO Position

ICAO 14th Air Navigation Conference Recommendations

Recommendation 2.2/2 – Addressing global navigation satellite system interference and contingency planning

that ICAO:

continue to assess the impact of global navigation satellite system interference on aviation safety and continuity of civil aviation operations and define adequate mitigation measures, while reminding States of their obligations;

develop a standardized implementation package to assist and guide States in implementing effective global navigation satellite system radio frequency interference 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;

develop guidance on GNSS interference information exchange and civil-military coordination in relation to harmful interference to global navigation satellite system(s) originated or detected by military authorities; and

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.

General Industry Approach to GNSS Interference

Short Term	Medium Term	Longer Term
• Update technical information regarding expected aircraft effects and recommended procedures • (Automatically) Report and analyze GNSS interference events • Continued airworthiness assessments – aircraft and operational impacts • Promote awareness of GNSS spoofing areas • Update Surveillance systems (e.g. Terrain avoidance systems) • Address Data-Link availability issues	• Update navigation systems to detect, report and reliably recover from spoofing • Study & standardize mitigation technologies (e.g.): ✓ Adaptive GNSS antenna systems, i.e. Controlled Reception Patten Antennas (CRPA) ✓ Signal authentication methods (cryptographic)	• Deploy more advanced mitigation technologies ✓ Introduce GNSS signal authentication ✓ Adaptive Antennas • Robust time reference that is independent from GNSS for applications requiring time synchronization (e.g. Datalink) • Complementary P.N.T. development to support PBN operations without GNSS

Work at **ICAO** with IATA, Airframe Manufacturers, Air Navigation Service Providers, Air Traffic Controllers, Airlines Pilots Associations on **technical and operational recommendations**

03 ICAO Position

ICAO 42nd Assembly

WP/108 MITIGATING GNSS VULNERABILITIES IN AVIATION: STRENGTHENING RESILIENCE AND OPERATIONAL CONTINUITY

(Presented by International Coordinating Council of Aerospace Industries Associations (ICCAIA), Civil Air Navigation Services Organisation (CANSO), International Federation of Air Line Pilots' Associations (IFALPA) and International Business Aviation Council (IBAC))

03 ICAO Position

ICAO 42nd Assembly

This paper examines the current landscape of GNSS vulnerabilities, their implications for aviation,

potential mitigations and proposes a series of recommendations to ICAO and the civil aviation community aimed at mitigating the effects of GNSS jamming and spoofing.

Action: The Assembly is invited to:

a) call on Member States to develop interference detection systems and support means to provide timely and operationally relevant information about GNSS interference to operators;

b) instruct ICAO to work with States and/or industry to support the development of standards and

guidance means to provide operationally relevant information about interference to operators;

c) instruct ICAO to expedite efforts to define and standardize complementary PNT (C-PNT) systems

that extend beyond the capabilities of current conventional navigation aids;

03 ICAO Position

ICAO 42nd Assembly

d) instruct ICAO to accelerate the development of standards for signal authentication for GNSS core constellations and augmentations;

e) instruct ICAO to work with States, standards development organizations (RTCA, EUROCAE, IEEE and others) and industry to develop requirements and supporting performance standards for time synchronization across all flight domains to promote operational safety and efficiency. This should include guidance concerning required levels of assured time synchronization to include accuracy, integrity and continuity of time synchronization; and

f) urge States to work with industry/encourage industry/support industry to continue development and deployment of technologies that make GNSS receivers and aircraft that incorporate them more resilient to GNSS jamming and spoofing.

04 Conclusion

- The GNSS interference threat is active and evolving
- It is a global problem that is considered at Industry level and State levels
- Evolution of regulations, standards and recommended practices have started in order to address short term challenges as well as develop long term solutions
- GNSS Interference was a major topic on the agenda of the ICAO 42nd Assembly

Thank You

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