ICAO MID 5th Safety Summit

GNSS Interference on Airbus A/C

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Kuwait, November 2024

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Agenda

1. Introduction
2. Airbus GNSS Navigation Architecture
3. GNSS interference operational recommendations
4. Design perspectives
5. Standardization activities
6. Communications
7. Conclusions

Introduction

Example of Spoofing

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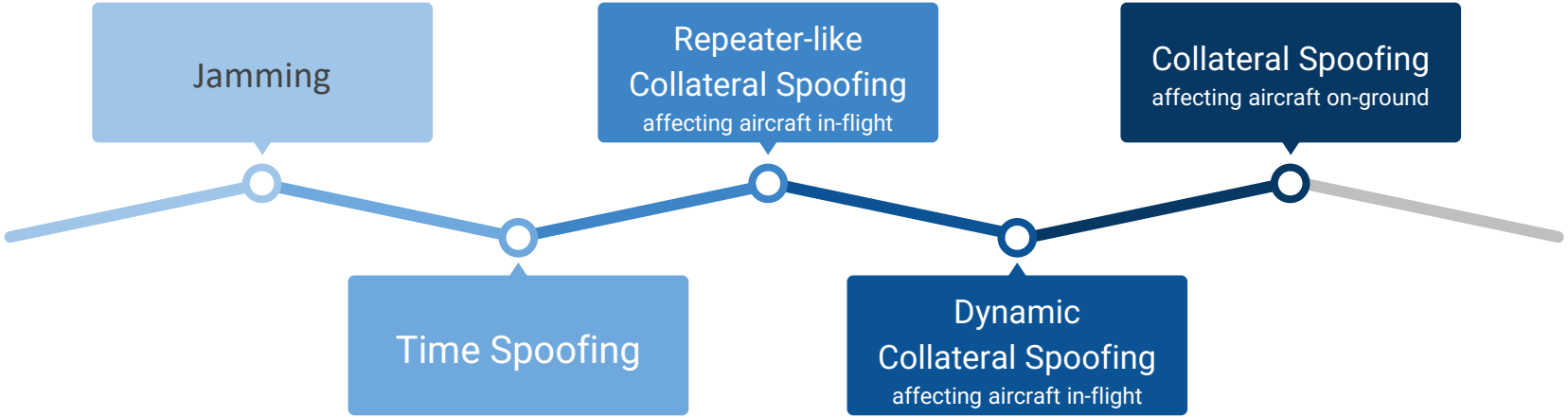
Introduction

Example of Erroneous IRS Alignment under Spoofing during cockpit preparation:

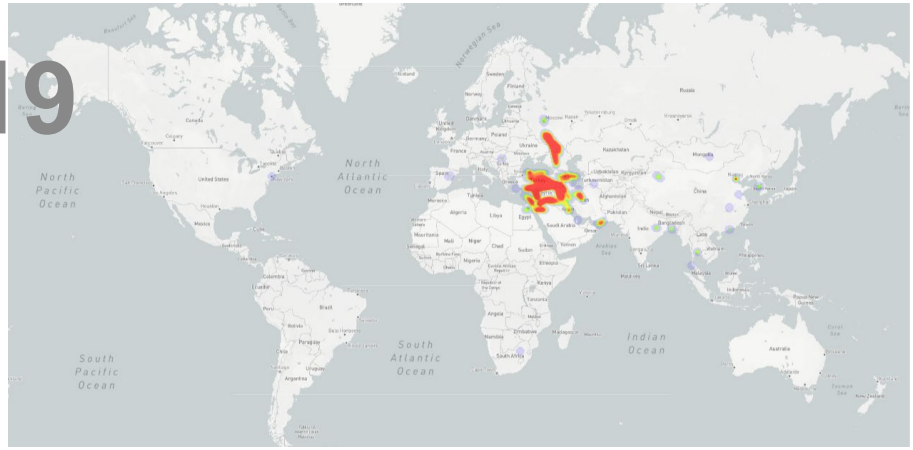
Introduction

Sophistication increasing



Introduction

2019



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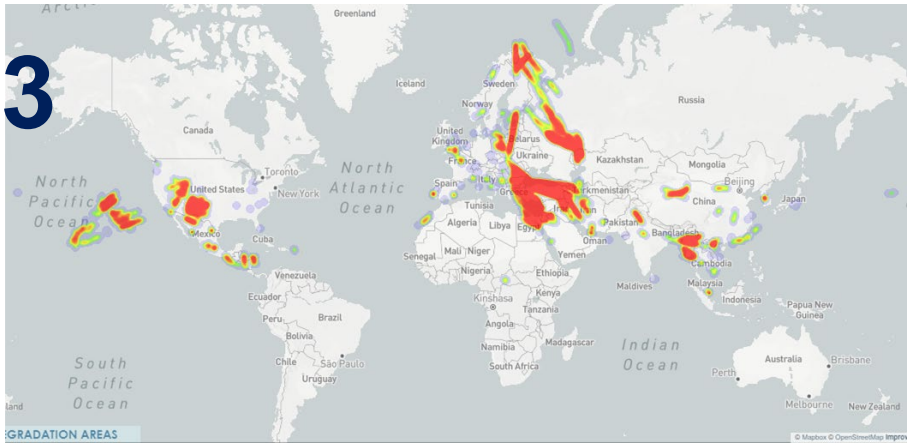

- **The GNSS Interference threat continues to evolve**
- **Airbus works in design evolutions**
- **Airbus is involved with authorities and standardization groups**
- **Operational mitigations updated in the FCOM Supplementary Procedures GPS/GNSS Interference** (when applicable)

Source: Airbus Skywise

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Introduction

Effects of GNSS Jamming & Spoofing

Loss of Functions

Navigation
- GPS PRIMARY / NAV PRIMARY
- GLS / SLS
- OANS / ANF

Surveillance
- ADS-B OUT
- Predictive TAWS
- TCAS, PWS

Communication
- CPDLC
- ADS-C

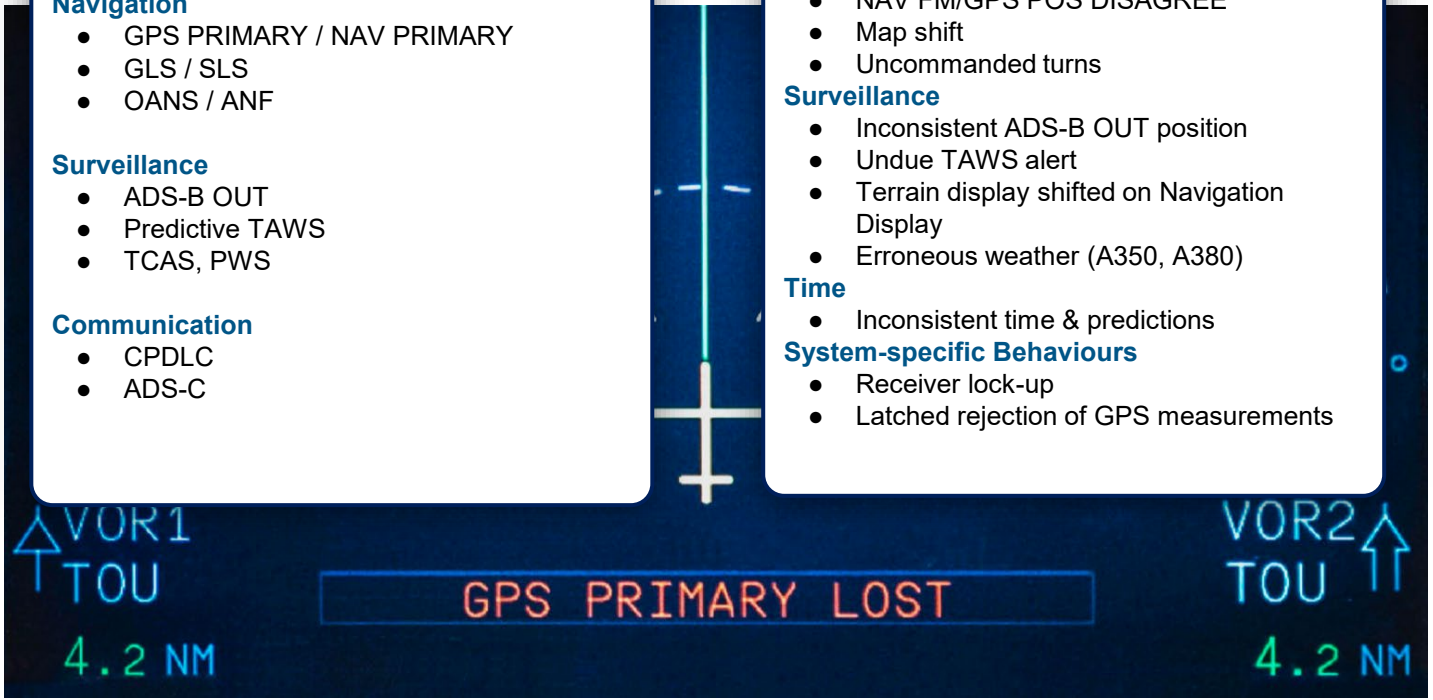
Other Observed Effects

Navigation
- NAV FM/GPS POS DISAGREE
- Map shift
- Uncommanded turns

Surveillance
- Inconsistent ADS-B OUT position
- Undue TAWS alert
- Terrain display shifted on Navigation Display
- Erroneous weather (A350, A380)

Time
- Inconsistent time & predictions

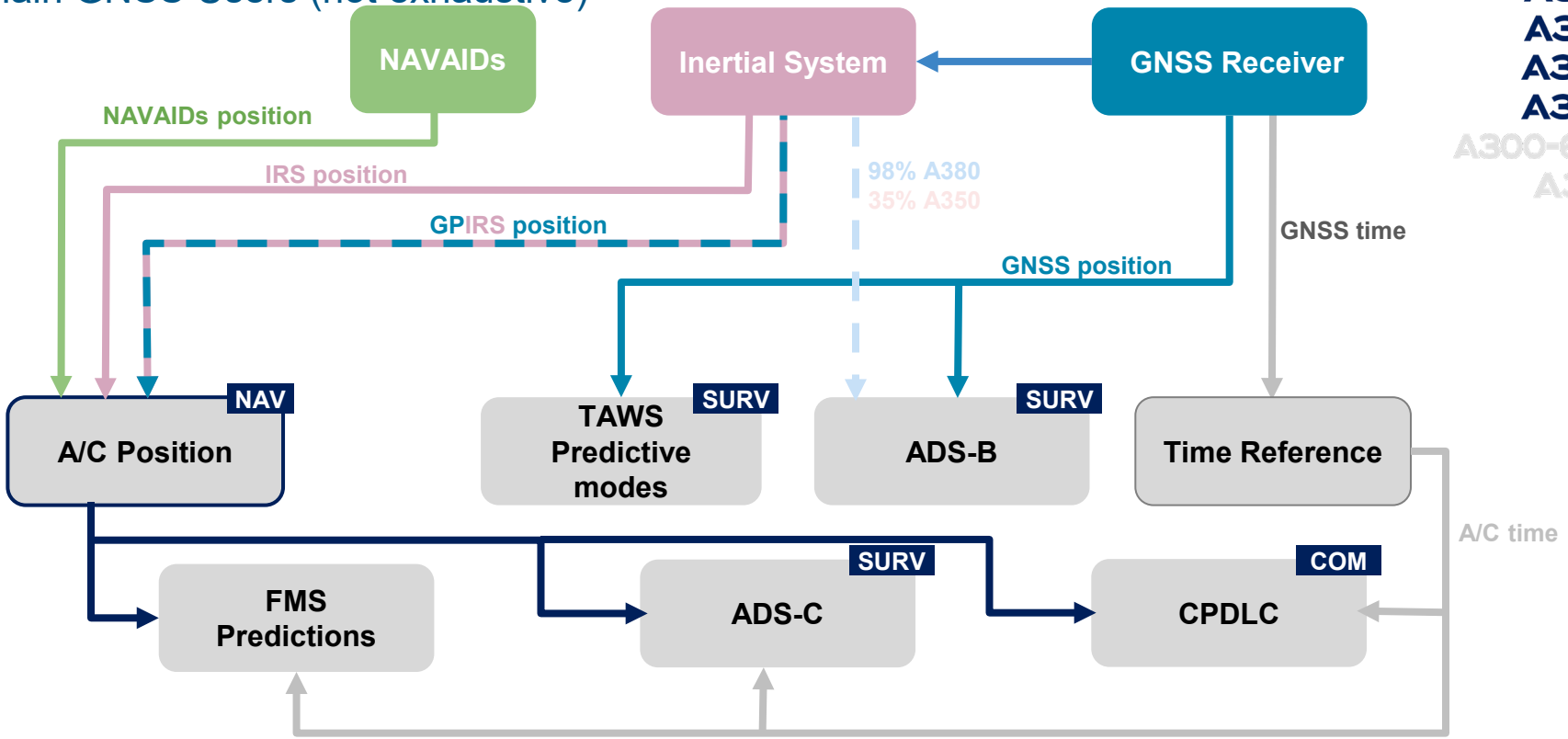
System-specific Behaviours
- Receiver lock-up
- Latched rejection of GPS measurements



Airbus GNSS Hybrid Navigation Architecture

Main GNSS Users (not exhaustive)

A220
A320
A330
A340
A350
A380
A300-600
A310



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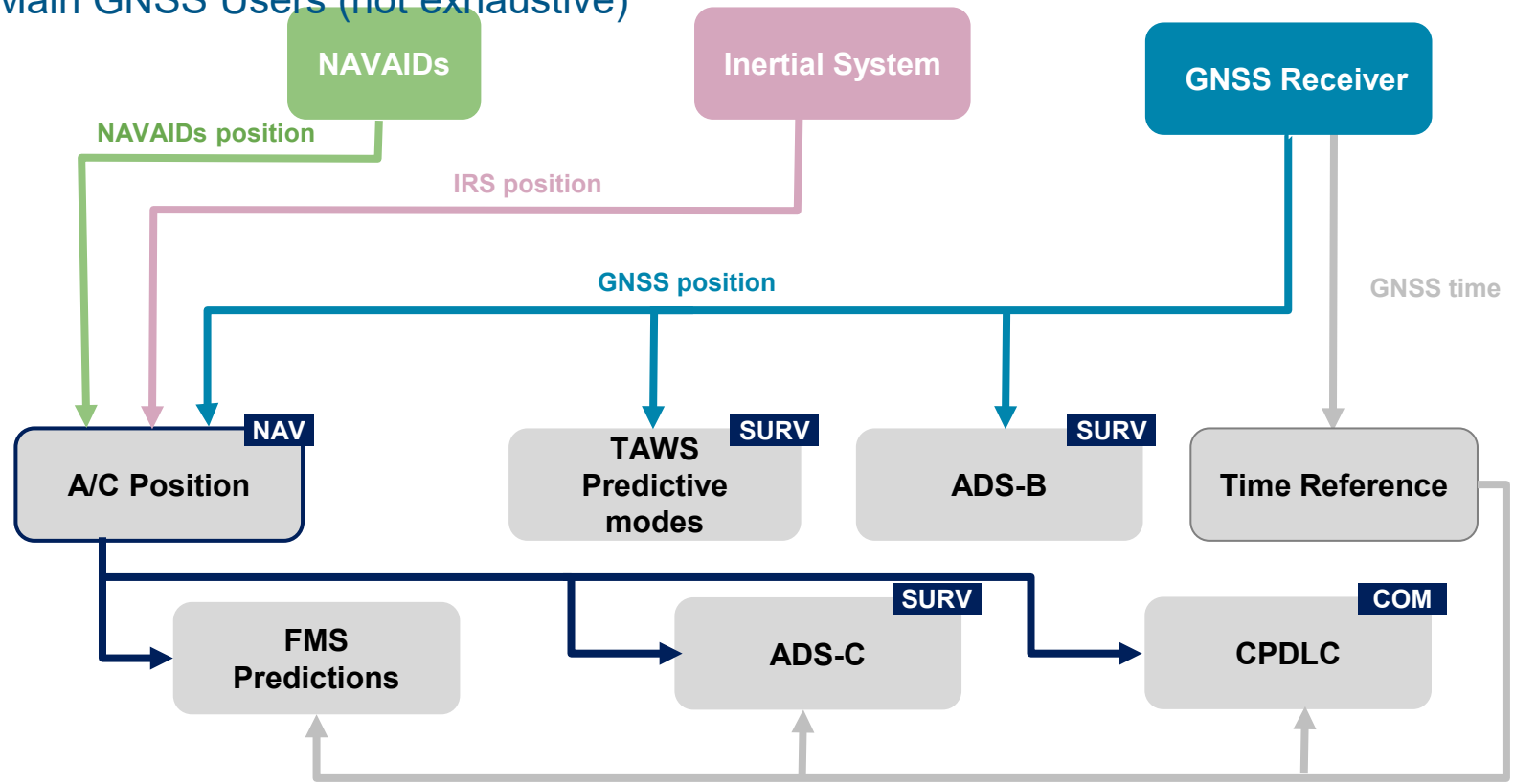
Airbus GNSS Autonomous Navigation Architecture

Main GNSS Users (not exhaustive)

A220
A320
A330
A340
A350
A380
A300-600
A310



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GNSS Interference: Cockpit Effects
A300-600, A310, A320, A330, A340, A350, and A380

Function	PFD/ND	ECAM Alert	ECAM Status	Other Effects
ADS-B IN	ADS-B	NAV ADS-B TRAF FAULT	ADS-B TRAF	
ADS-B OUT		NAV ADS-B RPTG 1(2) FAULT	ADS-B RTPG	
Aircraft position		NAV FM/GPS POS DISAGREE		
DBUS	Backup Mach, backup characteristic speeds, and backup altitude are not available.	NAV BKUP SPD FAULT	BKUP SPD FAULT	
FLS			FLS LIMITED TO F-APP+RAW	
GLS	GLS LOC G/S LOC and G/S deviation scale and index are not available (with or without ECAM alert).	NAV GLS 1(2)(1+2) FAULT	GLS 1(2)(1+2) GLS AUTOLAND	
GPS	GPS PRIMARY LOST	NAV GPS		
OANS	ARPT NAV POS LOST			
ROW/ROPS		SURV RO		
TAWS		NAV GPWS TERR DET FAULT NAV GPWS FAULT	GPWS TERR GPWS	Erroneous terrain alerts.
Time predictions				Erroneous time and FMS predictions (time drifts or jumps).
SATCOM				Degraded voice/datalink communications.
Wind information	Erroneous wind speed and direction.			
XLS	Non availability of Pre-Capture Zone of the LOC Beam			
Time predictions				Erroneous time and FMS predictions.
Wind information	Erroneous wind speed and direction.			
WXR	MAP NOT AVAIL WX GND CLUT			

Known cockpit effects per aircraft type is available in:

- A300/A310/A320/A330/A350/A380 - ISI 34.36.00049 and FCOM Proc SUP-customized by aircraft type
- A220 family: A220-FOT-34-50-002

A220

Function	EICAS	PFD / HSI / MAP	Other Effects	Comment
ADS-B OUT	ADS-B OUT FAIL ADS-B OUT 1 FAIL ADS-B OUT 2 FAIL		ADS-B erroneous report	
COM			CPDLC/ ADS-C erroneous position report	
ELT-DT			ELT-DT activation (undue TAWS alert)	
FMS		Position shift (aircraft symbol not on FMS flight path)		
	APPROACH NOT AVAIL	NO APPR NO APPR		
	LPV NOT AVAIL	LPV APPR		
		OS		FMS navigation sensor does not meet the accuracy requirements for the current phase of flight.
		AS DISAGREE AS DISAGREE		
		R R EXCEEDS 5NM		FMS has no valid source of position information from any sensor.
		SS REVERTED		
			GNSS1 and/or GNSS 2 locked in Acquisition mode "ACQ" on FMS - POS - GNSS - GNSS information)	
SMS		RUNWAY RUNWAY AMM NOT AVAILABLE	Undue SMS alert	
	SMS FAIL			
		MAP POSITION FAULT		
TAWS		PULL UP TERR	Undue terrain alerts	TAWS predictive alert Note: Undue TAWS alert triggers undue ELT-DT transmission (if installed) with avionics 8A2+ (not applicable on 8A3 and subsequent)
	TAWS MAP FAIL	MAGENTA TAWS overlay		
Time		Time shift Time Frozen	Erroneous time and/or date Erroneous FMS/fuel predictions (time jumps) CPDLC/ADS-C erroneous time stamping OMS erroneous time stamping	Time no longer UTC synchronized (erroneous time) CPDLC/ADS-C should be considered inoperative (erroneous time stamp on position report may affect the controlled aircraft separations)

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Procedure - New Structure

Cockpit effects table

Effects of erroneous GNSS

Persistent effects

Refer to your FCOM
Which is customized by equipment fitted on A/C

Flight preparation	Anticipate GNSS interference
Preliminary cockpit preparation	Consider IRS full alignment Airports affected by Spoofing: Dedicated procedure on ground (A320)
Before Interference Area	Protect A/C time Consider GPS deselection depending on A/C configuration
Within Interference Area	Undue TAWS considerations Follow ECAM procedures
After Interference Area	Restore systems to nominal Handle persistent effects depending on A/C configuration

Design Perspective

SHORT/MID-TERM

- **ADIRU S8.2 A350** (TFU 34.10.00067 *Permanent Rejection of GPS*)
- **MMR C/B in the cockpit** (TFU 34.36.00030 *MMR Lock*)
  - ➢ Feasibility completed on the A380
- **TAWS robustification**
  - ➢ Feasibility assessment in progress
- **Better MMR resilience**
  - ➢ Feasibility assessment in progress

MID/LONG-TERM

- ADIRU Enhanced Spoofing Detection
- MMR Dual Frequency Multi Constellation (+ Galileo OS Navigation Message Authentication)
- Controlled Radio Pattern Antenna (directional antenna), without ITAR restrictions

ITAR: International Traffic in Arms Regulations
TFU: Technical Follow-Up

Standardization activities

Resilience to jamming & spoofing has become a focus of standardization activities in aviation (preparing mid-/long-term technical solutions)

ICAO Navigation System Panel

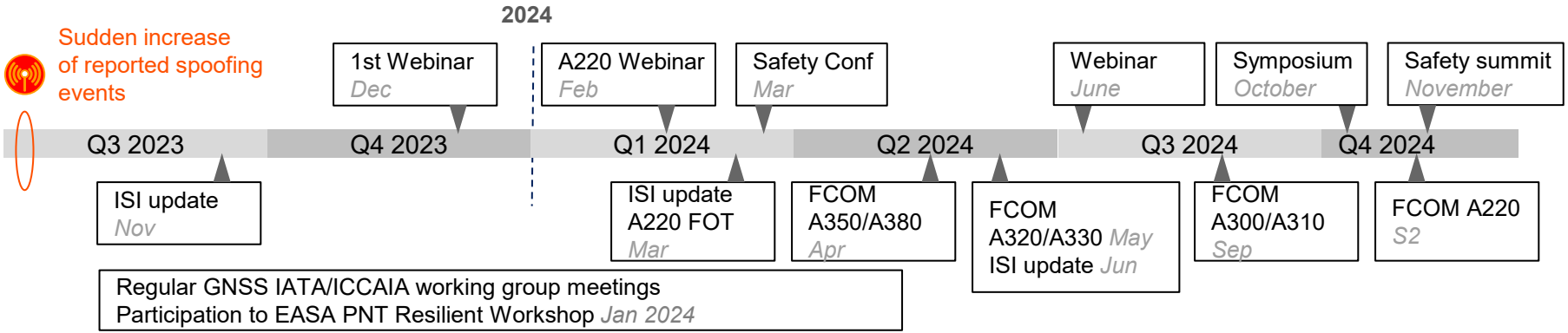
- Context: Standards and Recommended Practices (SARPS) for Radio Navigation Aids (Annex 10, Vol I)
- SBAS navigation message authentication under definition
- Proposal to include Galileo OSNMA

RTCA SC-159 / EUROCAE WG-62

- Context: Minimum Operational Performance Standards (MOPS) for DFMC SBAS receivers
- Requirements and test procedures on
  - avoiding erroneous outputs (under “simple” spoofing)
  - RFI detection & indication
  - return-to-normal after a threat disappears
- Navigation message authentication (upon SARPS availability)

Communications

➢**Communication & sharing on latest updates on the subject is key:**



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Conclusions

❖**GNSS interference threat is active and evolving** (e.g. increasing in sophistication)

❖**Aircraft Systems**

- ➢**Corrective std** for known misbehaviours: ongoing or under consideration
- ➢**RFW & feasibility studies launched** to:
  - Further improve **resilience** to GNSS interference
  - Improve GNSS interference **awareness**

❖**Flight Ops:**

- ➢Flight crew procedures are **available** in FCOM and/or ISI 34.36.00049 / A220-FOT-34-50-002
- ➢If **new cockpit effects** confirmed:
  - ISI/FOT update first, then FCOM revised (FCOM proc update if relevant)
- ➢**Communications:**
  - Webinar content + Q&A published in AirbusWorld
  - Update on GNSS Interference is presented to operators at Oct Symposium
  - Continuous updates with NAAs and ICAO
  - Next Webinar expected Jan 2025
  - Special webinar for NAAs (TBD)

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Conclusions

❖Collect / Analyze Operators' feedback

- ➢**Airbus continuously monitors** in service feedback
- ➢**Reports from operators** essential for:
  - ■ Technical understanding of effects and operational impacts
  - ■ Evolutions of systems or procedures

Note: Necessary data that may assist in the analysis of events is listed in ISI 34.36.00049 §3 / A220-FOT-34-50-002 §3

❖Authorities / Standardization

- ➢**Global issue** that still needs to be addressed at industry-wide level
- ➢**Airbus actively involved** in the relevant forums for evolution of regulations, standards, and recommended practices

Thank you