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ICAO

PBN SG/9  
(Doha, Qatar, 9 - 11 December 2024)





# **GNSS RFI** **Airline's perspective**

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09 DEC 2024

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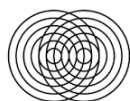
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# GNSS RFI

## Airline Perspective

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#### **GNSS RFI – introduction**

International Safety Concern



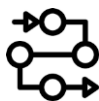
#### **GNSS RFI – Affected Area**

GPS RFI all around QTR Ops



#### **GNSS RFI – Affected System**

Increasing effects



#### **GNSS RFI – RA and Mitigations**

No deviation from MFR



#### **GNSS RFI – Challenges**

Operational Impacts



#### **GNSS RFI – Conclusion**

Let's stay tuned



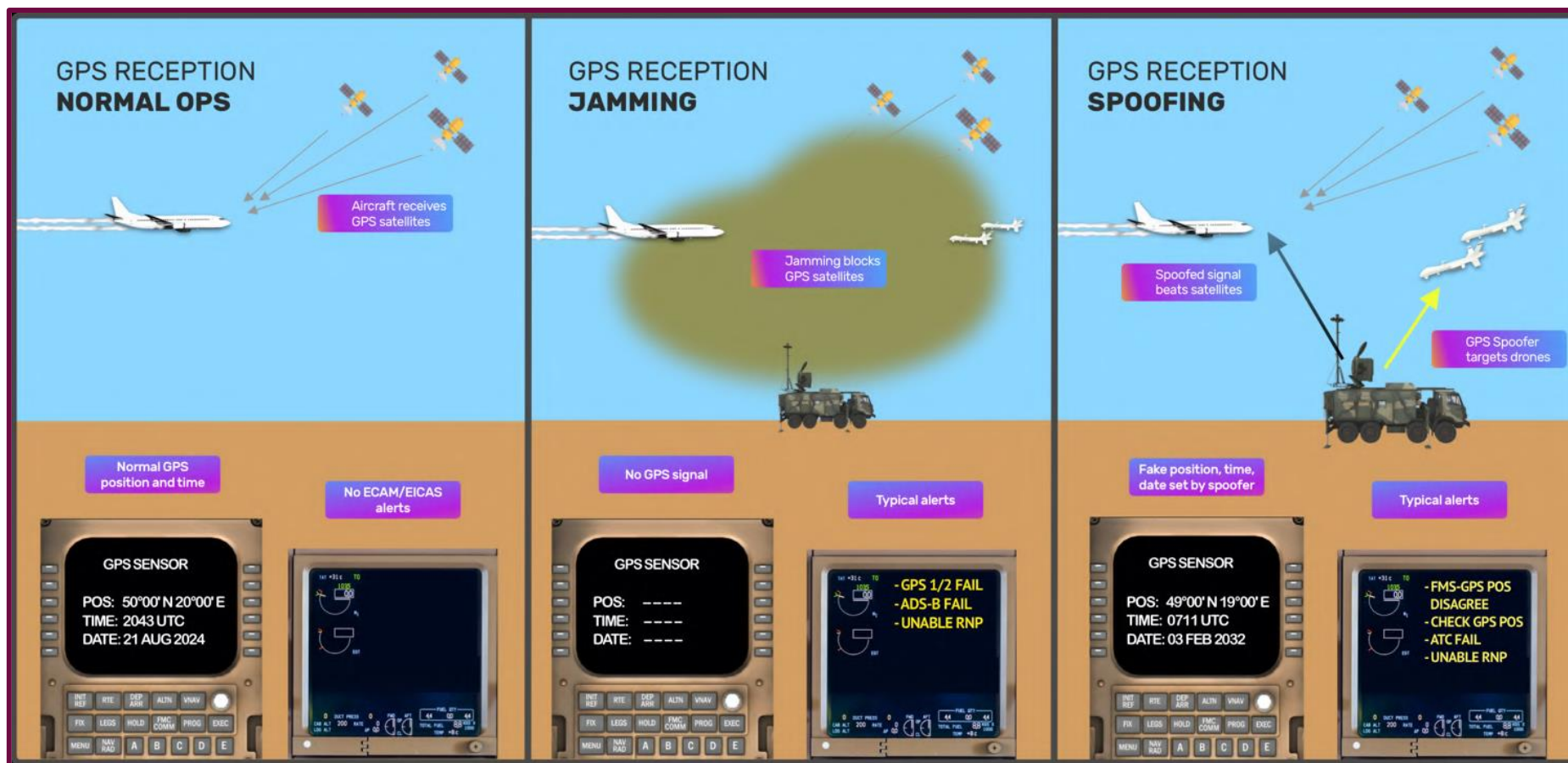
## GNSS RFI Airline Perspective

### ➤ Introduction

- *Worldwide Safety Operational issue*
- *Increasing Number of events during the last year*
- *New Cockpit effects*
- *Different Interference : Spoofing versus Jamming*
  - *Jamming causes a loss of measurement and a degradation of the position/velocity/time (PVT) solution.*
  - *Spoofing is a fake signal that causes the receiver to output misleading data, such as incorrect position or time.*
- *Enlarged Area Affected*
- ***International involvement required***

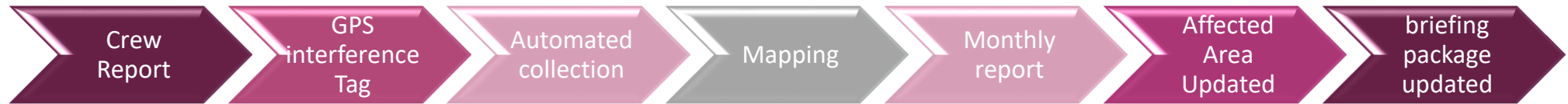
# GNSS RFI Airline Perspective

## ➤ Jamming vs. Spoofing



## GNSS RFI Airline Perspective

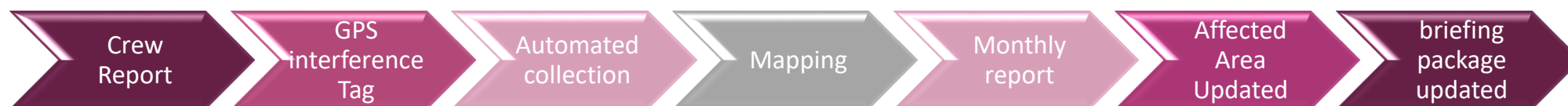
### ➤ GPS interference – Affected Area - QTR process



- *Crew report with dedicated Topics “GPS interference”*
- *Automated process to capture the reports*
- *Location mapped and populated through a monthly report*
- *Dedicated Special Crew Briefing with affected FIRs*
- *Dedicated crew alert in FPS – Briefing package if any update*

## GNSS RFI Airline Perspective

### ➤ GPS interference – Affected Area - QTR process



#### CO604/22 SUBJECT - GPS OUTAGE

INTERMITTENT LOSS OF GPS SIGNALS MAY BE EXPERIENCED IN  
**EFIN, ENOR, EPWW, ESAA, EVRR, EYVL, HECC, HLLL, LBSR, LCCC, LLLL, LRBB, LTAA, LTBB, OIIX,  
 OJAC, OLBB, ORBB, OSTT, UATT, UBBA, UDDD, UGGG, UMKK, UUVV, UWWW AND VVYF FIRS.**

FLIGHT CREW SHOULD APPLY RELEVANT FCOM PROCEDURES. FLIGHT CREW ARE REQUESTED TO REPORT GPS OUTAGES VIA EJOURNEY LOG UNDER TOPIC: ATC ATM SERVICES; SUB-TOPIC: GPS OUTAGE.

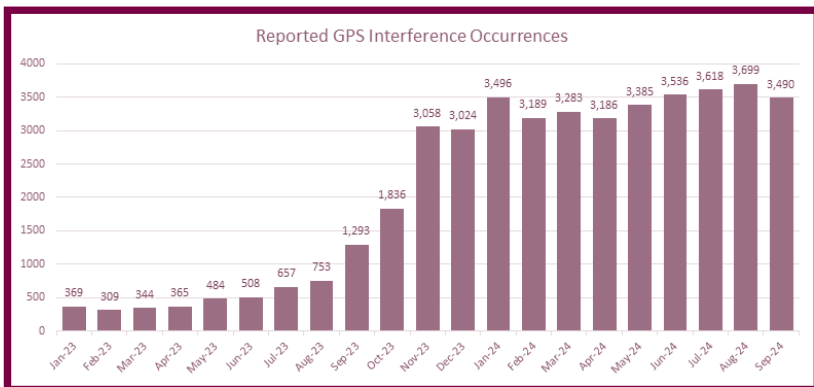
KINDLY MENTION THE FIR, TIME AND DURATION OF OUTAGE AND WHEN / IF THE GPS SIGNAL WAS RECOVERED.

IF GPS INTERFERENCE WAS EVIDENT, PLEASE MENTION "GPS INTERFERENCE" IN TECH LOG AS WELL. IN CASE THE GPS OUTAGE IS EXPERIENCED IN EFIN, ENOR, EPWW, ESAA, EVRR, EYVL AND UMKK FIRS, FLIGHT CREW SHALL PROMPTLY NOTIFY ATC.

# GNSS RFI Airline Perspective

## ➤ GPS interference – Events during the Month of November

- GNSS RFI : Not new
- Past : Steady
- Huge ↗ since April 23
- > 3000 Monthly events
- 10 times > 2022



Reports
FLT\_MONTH
FLT\_DATE
FIR
AC\_IATA\_CODE
FLT\_NO
DEP\_STN
ARR\_STN

Total Number of GPS Outage Journey Logs Received:

# 3.19k

### GPS Outage Journey Logs

#### FIRs with GPS Outage Journey Logs

| FIR           | FIR ICAO | Reported Flights | %   |
|---------------|----------|------------------|-----|
| FIR ANKARA    | LTAA     | 2055             | 64% |
| FIR BAGHDAD   | ORBB     | 2053             | 64% |
| FIR YANGON    | VYYF     | 448              | 14% |
| FIR JEDDAH    | OEJD     | 239              | 7%  |
| FIR CAIRO     | HECC     | 232              | 7%  |
| FIR GUANGZHOU | ZGZU     | 108              | 3%  |
| FIR AMMAN     | OJAC     | 100              | 3%  |
| FIR KUNMING   | ZPKM     | 87               | 3%  |
| FIR KOLKATA   | VECF     | 74               | 2%  |
| FIR SAMARA    | UWVW     | 70               | 2%  |
| FIR TEHRAN    | OIIX     | 61               | 2%  |
| FIR DHAKA     | VGFR     | 57               | 2%  |
| FIR TEL AVIV  | LLTA     | 56               | 2%  |
| FIR SHANGHAI  | ZSHA     | 47               | 1%  |
| FIR KARACHI   | OPKR     | 38               | 1%  |
| FIR MOSCOW    | UUWV     | 37               | 1%  |

#### Reported GPS Outage per 1000 flights

| AC_IATA_CODE | Reported Flights per 1000 departures |
|--------------|--------------------------------------|
| 359          | 259                                  |
| 77X          | 246                                  |
| 351          | 240                                  |
| 789          | 202                                  |
| 77W          | 176                                  |
| 788          | 163                                  |
| 320          | 139                                  |
| 77L          | 124                                  |
| 388          | 78                                   |
| 333          | 42                                   |
| 332          | 20                                   |
| 74Y          | 0                                    |

#### Reported GPS Outage per 1000 flights

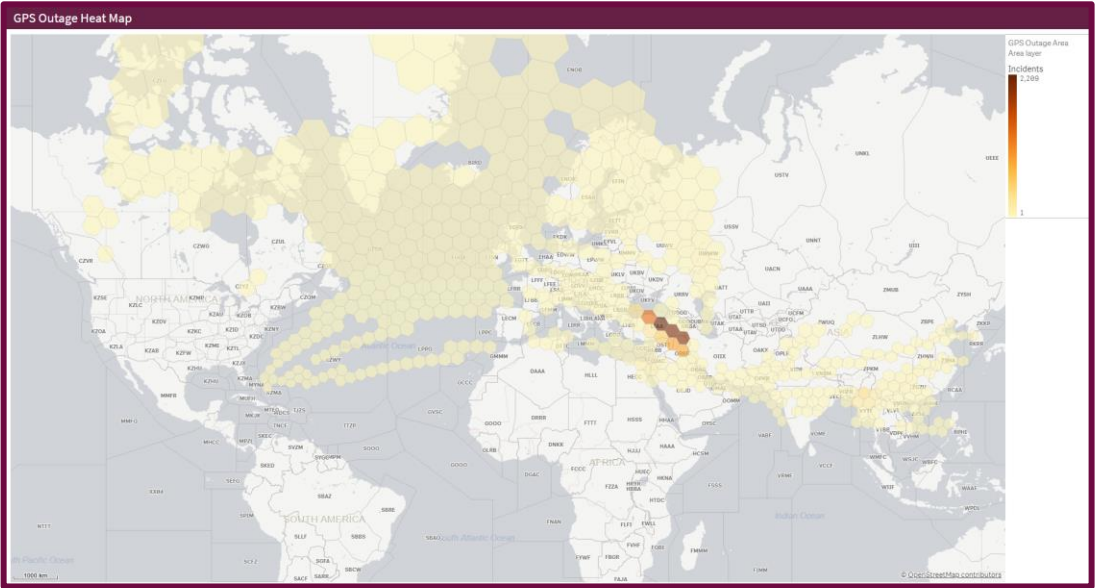
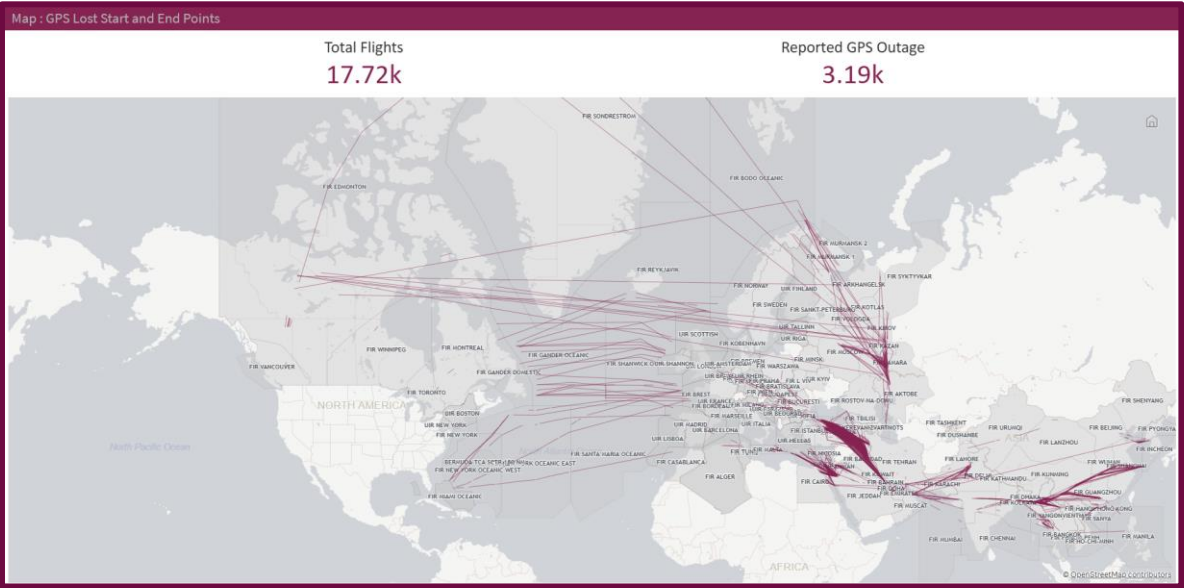
| AC_REG | Reported Flights per 1000 departures |
|--------|--------------------------------------|
| A7-ALF | 411                                  |
| A7-ALO | 389                                  |
| A7-ANC | 388                                  |
| A7-BEI | 375                                  |
| A7-AHG | 371                                  |
| A7-ALR | 361                                  |
| A7-ALG | 360                                  |
| A7-ANM | 353                                  |
| A7-BOC | 344                                  |
| A7-ALW | 343                                  |
| A7-BAM | 339                                  |
| A7-BEW | 324                                  |
| A7-AOD | 317                                  |
| A7-BEH | 316                                  |
| A7-BER | 316                                  |
| A7-ALE | 312                                  |
| A7-RCM | 300                                  |

#### Reported GPS Outage per 1000 flights

| SECTOR  | Reported Flights per 1000 departures |
|---------|--------------------------------------|
| DOH-OTP | 635                                  |
| OTP-DOH | 635                                  |
| DOH-VIE | 594                                  |
| VIE-DOH | 594                                  |
| AMS-DOH | 569                                  |
| ZRH-DOH | 547                                  |
| DOH-BRU | 531                                  |
| BRU-DOH | 531                                  |
| DOH-AMS | 526                                  |
| DOH-MXP | 519                                  |
| PVG-DOH | 517                                  |
| MXP-DOH | 512                                  |
| IST-DOH | 488                                  |
| DOH-SAW | 475                                  |
| CAN-DOH | 473                                  |
| DOH-CAN | 473                                  |
| DOH-MAW | 460                                  |

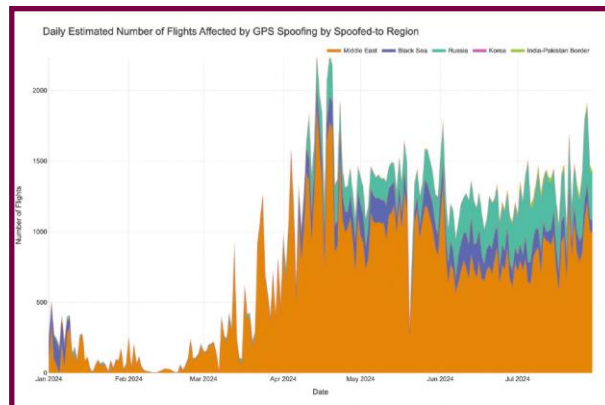
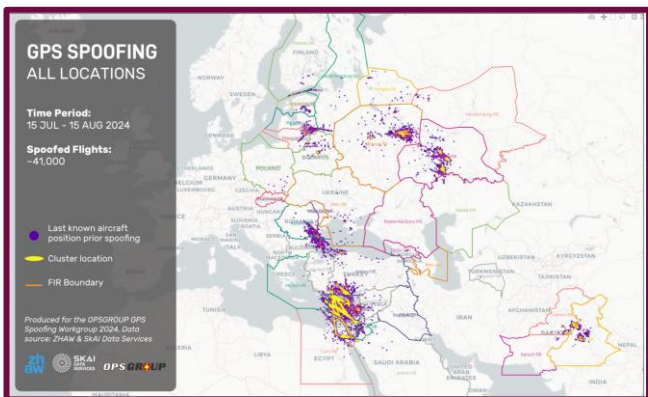
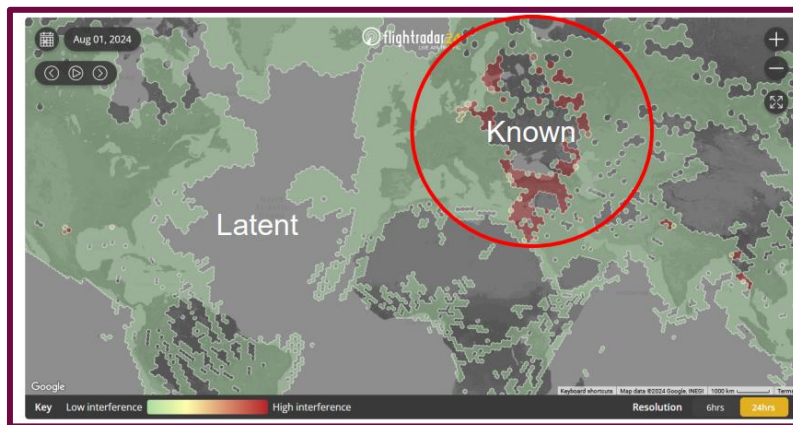
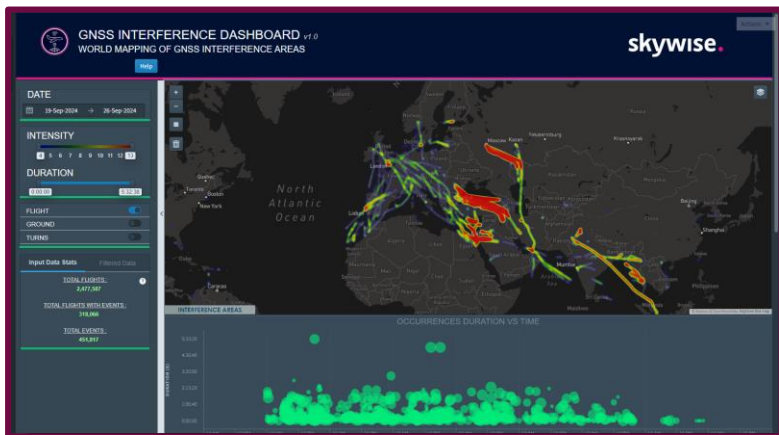
# GNSS RFI Airline Perspective

## ➤ GPS interference – Affected Area



# GNSS RFI Airline Perspective

## ➤ GPS interference – Affected Area – Other sources



**Spoofing by Flight Information Region (FIR)**

The table below shows the number of aircraft impacted by spoofing in the Top 20 FIR's affected, during the period July 15 – August 15.

| FIR                | COUNTRY      | TOTAL FLIGHTS |
|--------------------|--------------|---------------|
| Nicosia FIR        | Cyprus       | 5655          |
| Tel-Aviv FIR       | Israel       | 3228          |
| Cairo FIR          | Egypt        | 2375          |
| Ankara FIR         | Turkey       | 1195          |
| Samara FIR         | Russia       | 1186          |
| Moscow FIR         | Russia       | 988           |
| Lahore FIR         | Pakistan     | 492           |
| Minsk FIR          | Belarus      | 372           |
| Beirut FIR         | Lebanon      | 371           |
| Delhi FIR          | India        | 316           |
| Sofia FIR          | Bulgaria     | 235           |
| Bucarest FIR       | Romania      | 231           |
| Athens FIR         | Greece       | 193           |
| Amman FIR          | Jordan       | 169           |
| Riga FIR           | Latvia       | 169           |
| Jeddah FIR         | Saudi Arabia | 115           |
| St. Petersburg FIR | Russia       | 77            |
| Istanbul FIR       | Turkey       | 67            |
| Tallinn FIR        | Estonia      | 57            |
| Vilnius FIR        | Lithuania    | 51            |

## GNSS RFI Airline Perspective

### ➤ **GNSS RFI – Cockpit Effects – Similar on different Aircraft types**

#### ***GPWS Look-Ahead Terrain / EGPWS***

- *For a GPWS Look-Ahead Terrain warning at a cruise altitude that is clearly above the highest known actual terrain in the area, pilot discretion can be used in determining the alert to be false.*
- *The basic GPWS is still operational. The GPWS immediate alerts are still valid.*
- *Selecting GPS updating to OFF on the POS REF page does not inhibit GPS data for GPWS Look-Ahead Terrain.*

#### ***Runway Awareness and Advisory System (Boeing RAAS - Airbus ROW / ROP)***

- *On airplanes equipped with RAAS. when the GPS signal is lost, the system is unavailable and associated EICAS/ECAM will be displayed*

## GNSS RFI Airline Perspective

### ➤ GNSS RFI – Cockpit Effects – Similar on different Aircraft types

#### *Time/Clock*

*Jamming can result in the loss of GPS time source.*

*Effects of spoofing on time/clock: Inaccurate time and date information. FMC ETA can be affected.*

#### *Air Traffic Control (ATC) data link*

*The Aeronautical Telecommunication Network (ATN) data link logon reports the time and date. With an incorrect time or date, ATN data link logons can be rejected by the ground system*

#### *ADS-B*

- Jamming causes a loss of ADS-B capability. Coordination with ATC is necessary.*
- Effects of spoofing on ADS-B: Erroneous position data to ADS-B.*

#### *Operations in PBN Airspace – NATS*

*Issues operating in NAT Airspace where 2 LRNS are required*

## GNSS RFI Airline Perspective

### ➤ GNSS RFI – Cockpit Effects – Similar on different Aircraft types

#### *Possible new symptoms*

- *Loss of Wi Fi Connectivity Installation utilizing Hybrid IRS/GPS data for antenna beam steering*
- *Loss SATCOM Functionality*
- *FMS Resets*
- *NFS Failure due to incorrect time*
- *Autopilot Unavailable with Single IRU*
  - *QTR : Confirmed for 787: MMEL Dispatch restriction*
- *Shift during ILS approach*
- *Weather Radar*



## GNSS RFI Airline Perspective

### ➤ GNSS RFI – Information by Manufacturers

#### Airbus : ISI Article & Supplementary Procedures

- ISI 34.36.00049 : GNSS loss and GNSS Interference
- Covered in FCOM by Airbus (Supplementary Procedures)
  - ✓ A320 & A330 : FCOM PRO-NOR-SUP-GPSINT
  - ✓ A350 : FCOM PRO-NOR-SUP-SUP-GNSS
  - ✓ A380 : PRO-NOR-SUP-SUP-GPS
- MMR Reset Included in A320 QRH end 2023 : recovery in most cases

## GNSS RFI Airline Perspective

### ➤ GNSS RFI – Information by Manufacturers

#### Boeing : Flight Operations Technical Bulletins

**FOTB contains comprehensive information and guidance for operators to develop SOP**

Describes:

- The threat (jamming and spoofing)
- Known effects on airplane systems
- known Flight Deck Effects for both Jamming and Spoofing
- Existing crew procedure mitigations
- Operator risk assessment considerations
- Support available in developing Standard Operating Procedures

| Major Model | Most Recent Published FOTB        | Released Month       |
|-------------|-----------------------------------|----------------------|
| 737         | 737 23-01R1<br>737 24-01 (hybrid) | Dec 2023<br>Mar 2024 |
| 747         | 747 23-80                         | Dec 2023             |
| 757         | 757-23-99                         | Dec 2023             |
| 767         | 767-23-102                        | Dec 2023             |
| 777         | 777-62                            | Dec 2023             |
| 787         | 787-27                            | Nov 2023             |

- QTR : Inclusion of the information in dedicated supplementary procedures
- Boeing offers a technical review to operators
- Boeing will create supplementary procedures

## GNSS RFI Airline Perspective

### ➤ GNSS RFI – Risk Assessment and Operational Mitigations



#### ***Internal Risk assessment – regular review***

- *Follow up with manufacturers and Update Flight crew communication*
- *Raise Crew awareness : Affected Areas , Expected Cockpit Effects , Flight crew Vigilance*
- ***No deviation from MFR***

#### ***Many practices are at the discretion of the operator after a risk assessment:***

- *Provide the flight crew guidance*
- *Liability is with airlines*

## GNSS RFI Airline Perspective

### ➤ GNSS RFI – Risk Assessment and Operational Mitigations

*GPWS Look ahead can be override as preventive measure*

➤ MFR:

- *Terrain Look-Ahead can be disabled on a discretionary basis within normal operations*
- *Easy decision at some Scenarios – Videos*
- *Can be complicated depending on the location and the flight phases*
- *Considerations*
  - *Disregard of alerts (desensitizing crew to genuine alerts)*
  - *Since disabling of Terrain Look-Ahead deactivates a safety enhancement, this action should not be normalized or applied unnecessarily.*

### QTR

- *Possible. Crew discretion*

# Scenario 1



# Scenario 2



## GNSS RFI Airline Perspective

### ➤ GNSS RFI – Risk Assessment and Operational Mitigations

#### *New ACMF AMI*

Parts are available now to order for installation via the PART Page in MyBoeingFleet.  
Service Letter to be published

| AMI type                 | MSP Part Number | LSP Part Number | Announcement                                  |
|--------------------------|-----------------|-----------------|---|
| <b>AHM GE ACMF-R AMI</b> | 243W0001-1016   | 316D-BSM-799-62 | MOM-MOM-24-0364-01B,<br>In-work 777-SL-31-065 |
| <b>AHM RR ACMF-R AMI</b> | 243W0001-1019   | 316C-BSM-799-63 | MOM-MOM-24-0364-01B,<br>In-work 777-SL-31-065 |
| <b>AHM PW ACMF-R AMI</b> | 243W0001-895    | 3164-BSM-799-58 | MOM-MOM-24-0364-01B,<br>In-work 777-SL-31-065 |
| <b>Basic ACMF-R AMI</b>  | 243W0060-429    | 3107-BCG-00A-31 | In-work 777-SL-31-065                         |
| <b>Basic FDCF AMI</b>    | 243W0001-1022   | 316D-BSM-699-14 | In-work 777-SL-31-065                         |

## GNSS RFI Airline Perspective

### ➤ GNSS RFI - Challenges faced from Operator level

- *Safety concern*
- *Affected Area expanding all around our area of operations*
- *Deviation not always possible . Might involve additional Fuel and Cost*
- *Not Always enough guidance from Manufacturers*
- *Cockpit Warnings during critical phases of flights– Time limited for crew assessment*
- *Risk of Crew complacency*
- ***Development of new systems more robust towards GNSS interference is required***
  - ✓ *Time*
  - ✓ *Cost*
  - ✓ *Unknown*

## GNSS RFI Airline Perspective

### ➤ Conclusion

- *Experience Sharing is important*
- *Lessons learnt from each others*
- *International entities involvement required.*
- *Priority for new systems development required*
- *Working together required*
- *Increase industry co-operation and information sharing, with regard to spoofing reports, lessons learned, mitigations, and potential solutions*
- *Let's stay tuned*

# GNSS RFI Airline Perspective

## ➤ References and Further Reading

- *IATA Global Navigation Satellite System GNSS Radio Frequency Interference Safety Risk Assessment – 04 Sep 2024*
- *GPS Spoofing – Final Report of the GPD Spoofing workgroup – 06 SP 2024*
- *IFALPA Effects of Manipulated GNSS Signals on Aircraft and Mitigation Measures – 11 December 2023*



Thank you