

Supporting
European
Aviation



GNSS RFI Mitigation

ICAO SAM Radio Navigation Workshop

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Head of Navigation

Lima, Peru, 2 – 4 September 2026

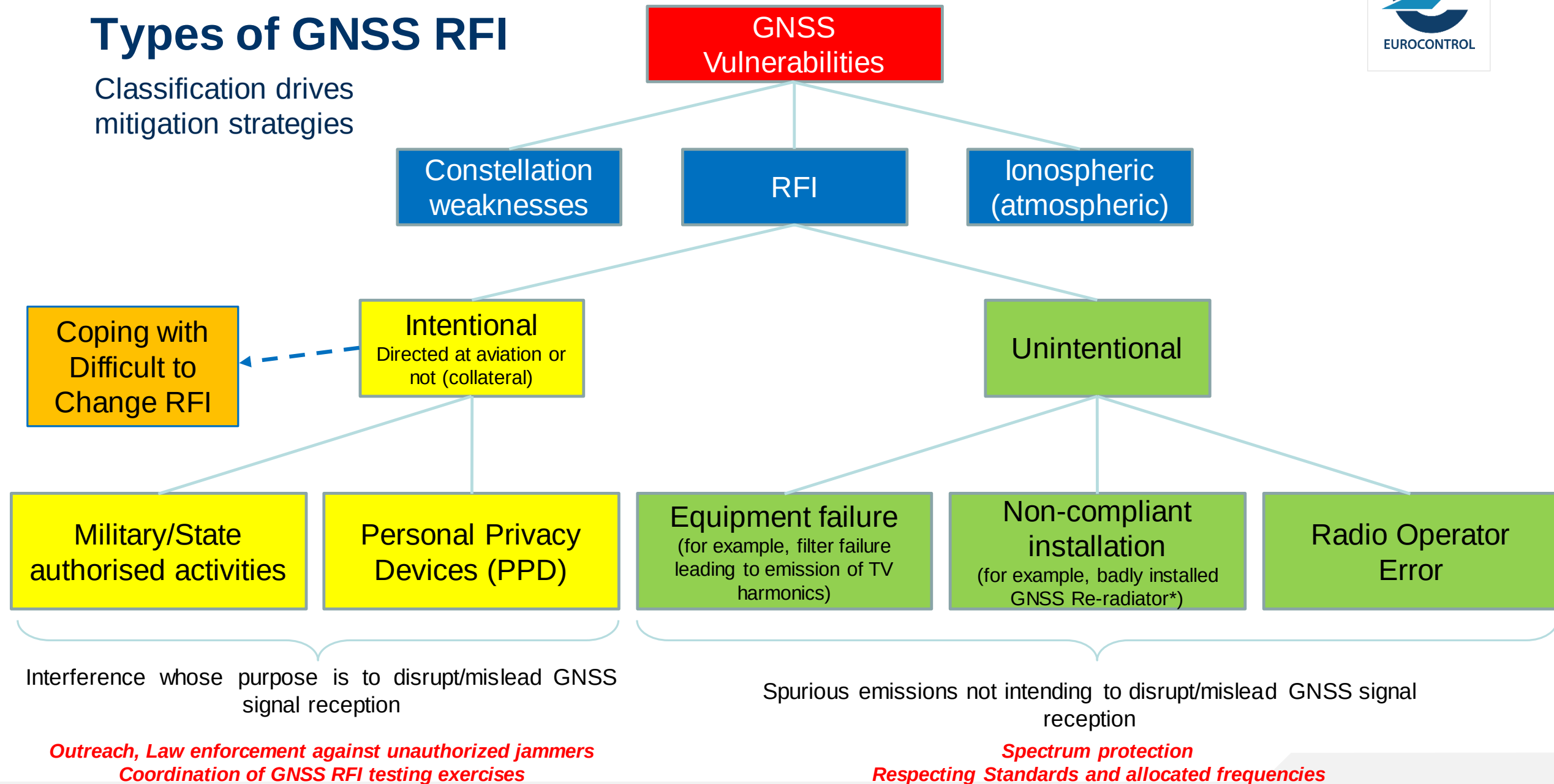


NETWORK
MANAGER



Types of GNSS RFI

Classification drives mitigation strategies



Joint GNSS RFI Action Plan Published



European Aviation Action Plan for Ensuring Safe Operations during GNSS Interferences **GNSS RFI Action Plan**

- Short, Medium & Long Term Actions
- 4 Workstreams:
 - Human (ATCO, Pilot, Phraseology)
 - Procedures (Contingency, Monitoring)
 - Aircraft Capabilities
 - Infrastructure
- Align with ICAO iPack

GNSS RFI Mitigation Activities

Preventive and Reactive Radio Regulatory Engagement

Short-term mitigation measures: Keep airspace safe and open

Short-term avionics / ATM improvements

(voluntary, based on existing standards, product updates)

Long-term avionics / ATM improvements based on new, more robust standards:
Complementary PNT

GNSS RFI Mitigation Activities

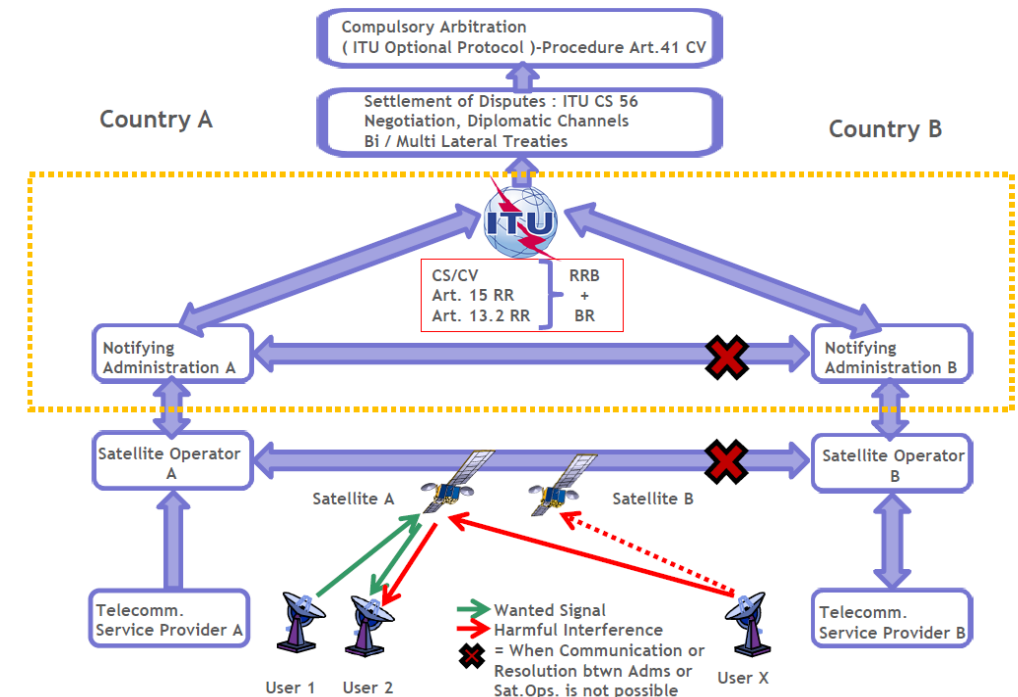


Preventive and Reactive Radio Regulatory Engagement

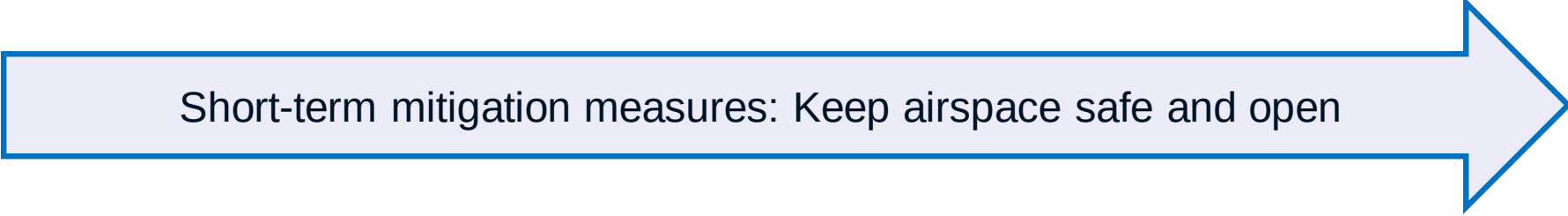
A “duty to complain” and use formal process

- ANConf/14 WP63 provides relevant references to ITU Radio Regulation (RR art 15)
 - What you see on the ground **is not** what you see in the air
 - ADS-B makes aircraft impact visible, **but is NOT an RF signal measurement!**
 - Need measurements of interference signals, ideally with source geolocation
 - *Build up flight inspection, other aerial work or UAS capabilities!*
 - Especially for persistent RFI sources operating 24/7
 - Need indisputable / impartial technical evidence
 - Once neighbouring State has not responded to bilateral letter, escalate to ITU Radiocom Bureau
- Further develop procedures between cooperative States (C-UAS, Military Exercises & Testing)

Schema of Actions in case of Harmful Interference



GNSS RFI Mitigation Activities



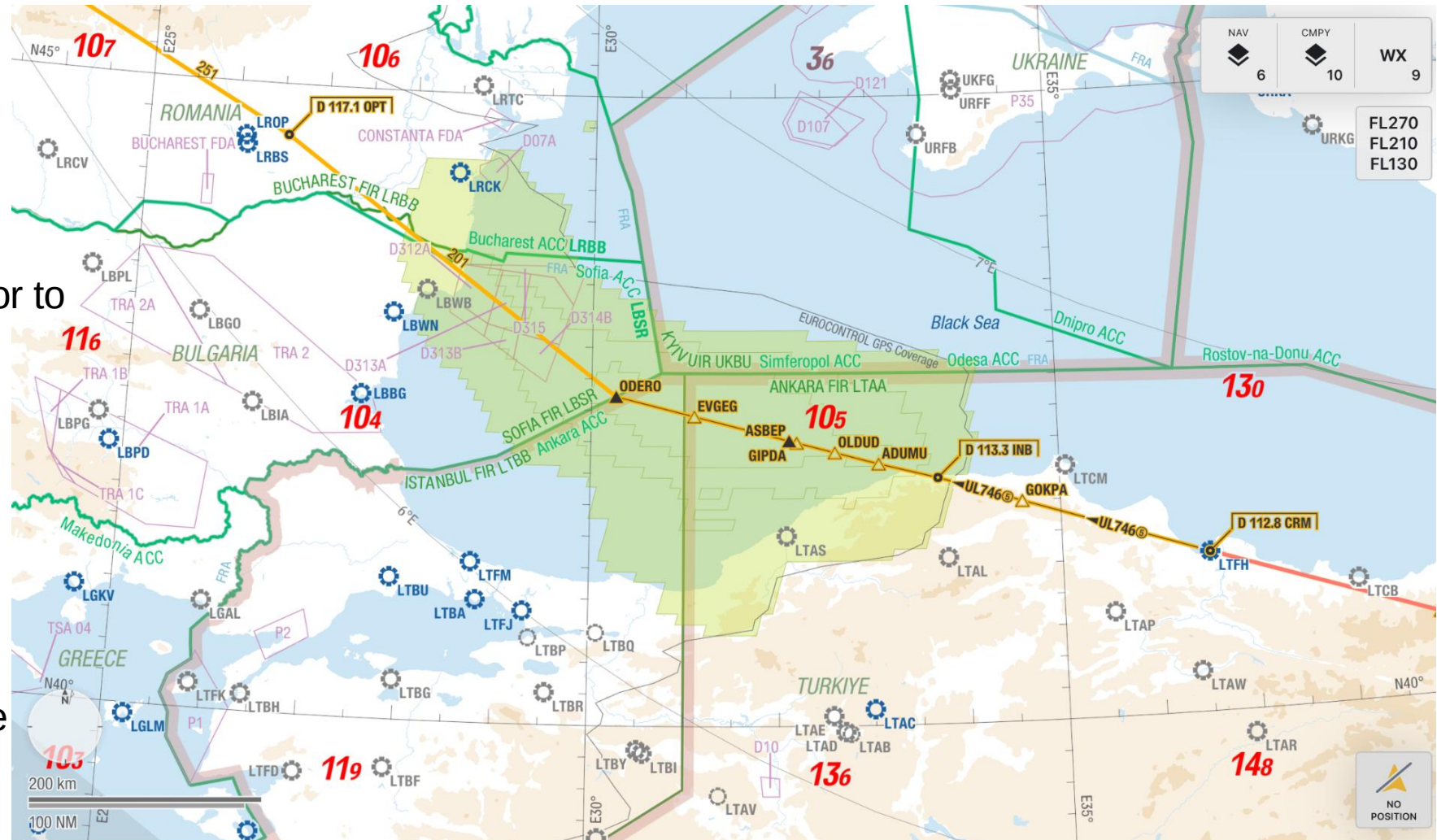
Short-term mitigation measures: Keep airspace safe and open

Already Implemented by some Operators:

“GPS Weather” on the Electronic Flight Bag!

- Picture from Lufthansa Systems LIDO mPilot
- Jeppview has similar product

- Pilots can deselect GPS prior to entering degraded GNSS environment to protect CNS system performance
- And reactivate GPS and associated systems once outside known zone of RFI
- Ongoing discussion: Disable Enhanced GPWS function ONLY if there is **spoofing**



The same information can be provided to ATC!

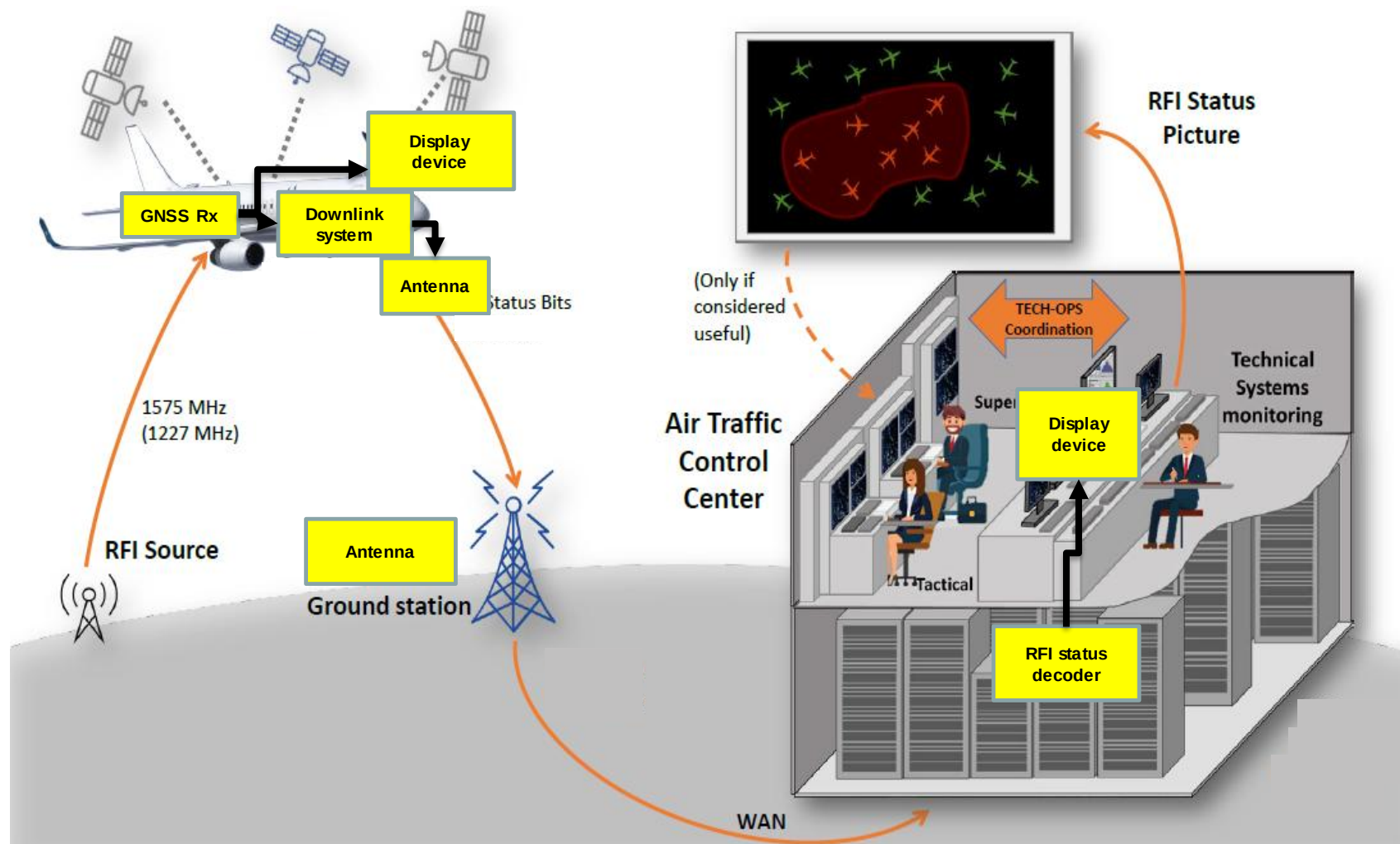
Using ADS-B low PIC today, working on standardized function in future

Steps

1. ADS-B PIC + other data **detects RFI** and **reports** it to the **ground**
2. Ground stations **process PIC's**, and **integrate RFI status** in a given area
3. ATSEP/SMC coordinates with OPS on impacted areas and determines appropriate **operational mitigation measures**

Concept of Operations Use Cases:

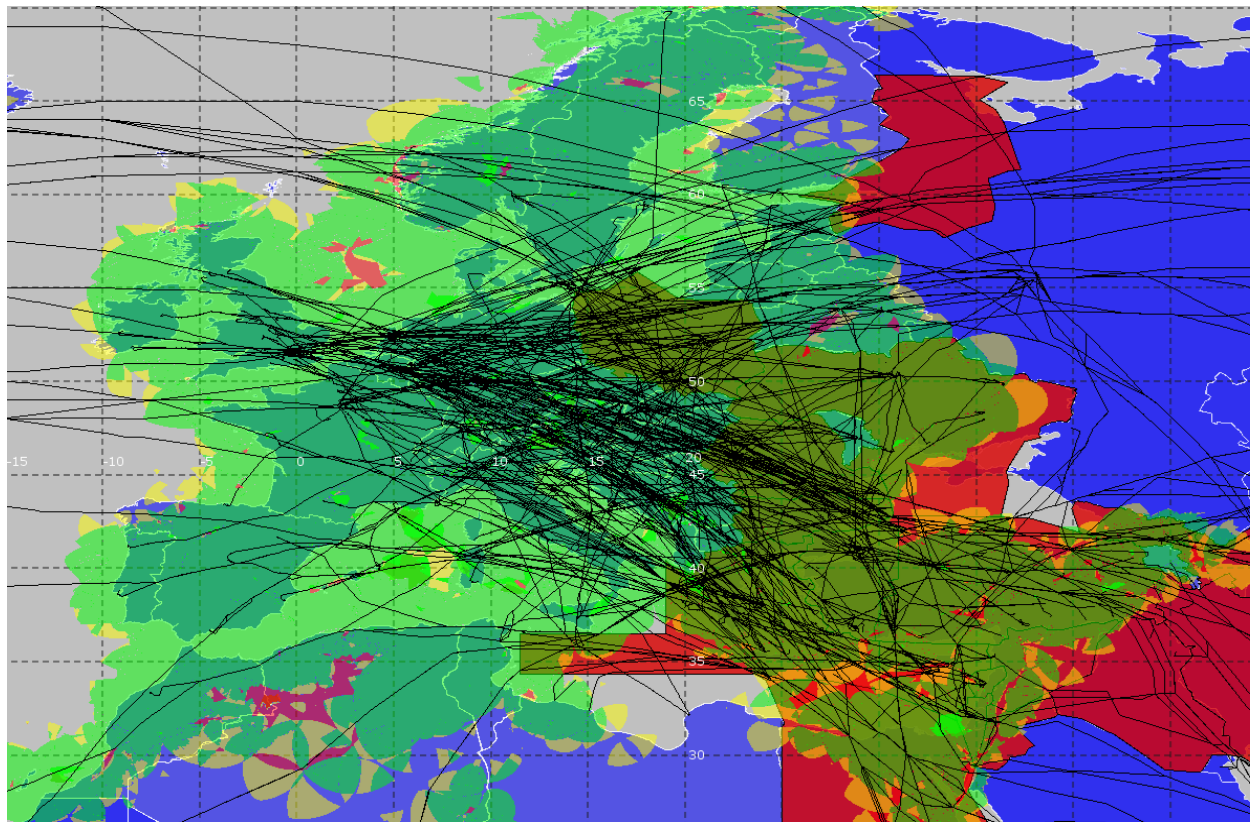
- 1) **Jamming Awareness**
- 2) **Spoofing Awareness**
- 3) **Lock Up Awareness**
- 4) **Maintain RNP Approach**
- 5) **RFI Event Coordination**



GNSS RFI D/L CONOPS is an Agreed ICAO NSP Job Card Task

Jamming Awareness: Estimate Number of Aircraft which could require ATC vectoring assistance

- a) IF Aircraft has DME/DME (Flight Plan), and DME Coverage is good → OK
- b) IF Aircraft has INS (Flight Plan) and coasting time is short → OK
- c) IF Aircraft is “GPS Only” for PBN → NOT OK
- d) IF Number of NOT OK Aircraft Exceeds Acceptable Threshold → Reduce Sector Capacity?



Dark RED: FIR affected by GNSS RFI

Black: Flights crossing affected FIRs

Green: Alternative DME/DME RNAV Coverage Available

Yellow/orange: DME/DME RNAV Coverage Available but no redundancy

Light red: No DME/DME RNAV Coverage

Short-term GNSS RFI Mitigation Measures

- Move towards real-time GNSS RFI Monitoring
- Improve reporting and operational procedures (especially Ground Prox)
- Safety Collaboration between ANSP & Operators (ANConf/14 WP61)
 - Ensure aircraft operators knows what ANSP provides to support contingency
 - Ensure aircraft are equipped to use the provided contingency services
- Provide a Resilient Operational Network (RON)
 - DME/DME based SID/STAR and ENR support whenever possible
- Ensure ILS remains available as needed
 - Ensure ILS intercept is possible without GPS (RNAV waypoints for IAF, MAPt)
- Provide a Minimum Operational Network (MON)
 - VOR/DME for non DME/DME equipped airspace users to enable safe landing
- Ensure CNS/ATM infrastructure is robust against compromised GNSS time

GNSS RFI Mitigation Activities

Long-term avionics / ATM improvements based on new, more robust standards:
Complementary PNT

Moving towards Complementary Resilient Navigation

(ICAO Assembly Resolution 42-8C)

- Need “all sensors” interoperable integrity
 - More than multi-sensor: cross-check sensors for anomaly detection
 - Propagate robust position and time to all systems including ADS-B
 - Develop robust timing and time synchronization
- Similar principles can apply to SUR position integration
 - Compare ADS-B to SSR / MLAT position

Flight Management System

Integrated Position and Time Management Function

Incl. other sensor data (airspeed, heading, altitude, motion models)

FOM /
Protection
Level
and
RF Health
Status

**Dual Frequency,
Multi
Constellation
(DFMC) GNSS**



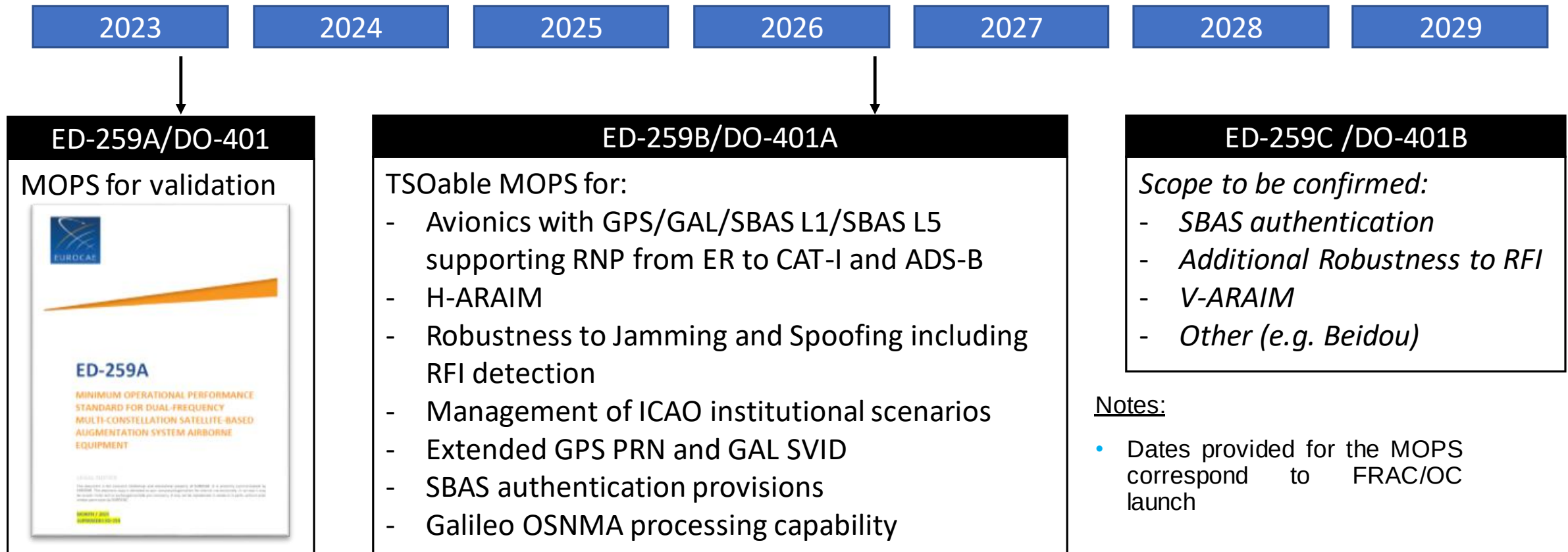
**Inertial Navigation
Systems /
Sensors**



**Multi DME
Navigation**
Including path for
future evolution
→ *Complementary
Effort to DFMC*

**VOR / DME Back-
Up Functions**
Including path for
future evolution??
→ *Solution for less
capable aircraft?*

Airborne GNSS standard development roadmap (DFMC SBAS MOPS: ED-259B / DO-401A)



Developed by EUROCAE WG-62 / RTCA SC-159

Why do we need DFMC SBAS airborne equipment?

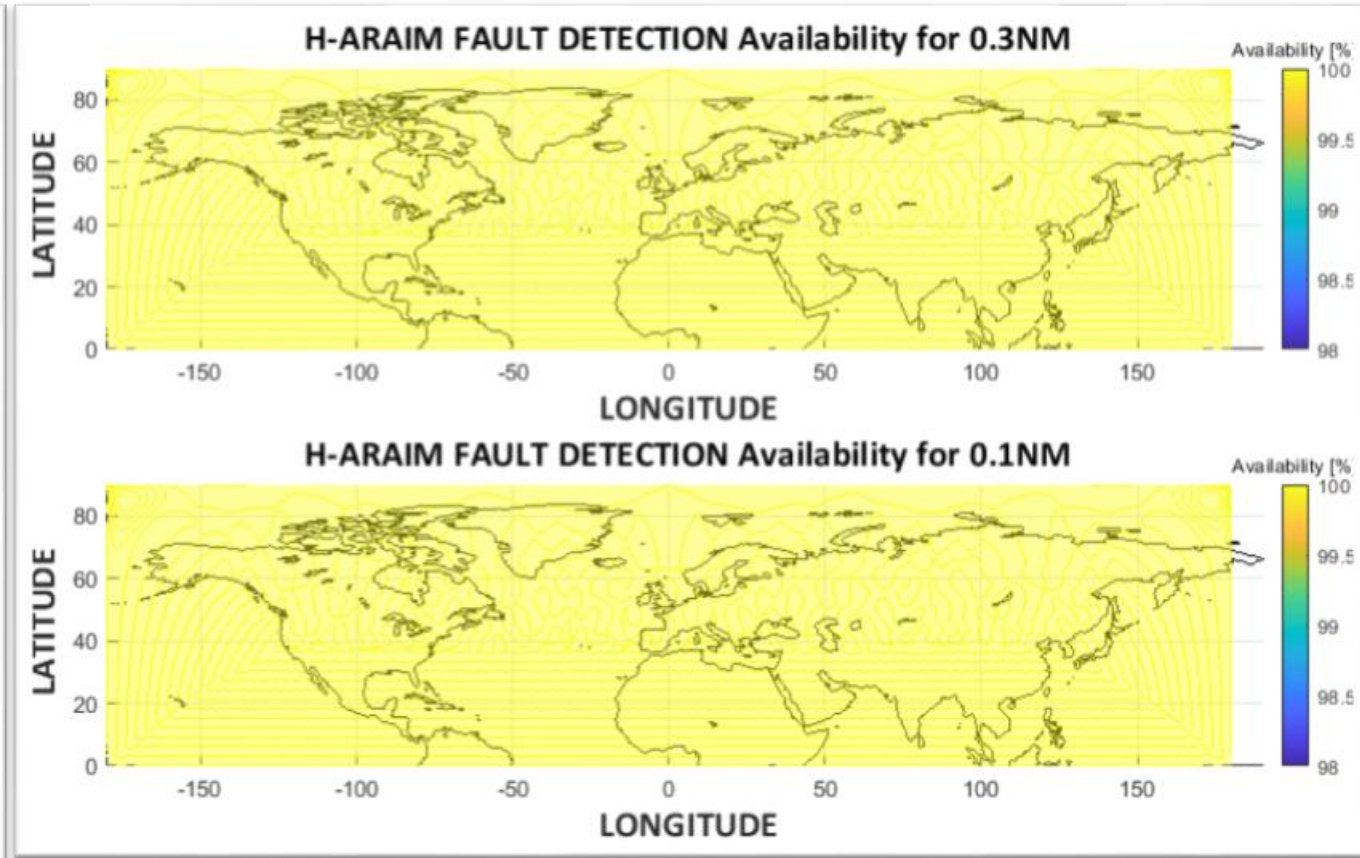
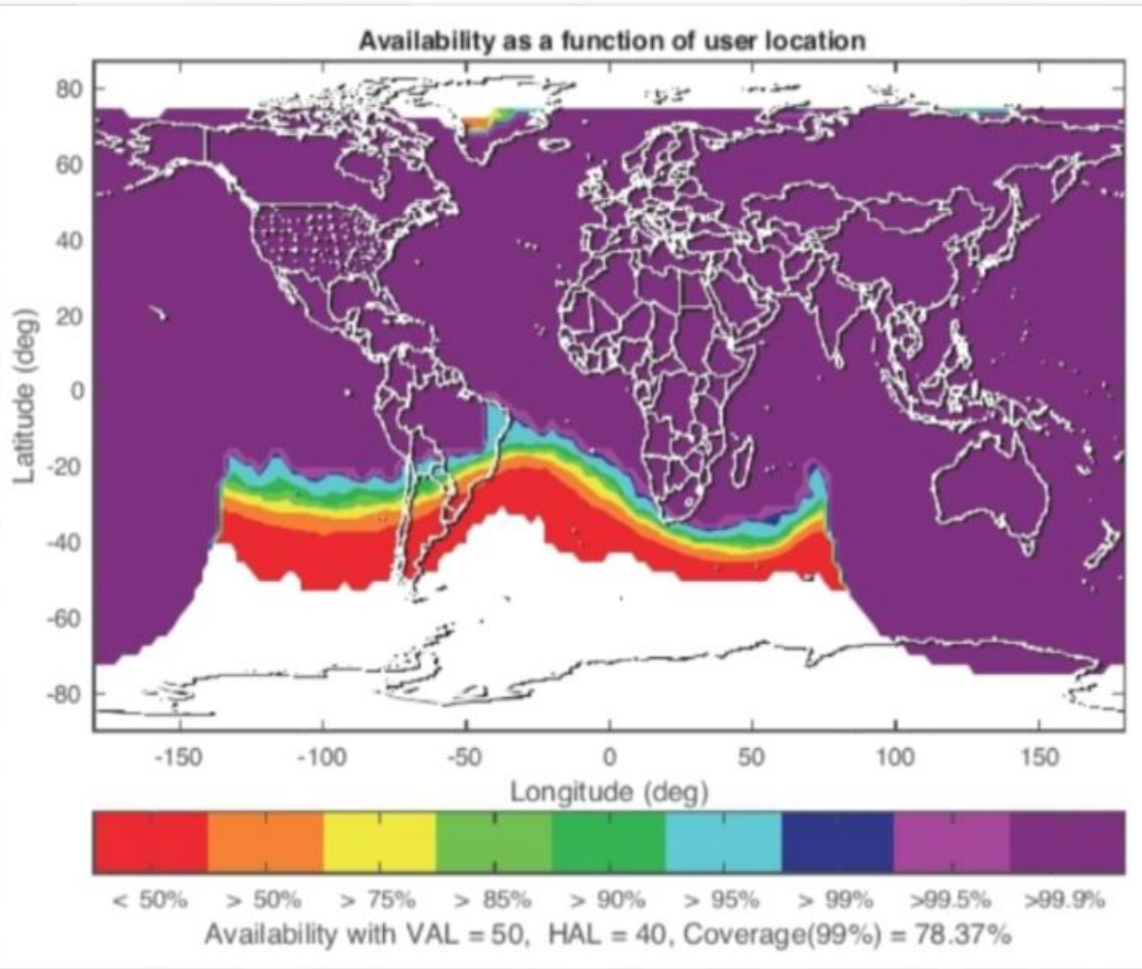
- Responds to expressed user requirements for RFI resilience
- Capabilities/functions in the new DFMC GNSS Rx MOPS:
 1. Enhanced robustness to Jamming and Spoofing **including recovery capability**
 2. GNSS RFI indicator on L1/E1 band and on L5/E5a band
 3. GNSS spoofing indicator (still under development)
 4. Clock function supporting time synchronization for authentication services
 5. Galileo Open Service Navigation Message Authentication (OSNMA)
- Increased navigation capability: Dual frequency multi-constellation GNSS including DFMC SBAS and Advanced RAIM
 - Use of Advanced Antennas (CRPA): work has started on new standards
 - New work started on DFMC GNSS and INS integration



New GNSS equipment capabilities with DFMC SBAS and ARAIM integrity monitoring

SBAS LPV (APV-I) service coverage
(based on Stanford University MASP tool)

ARAIM RNP 0.3 and RNP 0.1 service coverage
(based on EUROCONTROL PEGASUS tool)

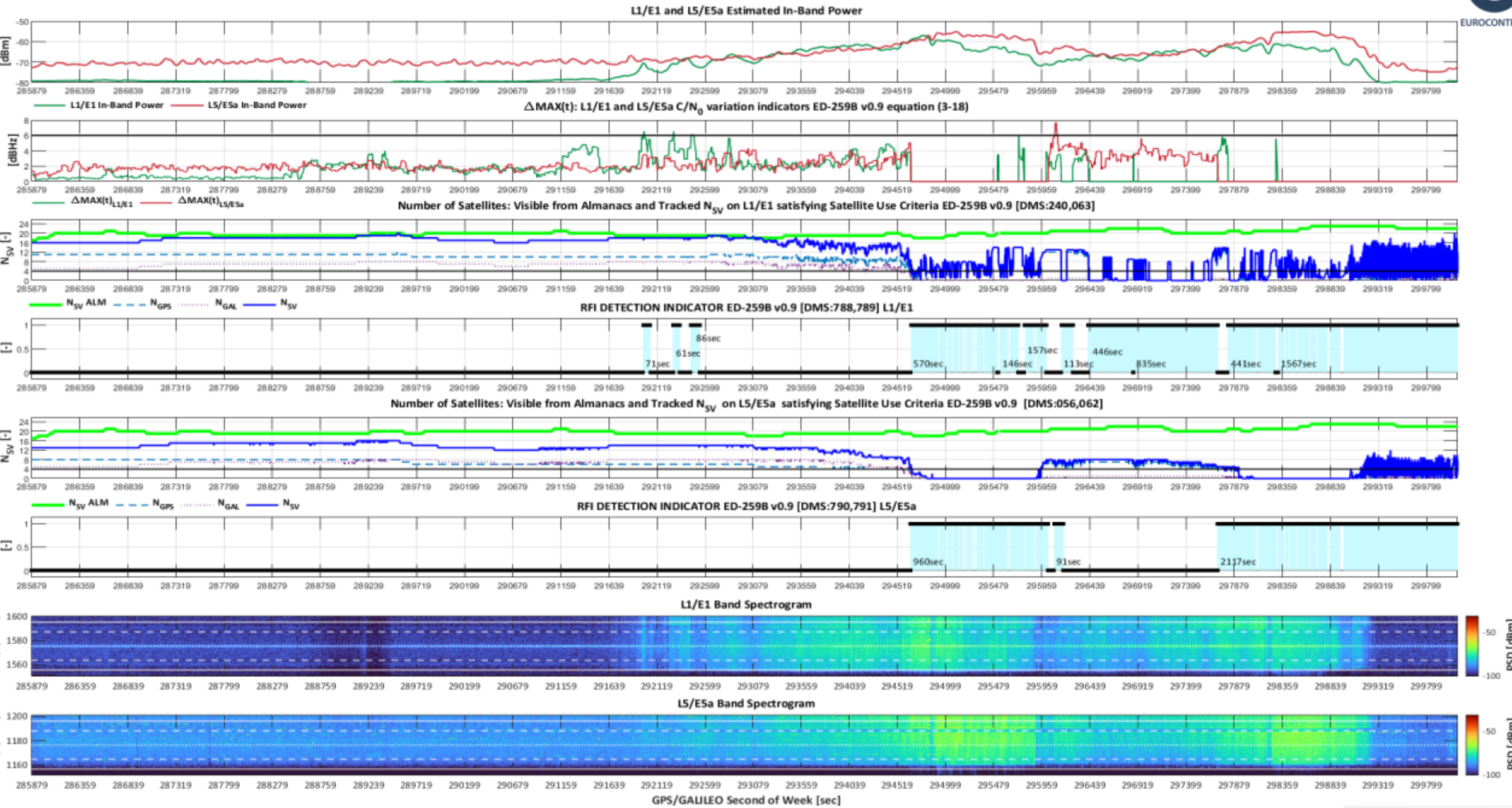


Monitoring Flight: 29 October 2025 (Prague - Tallin)

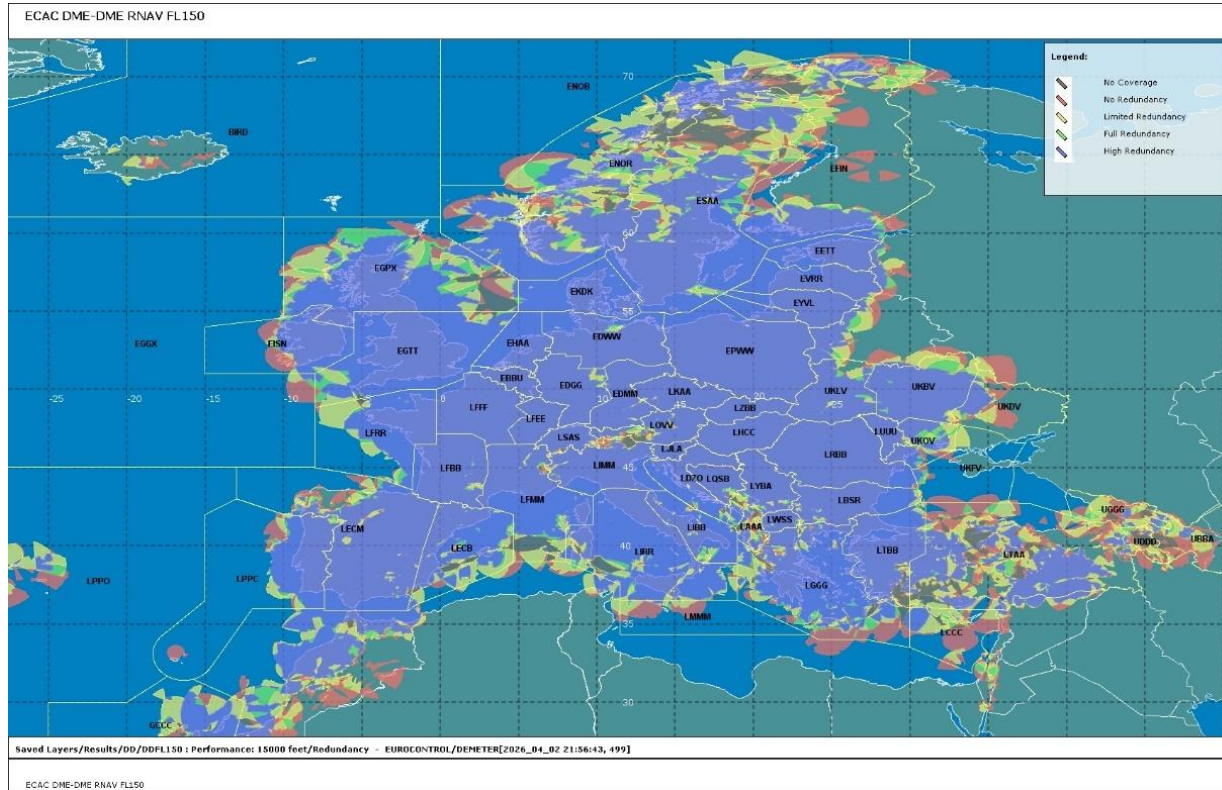
JammerTest Flight 29th October 2025, DOY 302 - AIR1



Monitoring Flight: 29 October 2025 (Prague - Tallin)



DME Navigation – the current and short-term solution



DME/DME coverage and redundancy in Europe – FL 150

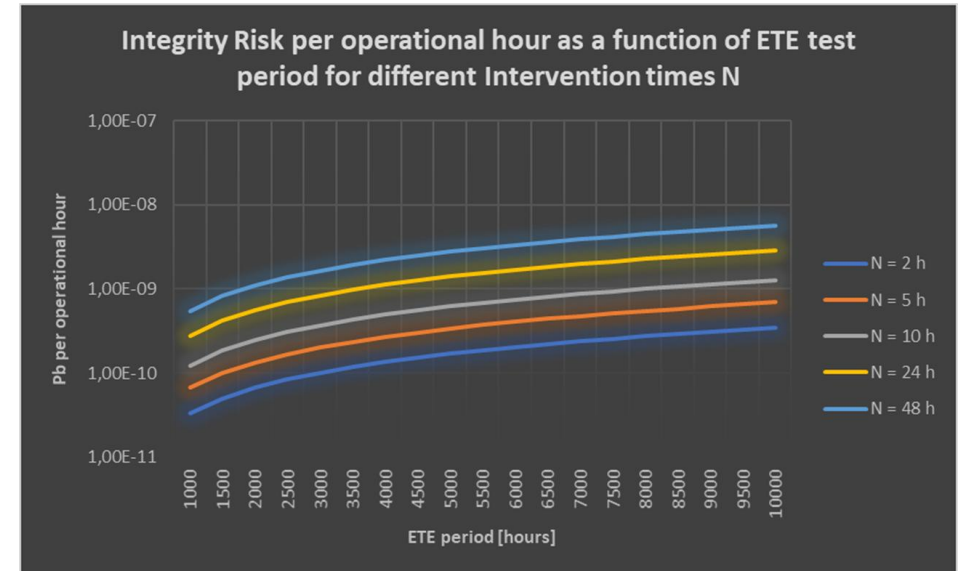
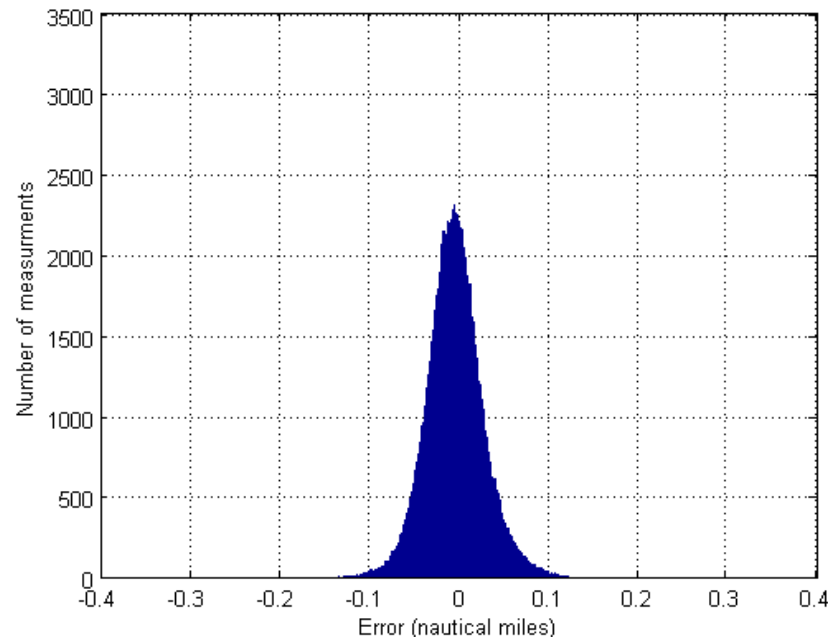
- Status and evolution in EUROPE
 - Extended coverage with high redundancy for en-route operations
 - In general good coverage in major TMAs
 - ANSPs are installing additional stations to improve the service in TMA where needed
 - Enhanced DME (eDME) expected to demonstrate TRL6
- Other technologies under development
 - LDACS-NAV, Mode-N
 - Lower maturity levels, may only be available in mid/long-term

DME Equipment Improved over Time

Current generation of DME

- Provide better accuracy than specified
- Transponders typically meet $1\text{-}10^{-7}/\text{h}$ Integrity!

The update of standards is required to take advantage of this better performance



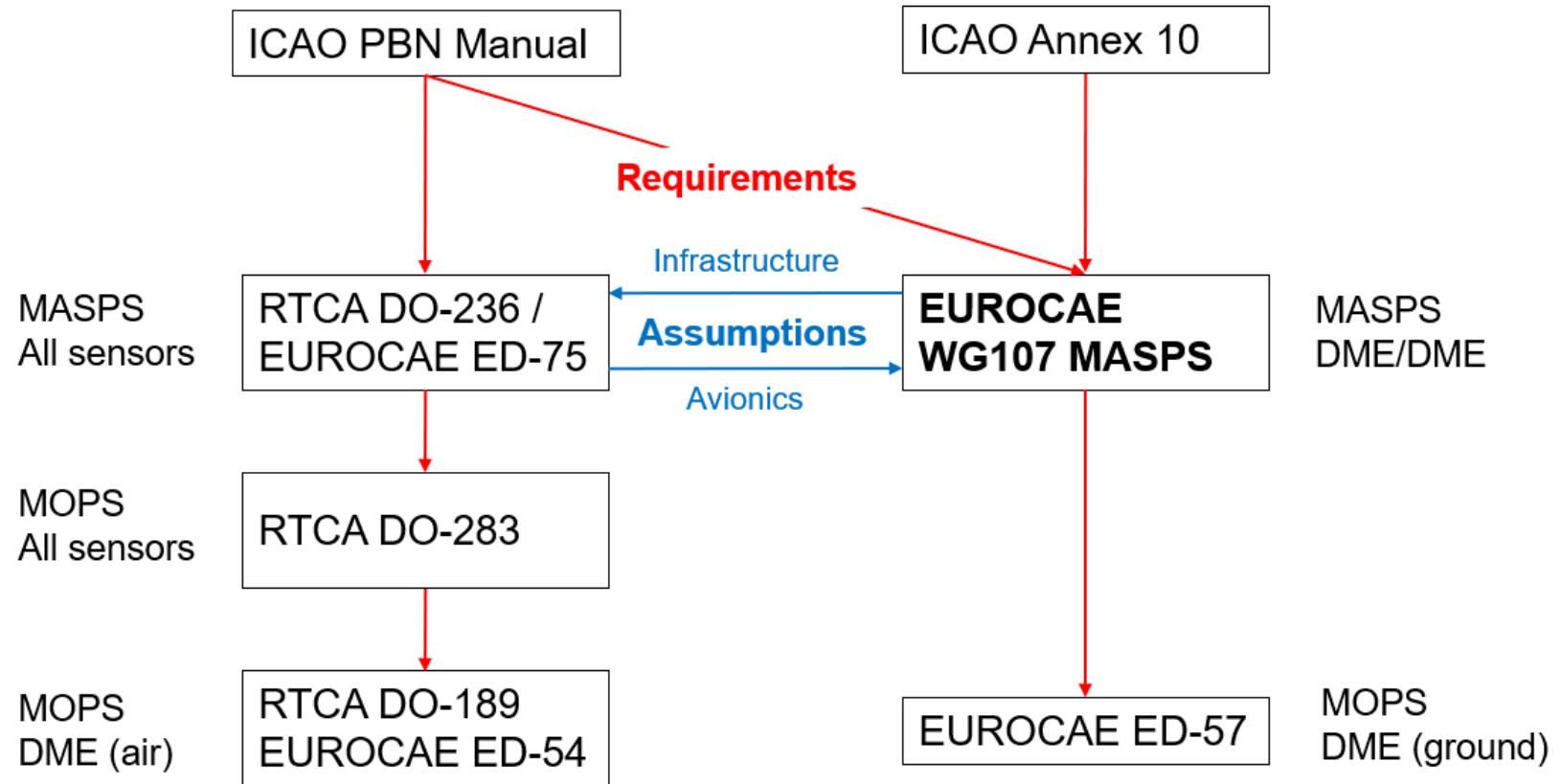
DME/DME navigation

- Available in over 90% of commercial flights.
- Supports RNAV 1 and possibly RNP 1
- Outdated solution – shift to Multi-DME
 - Improved accuracy and integrity (OBPMA)
 - RNP 0.3 feasible – may require INS integration

The update of standards is required to foster Multi-DME (/INS) navigation

Standardisation activities

*New editions of
MASPS and MOPS
target publication
date:
Q4 2027*



*New editions of DO-189/ED-54
target publication date:
Q4 2027*

*ED-57A published
August 2026*

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CLOSING THOUGHTS

- A lot of GNSS RFI remains in areas which do not have an obvious link to any zone of conflict
- Experience has shown that States get active on GNSS RFI once they have events
 - Nobody can say by now that they have not been warned
 - Even occasional events (Denver & Dallas in the US) can have significant cost
 - “An ounce of prevention is worth a pound of cure”
- Significant effort underway to improve aircraft navigation architectures
 - Evolution towards more robust DFMC GNSS including advanced antennas
 - Improved DME Navigation
 - Updates of GNSS/INS and DME/INS Integration
- Even simple upgrades take a lot of time to implement and deploy
 - ANSP need to be ready: GNSS RFI situation can evolve dynamically