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Key Potential Operational Effects from 5G on Radio Altimeter

Regional preparations for WRC-23 – ATU

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Agenda & Acknowledgements

- The Problem & Impacts
- 5G and Radio Altimeter Band
- Context & Technical concern
- AMOC process V1, V2 & V3
- Conclusion & Way Forward

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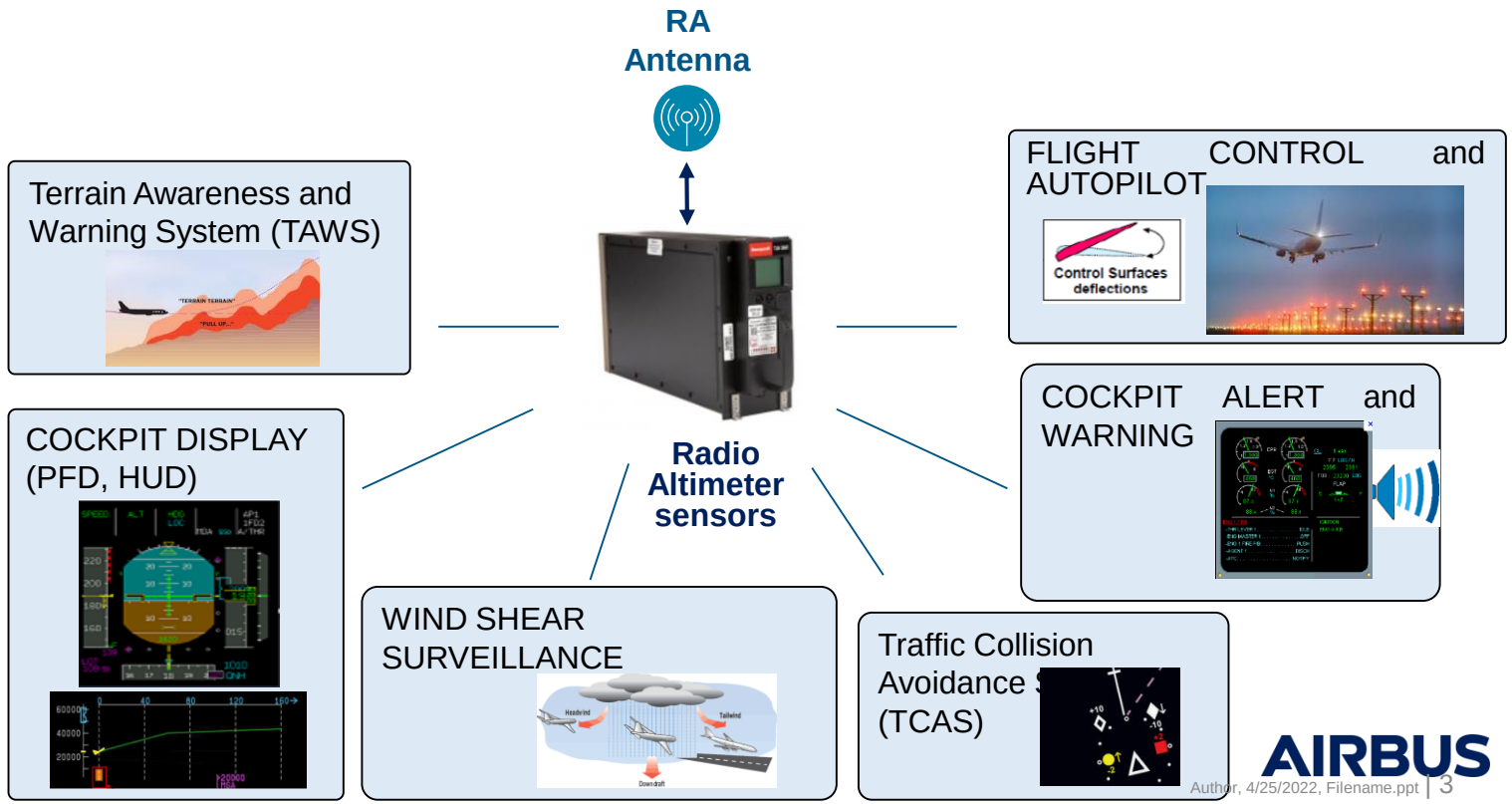
The Problem and Impacts

- Governments all over the world are considering (or have considered) allowing 5G cellular systems to operate in parts of the frequency ranges 3.4 - 4.2 GHz and 4.4 - 4.9 GHz (adjacent to the band used by radio altimeters from 4.2 - 4.4 GHz.)
- Based on the Radio Technical Commission for Aeronautics (RTCA) Paper No. 274-20/PMC-2073, the 5G mid-band emissions may interfere with the Radio Altimeters.
- Impacted aircraft potentially include commercial aircraft, military aircraft, helicopters and larger GA & UAS aircraft with radio altimeters

- Some altimeters appear to be vulnerable to high power cellular systems.
- New Radio Altimeter standards are being developed to sustain planned 5G environment.
- The level of the problem can be different depending on the platform and integration /architectures.



5G and Radio Altimeter band

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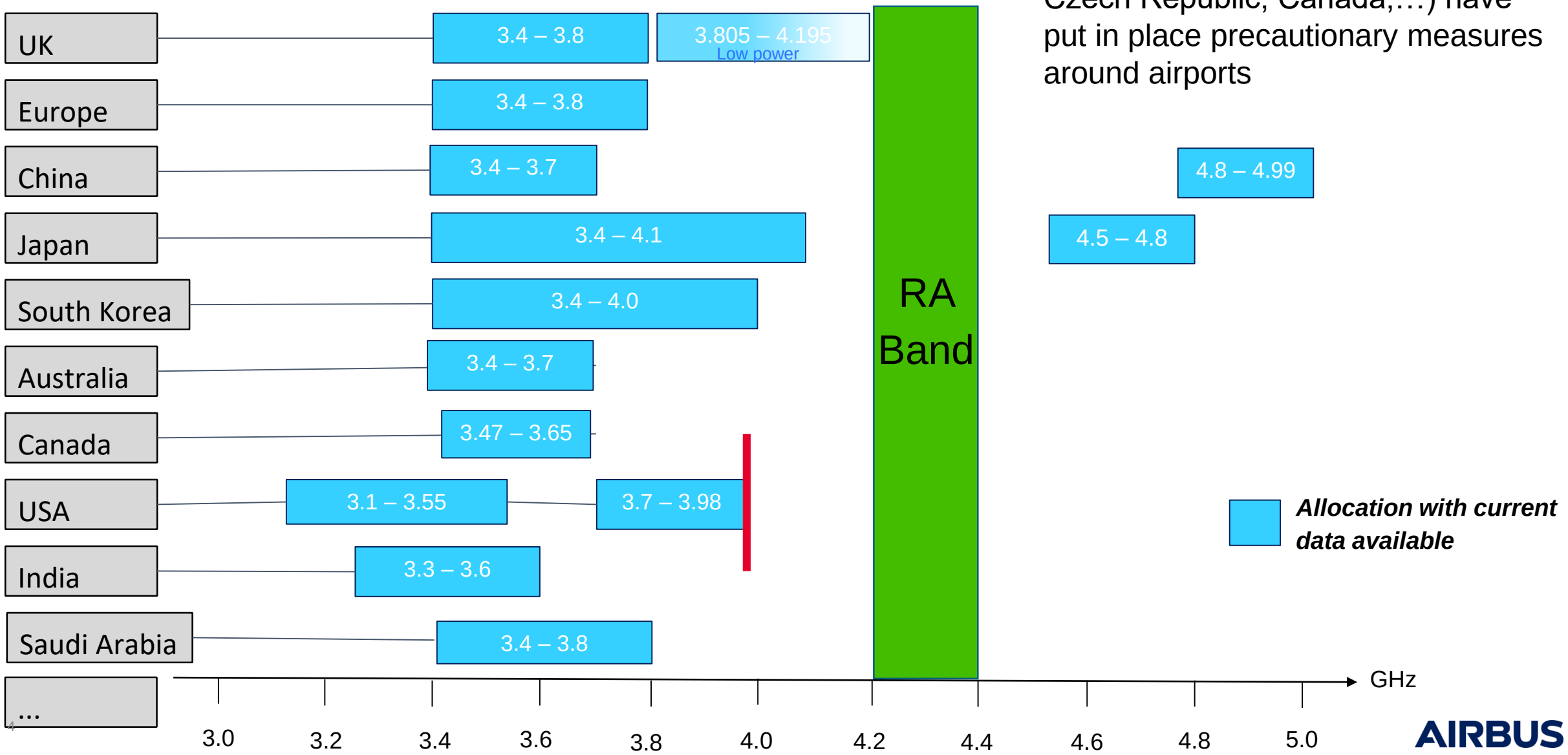
Snapshot of 5G roll-out in **mid-band spectrum (C Band)**



Some countries (France, USA, Czech Republic, Canada,…) have put in place precautionary measures around airports

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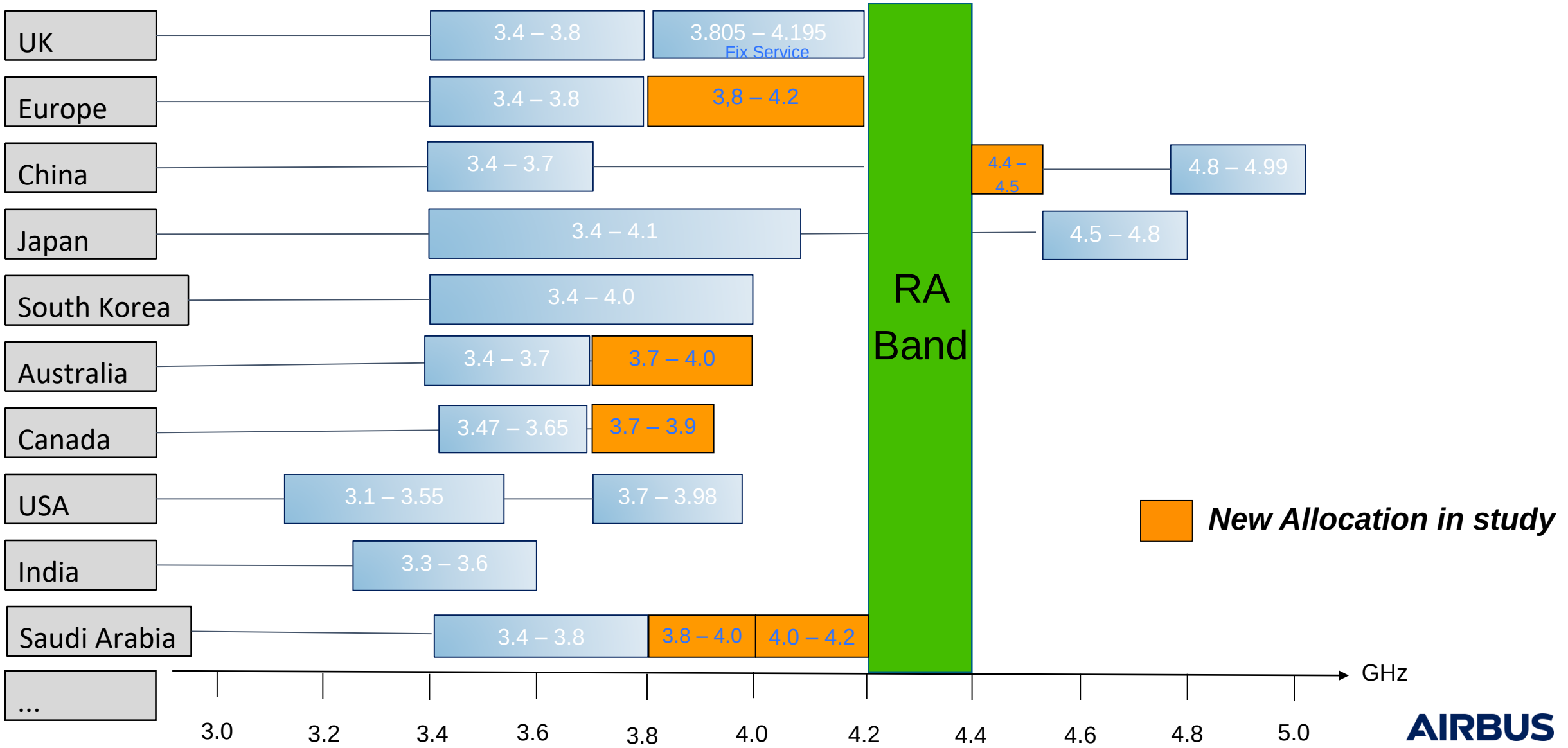
Future 5G roll-out in study



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Context and Technical concern

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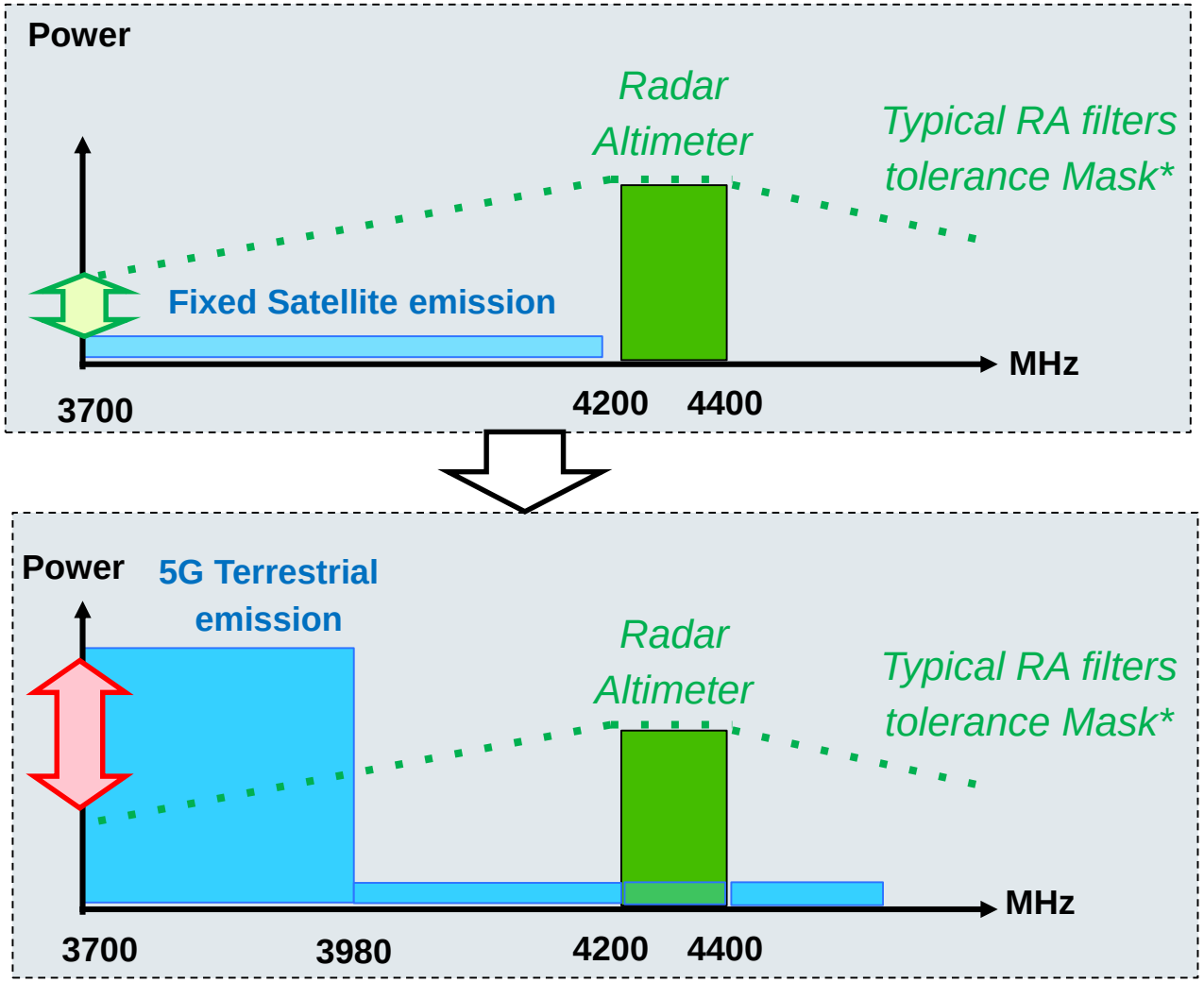
Fundamental Satellite signals are filtered by RA



Fundamental Terrestrial 5G energy not filtered by all RA models

***To ease understanding: Not to scale and not representative to current filters**

Air Transport **RA receivers have not been designed to support such level of terrestrial interferences** in its adjacent band (previously allocated to Fixed Satellites Services) even though they are fully compliant with **applicable** regulations

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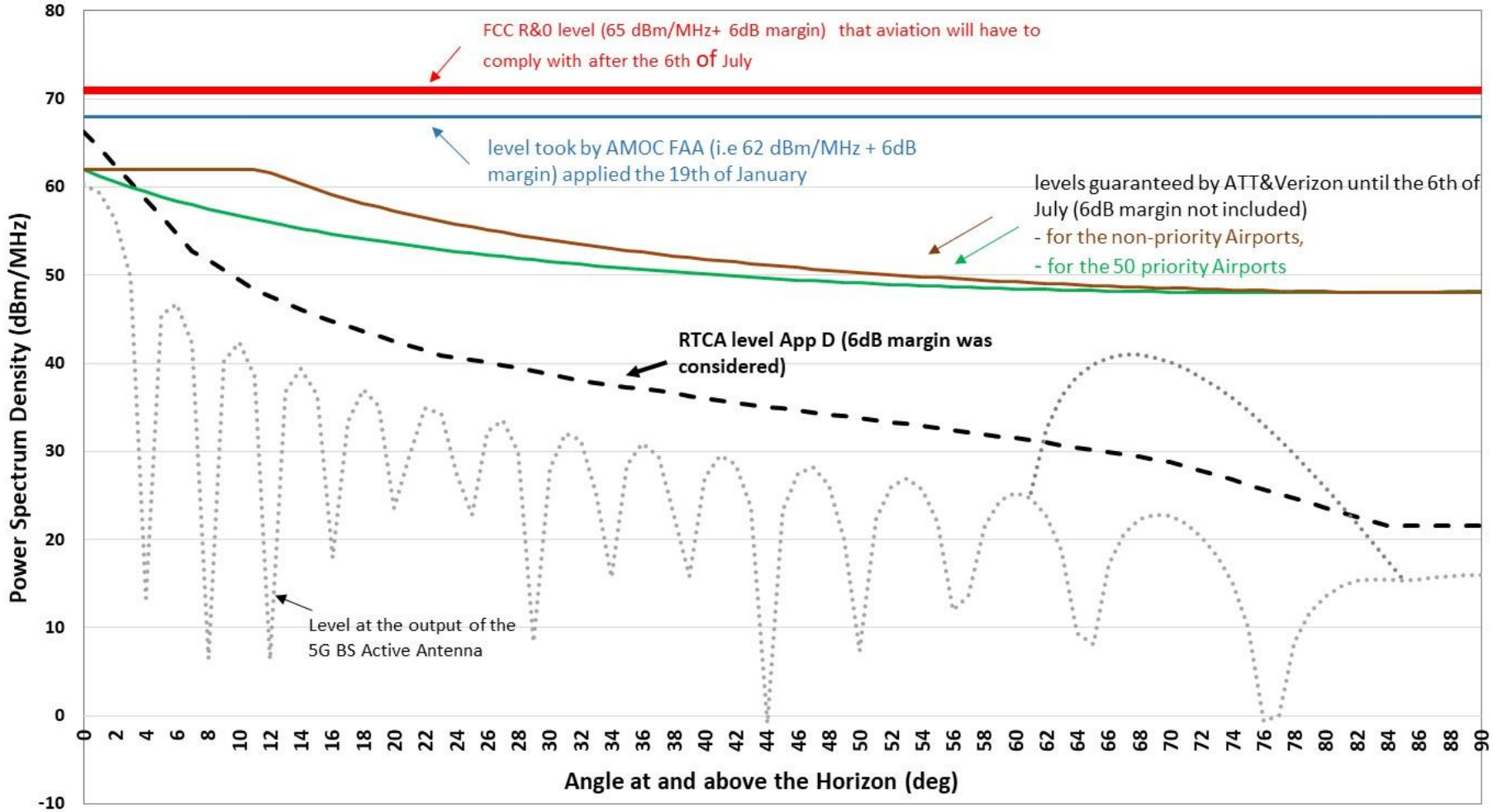
Context and Technical concern in US



- Important Note: Those levels need to be increased by +20dB when considering the total power (dBm) throughout the full 100MHz bandwidth. For the Radio Altimeter radius computation the spreadsheet defined by the AMOC task force requests considering 100MHz BW if no other value is able to be obviously justified
- Important Note: Telco community asked to only consider scan angles in the RTCA Report that were not subject to grating lobes (ref App D)

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AMOC (Alternative Means Of Compliance) Process raised by FAA

- AD 2021-23-12 Issued December 7, 2021 with an effective date January 4, 2022, prohibits certain types of approaches in areas of 5G C-band interference as identified by NOTAMs
- AMOC process refers to Radio Altimeter performance metrics based on standardized test parameters to define a protection radius per RA model without interferences
- Aircraft Manufacturers have submitted AMOCs based on:
  - Level taken by FAA (62 dBm/MHz + 6 dB margin)
  - Each RA suppliers technical parameters defined to compute the minimum radius
  - FAA tool (including all 5G NOTAMs) evaluate Airplanes/RA combination eligible for an AMOC approval per runway based on radius and base station locations
- Airports/Runways clearance is then provided by the FAA
- An AMOC Approval per Airport/Runways is composed of :
  - An introduction Letter stating the RA Supplier/associated Part Number(s) combined with associated aircraft types, for which the AMOC is applicable. This Letter mentions an expiry Date.
  - An appendix providing a 5G Cleared Airport/Runways List for given RA Part Number(s) and Aircraft type(s)

AMOC Process in force in the United States

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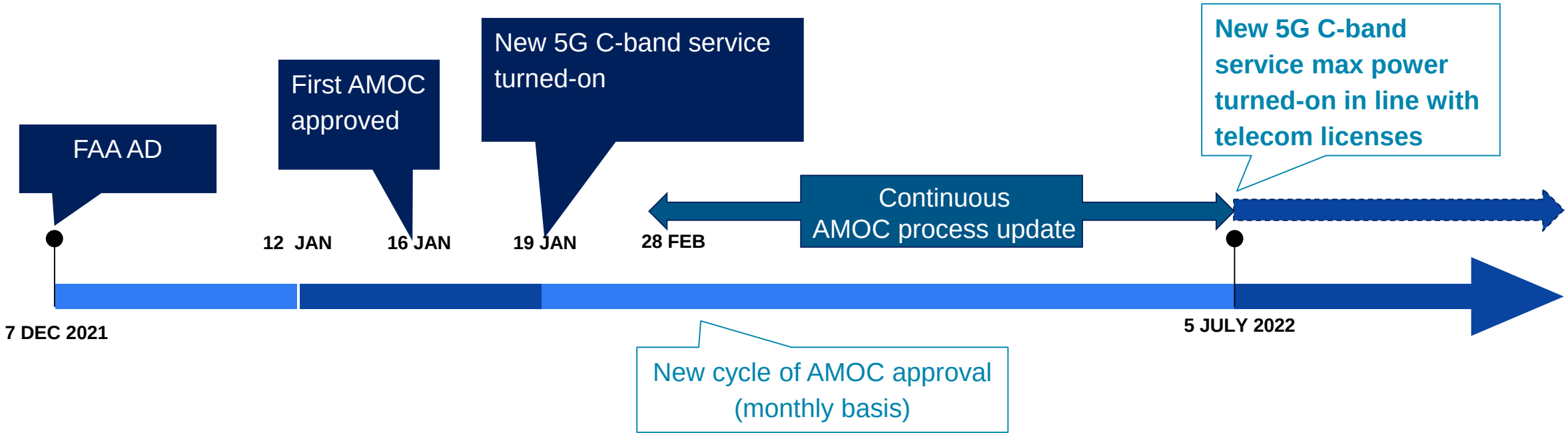
AMOC Task Force is composed of FAA, Airframers, RA Suppliers, Telecom operators



End 2021, belated awareness in US, huge activity linked to the AD 2021-23-12

87 main airports/runways clearance

Additional airports/runways clearance according to ongoing 5G base stations deployment

Unknown situation

AMOC: Alternative Means Of Compliance

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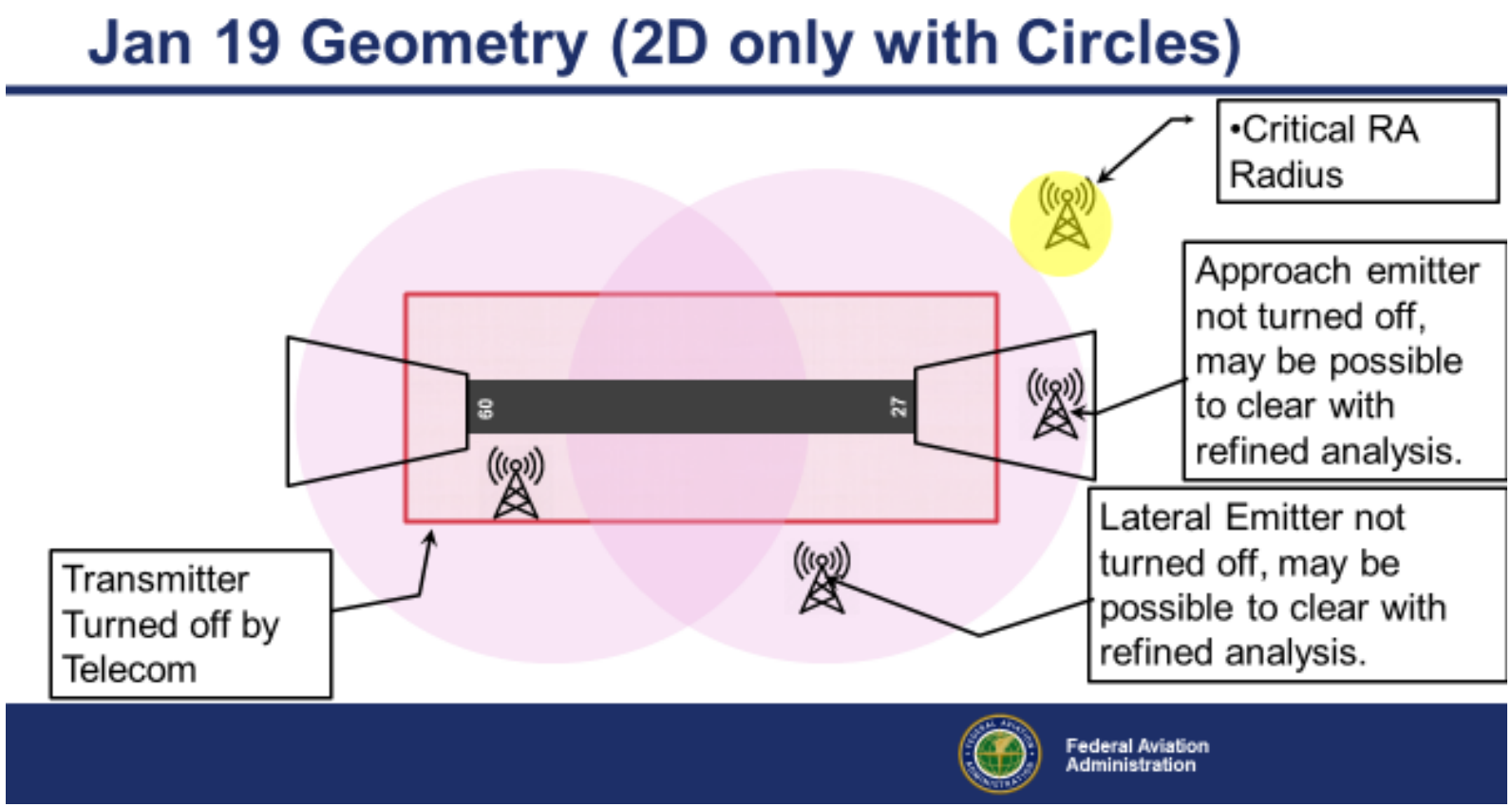
FAA protection surfaces as per January 19th 2022 (AMOC V1)



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FAA protection surfaces as per February 2022 (with AMOC V2)

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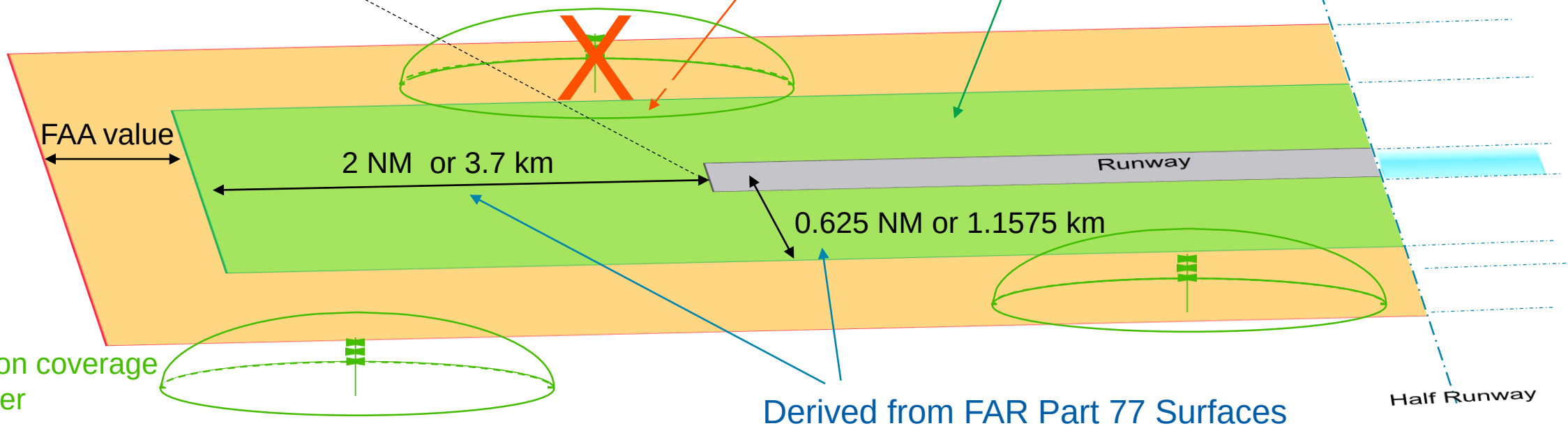
Fixed Radius Method
AMOC V2
AMOC FAA: 62 dBm/MHz + 6dB margin

Performance Buffer
5G base station in this zone and radiating in the exclusion zone shall be turned off

Runway Safety Zone
No 5G base station allowed in this area



BS radiation coverage at full power

Derived from FAR Part 77 Surfaces

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FAA protection surfaces as per end March 2022 (with AMOC V3)

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Variable Radius Method
AMOC V3

AMOC FAA: 62 dBm/MHz + 6dB margin

Realistic parametric model

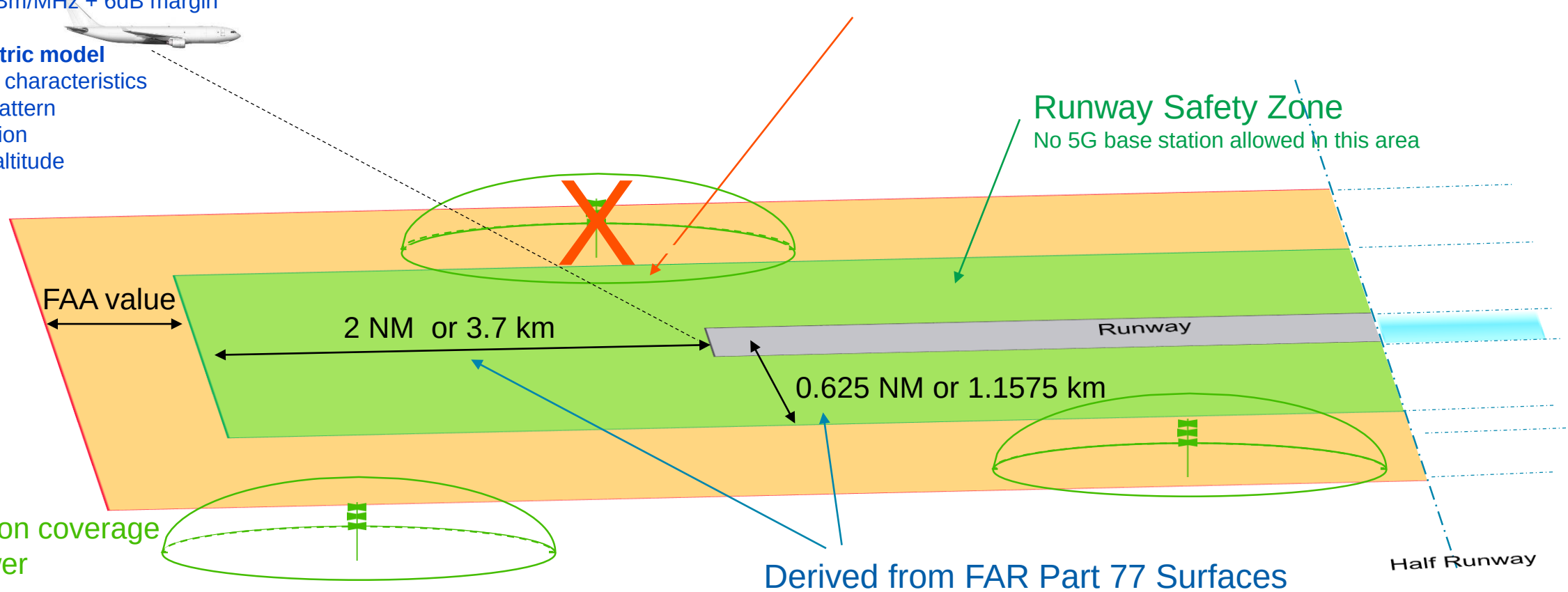
- RA sensitivity characteristics
- RA antenna pattern
- Terrain elevation
- Base station altitude

Performance Buffer

5G base station in this zone and radiating in the exclusion zone shall be turned off

Runway Safety Zone

No 5G base station allowed in this area



BS radiation coverage at full power

Derived from FAR Part 77 Surfaces

AMOC V3 “Variable Radius Method” will :
- clear more runways whatever Aircraft/RA couple
- allow more 5G base stations deployment

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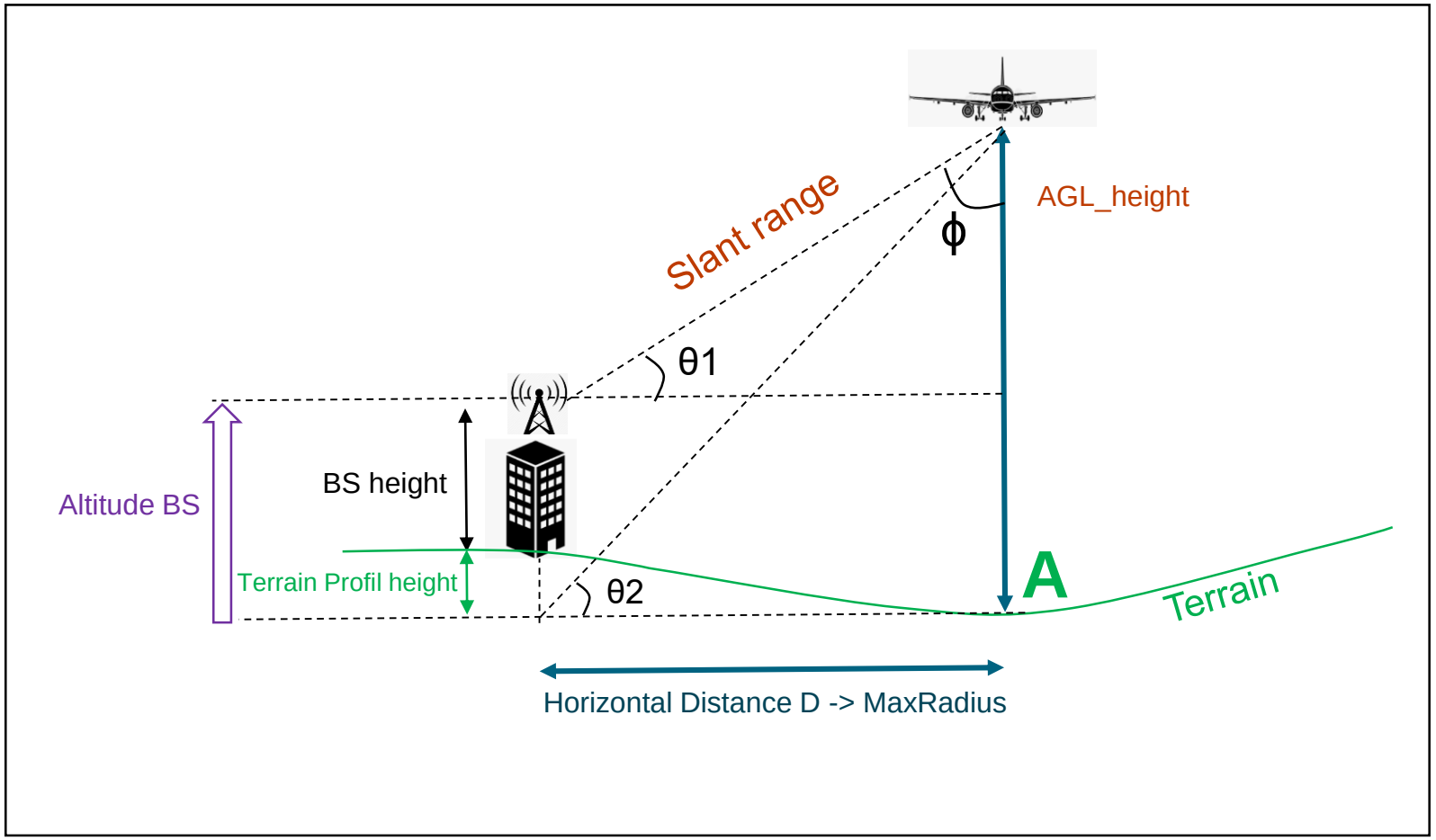
FAA Variable Radius Method or AMOC V3

- Above Ground Level height [0….1000ft], independent from the operation and from the vertical trajectory
- Horizontal Distance D between the Base Station and the aircraft [0…max]
  >>> MaxRadius = maximum D amongst all AGL heights with worse Altitude BS
- Altitude Base Station [0..500ft]



Realistic parametric model

- RA sensitivity characteristics
- RA antenna pattern
- Terrain elevation
- Base station altitude and exact location

➢ **This approach will allow more 5G base stations deployment and clearance of runways whatever aircraft/RA couple**

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RTCA/EUROCAE status about RA MOPS

Currently published standards:

- RTCA DO-155, “Minimum Performance Standards Airborne Low-Range Radar Altimeters”, published November 1, 1974

- EUROCAE ED-30, “Minimum Performance Specification for Airborne Low Range Radio (Radar) Altimeter Equipment”, published March 1980

Existing Radio Altimeter Standards
Do not address 5G/C-Band RF Interference

RTCA/EUROCAE status about RA MOPS

Radio Altimeter RTCA Special Committee SC-239 and EUROCAE Working Group WG-119 are working jointly to address minimum performance requirements for radio altimeters when subjected to RF interferences.

Original work plan was to completely re-write the MOPS document (including the addition of new RF interference requirements and test procedures) and to release the entire DO-155A/ED-30A MOPS update by Dec. 2022.

Since the immediate need by industry and regulators are the RF interference requirements & associated tests, the work plan has been revised to first release a new DO-XXX/ED-XXX document “Technical Standard on RF Interference Environment for Radar Altimeters” in Dec. 2022, followed by the DO-155A/ED-30A MOPS revision in Dec. 2023.

RTCA/EUROCAE SC-239/WG-119 Committee
DO-XXX/ED-XXX Plan and Schedule for Long Term (RA)

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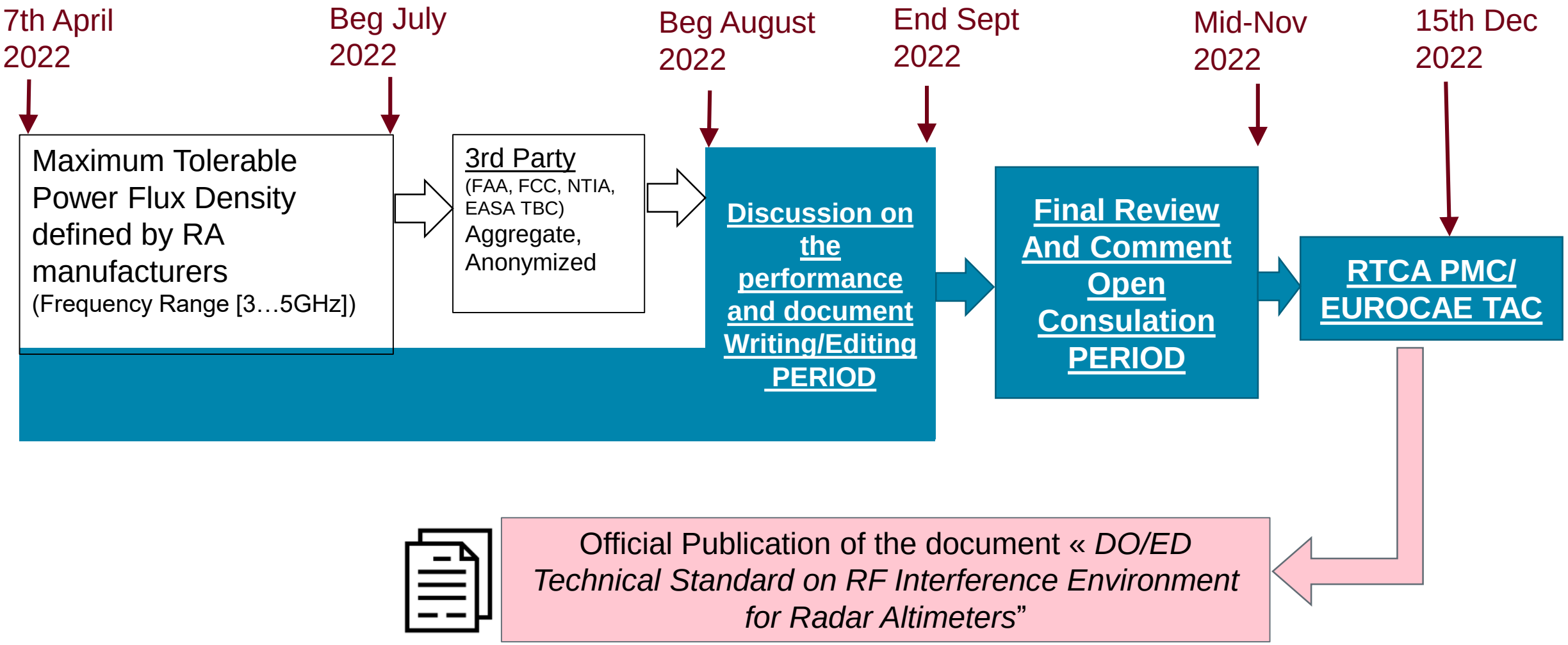

PMC: Program Management Committee
TAC: Technical Advisory Committee

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RTCA/EUROCAE Spectrum Guidance Committee

New joint RTCA Special Committee SC-242 and EUROCAE Working Group WG-124 has been initiated

– The WG is intended to provide guidance to ensure that the radio frequency characteristics of aeronautical Communications, Navigation and Surveillance systems use the spectrum efficiently while respecting the necessary safety margins.

– The guidance is intended to facilitate any future evaluation of compatibility with other systems and ensure that the usage of the allocated spectrum is as efficient as possible, fully taking into account the specificities of aeronautical CNS systems. The deliverables are envisaged to be referenced by EASA, FAA, other CAAs, ICAO, and national/international spectrum regulators, as appropriate, in guidance material for aviation systems.

ICAO letters

- ICAO Letter 25 March 2021, “Potential Safety Concerns Regarding Interference to Radio Altimeters”
  - Requested ICAO member States to “Consider as a priority, public and aviation safety when deciding how to enable cellular broadband/5G services in radio frequency bands near the bands used by radio altimeters”

- ICAO NAM/CAR/SAM Letter 25 January 2022 “Potential Safety Concerns Regarding Interference to Radio Altimeters
  - States were “urged to carry out evaluations of their operations, especially at international airports, to assess the impact that the implementation of 5G technology may have on operational safety”

ICAO HLCC outcome

Recommendation 5/5 from ICAO HLCC 2021

Recommendation 5/5 — Mitigating the risk of 5G implementation to safety-critical radio altimeter functions

That States:

a) consider, as a priority, public and aviation safety when deciding how to enable cellular broadband/5G services;

b) consult with aviation safety regulators, subject matter experts and airspace users, to provide all necessary considerations and regulatory measures to ensure that incumbent aviation systems and services are free from harmful interference; and

That ICAO:

c) continue coordinated aviation efforts, particularly at the International Telecommunication Union (ITU), to protect radio frequency spectrum used by aeronautical safety systems.

Take all practicable and necessary measures to ensure that mid-band 5G unwanted emissions will not cause harmful interference to Radio Altimeters and improve transparent data sharing between Telecom Operators & Manufacturers and Aviation Industry to safely co-exist in the future

Way forward

The introduction of 5G telecommunications networks across the world may introduce new threats towards the aviation sector and flight safety, nevertheless Airframe OEM's support 5G and its deployment.

Common objective is to ensure the continuous safe operations of airplanes in assessing & addressing potential interference between the 5G networks and aircraft systems, while allowing future 5G deployment including supporting aviation industry, once potential risks are mitigated.

Continuing activity with all stakeholders to address worldwide 5G levels threat.

Airbus continue to support airworthiness authorities and provide updates to airlines/ customers.

Conclusion

Fortunately, as of today, no misbehavior on RA due to 5G interference has been reported on the Airbus fleet worldwide.

Long Term:

- In addition to RTCA/EUROCAE committee activity to develop new Radar Altimeter Minimum Operational Performance Standards (MOPS) to cope with worldwide future Radio Frequency environment, it is also necessary to identify robustness need increase for radio receivers (Satcom, GNSS, DME, ILS…)

- RF environment becomes more and more constraining for Aviation CNS systems, Spectrum is a scarce resource, various actions are launched in different worldwide forums to prepare the future of aviation and anticipate design changes.

Thank you

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