



Navigation

Surveillance

Spectrum

POTENTIAL SAFETY CONCERNS DUE TO INTERFERENCE FROM 5G TO AERONAUTICAL RADIO ALTIMETERS

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Ref.: SP 74/1-21/22

Subject: Potential safety concerns regarding
interference to radio altimeters

Action required: As indicated in paragraph 5

Sir/Madam,

1. I have the honour to bring your attention to an ongoing initiative by the International Civil Aviation Organization (ICAO) to ensure continued public and aviation safety.

2. During recent meetings of ICAO experts, concerns about interference to radio altimeters on-board aircraft have been raised. A number of administrations are currently considering or have already begun deploying new cellular broadband technologies (such as 5G) in the frequency bands close to the radio altimeter's frequencies of operation (4.2-4.4 GHz), a critical aviation safety system. The international aviation industry has noted with concern that these broadband technologies may cause harmful interference to radio altimeters.

3. The radio altimeter¹ is a mandated critical aircraft safety system used to determine an aircraft's height above terrain. Its information is essential to enable several safety related flight operations and navigation functions on all commercial aircraft as well as a wide range of other civil aircraft. Such functions and systems include terrain awareness, aircraft collision avoidance, wind shear detection, flight controls, and functions to automatically land an aircraft. If not properly mitigated², harmful interference to the function of the radio altimeter during any phase of flight may pose a serious safety risk to passengers, crew and people on the ground.

4. ICAO has received studies from several States and organizations regarding the interference potential to radio altimeters³. These studies generally conclude that some radio altimeters will be impacted

¹ In some aviation publications it is also known as the radar altimeter or Low Range Radar Altimeter.

² General guidance on Interference Protection Considerations can be found in Chapter 9 of the *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation – ICAO spectrum strategy, policy statements and related information* (Doc 9718, Volume I)

³ Report by RTCA – https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG11/IP/FSMP-WG11-IP07_RTCA_Report.docx



Problem Statement by IATA and IFALPA



Problem statement - 5G interference with radio (radar) altimeter frequency band

Reference

Problem statement and industry response to the ICAO FLTOPSP/7 information paper IP03 "5G frequency interference" and agenda item 5.4 "5G interference"

Introduction

Radio (radar) altimeters (RA), operating at 4.2-4.4 GHz, are the only sensors onboard a civil aircraft which provide a direct measurement of the clearance height of the aircraft over the terrain or other obstacles (i.e. the Above Ground Level - AGL - information).

The RA systems' input is required and used by many aircraft systems when AGL is below 2500 ft. Any failures or interruptions of these sensors can therefore lead to incidents with catastrophic outcome, potentially resulting in multiple fatalities. The radar altimeters also play a crucial role in providing situational awareness to the flight crew. The measurements from the radar altimeters are also used by Automatic Flight Guidance and Control Systems (AFGCS) during instrument approaches, and to control the display of information from other systems, such as Predictive Wind Shear (PWS), the Engine-Indicating and Crew-Alerting System (EICAS), and Electronic Centralized Aircraft Monitoring (ECAM) systems, to the flight crew.

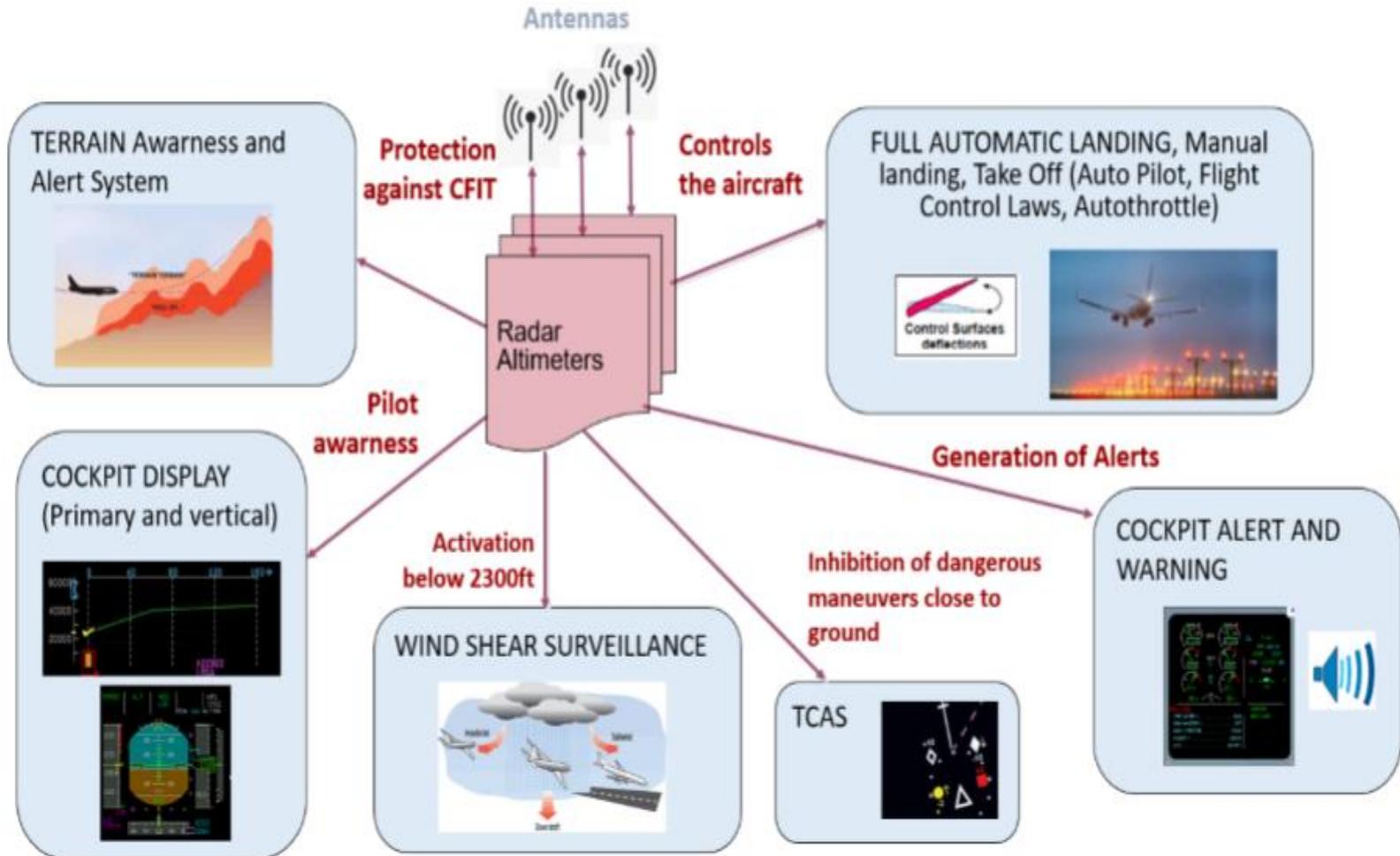
There is a major risk that 5G telecommunications systems in the adjacent frequency bands to radio altimeters, including 3.7–3.98 GHz, will cause harmful interference to radio altimeters on all types of civil aircraft—including commercial transport airplanes; business, regional, and general aviation airplanes; and both transport and general aviation helicopters. If there is no proper mitigation, this risk has the potential for broad impacts to aviation operations in the United States as well as in other regions where the 5G network is being implemented close to the 4.2-4.4 GHz frequency band.

An example listed further below shows, that the identified risk has materialized during certain airline operations impacted by similar interference.

List of potential equipment failures

Interference to RA operations can affect:

Critical Roles of Aircraft Radio Altimeters



Some history: The ITU Radio Regulations in 1947

Bands adjacent to the Radio Altimeter band already allocated to the Mobile service.

However in practice, until recently, with the advent of Satellite links and until recently, these bands were mainly used for Satellite Downlink

2 700–2 900 (200)	Aero- nautical radio- navigation <small>108)</small>			
2 900–3 300 (400)	Radio- navigation <small>109) 110)</small>			
3 300–3 900 (600)		3 300–3 900 (600) a) Fixed b) Mobile c) Radio- navigation	3 300–3 500 (200) Amateur	3 300–3 900 (600) a) Amateur b) Fixed c) Mobile d) Radio- navigation
			3 500–3 900 (400) a) Fixed b) Mobile	
3 900–4 200 (300)	a) Fixed b) Mobile			
4 200–4 400 (200)	Aero- nautical radio- navigation <small>111)</small>			
4 400–5 000 (600)	a) Fixed b) Mobile			
5 000–5 250 (250)	Aero- nautical radio- navigation			

Present:
The ITU Radio Regulations as a result of the latest WRC (rev 2020)

Allocation to services		
Region 1	Region 2	Region 3
3 600-4 200 FIXED FIXED-SATELLITE (space-to-Earth) Mobile	3 600-3 700 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.434 Radiolocation 5.433	3 600-3 700 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile Radiolocation 5.435
	3 700-4 200 FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile	
4 200-4 400	AERONAUTICAL MOBILE (R) 5.436 AERONAUTICAL RADIONAVIGATION 5.438 5.437 5.439 5.440	
4 400-4 500	FIXED MOBILE 5.440A	
4 500-4 800	FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE 5.440A	

Not much change.

Fixed Satellite Service allocations added in 1970s approx. (?)

Mobile bands below 3700 MHz identified for IMT in 2007/2012, through country footnotes.

Current rollout of 5G not related to the ITU WRC-23 agenda

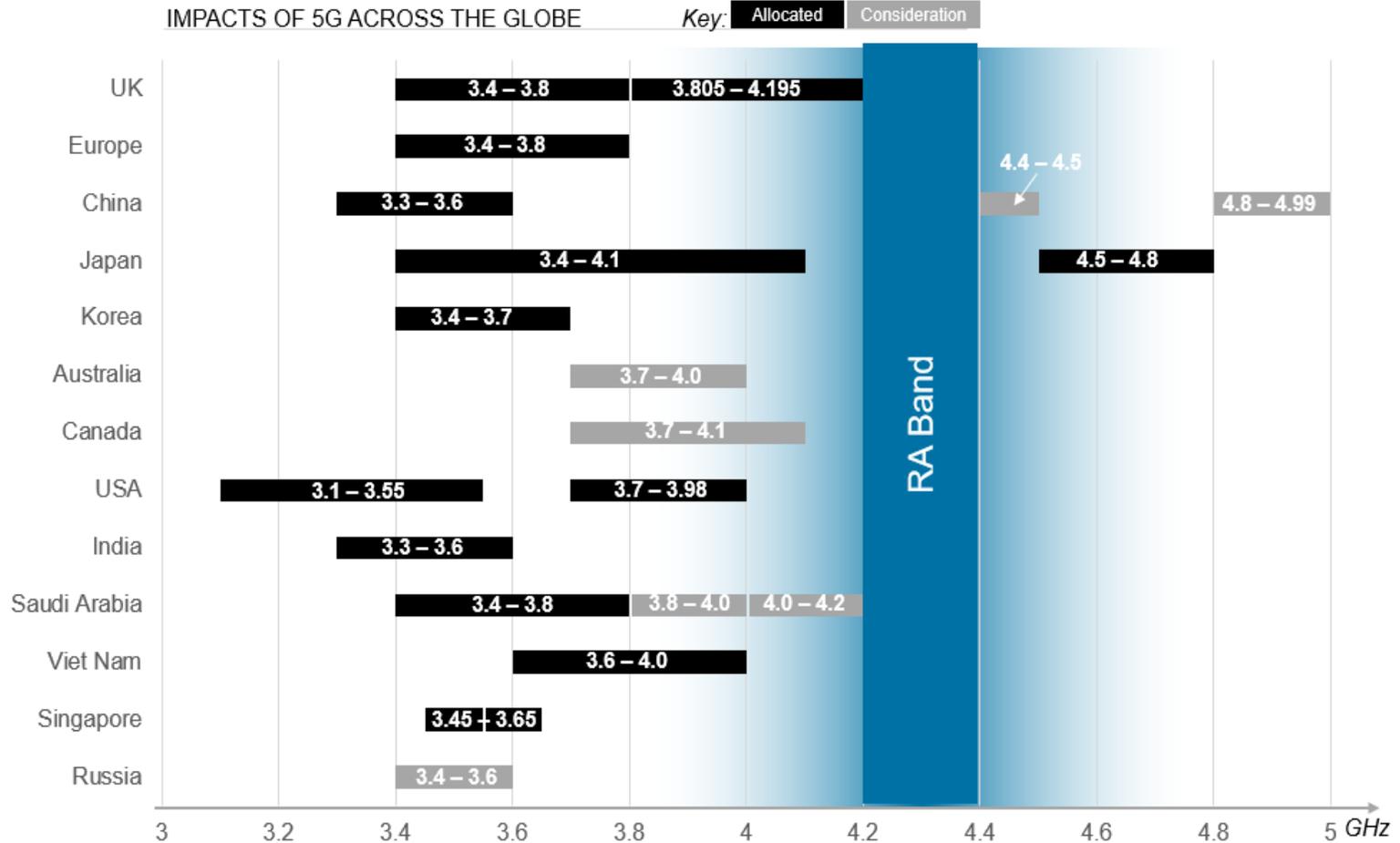
Brief Summary of Telecom & 5G

Telecom Industry (GSMA figures)	Aviation Industry (IATA figures)
\$USD 3.9 trillion or 4.6% of world GDP (2018)	\$USD 899 billion or 1% of world GDP (2019)
14 million direct jobs (2018)	2.9 million jobs (2019)

ITU - “[5G is] *an opportunity for policy-makers to empower citizens and businesses. 5G will play a key role in supporting governments and policy-makers in transforming their cities into smart cities, allowing citizens and communities to realize and participate in the socio-economic benefits delivered by an advanced, data-intensive, digital economy.*”

- **Deployments of 5G needs frequency spectrum – a very limited and finite natural resource**
- In the recent 5G spectrum auction, the Telecommunication Industry spent **US\$80+ billion** to obtain a **10-year lease** of spectrum from the US government.
- **Immense political and economic pressure often overwhelmed aviation safety arguments.**

5G Proposals Across the Globe

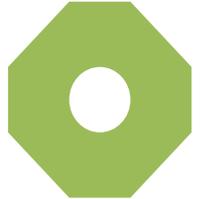
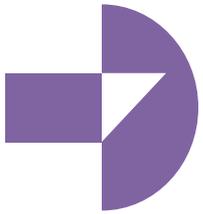


A Serious Aviation Safety Risk

Potential for Catastrophic Consequence

- ICAO SL 21/22 encourages *“Administration[s] 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.”*
- *“if not properly mitigated, harmful interference to the function of the radio altimeter during any phase of flight may pose **a serious safety risk** to passengers, crew and people on the ground.”* (ICAO)
- ***undetected failure** of the radio altimeter can lead to **catastrophic results** for people on board the aircraft and on the ground; and **false alarms** have the potential to **undermine trust** in the avionics systems.* (IATA & IFALPA)
- Similar concerns expressed formally by ICCAIA, RTCA, US Secretary of Transport...

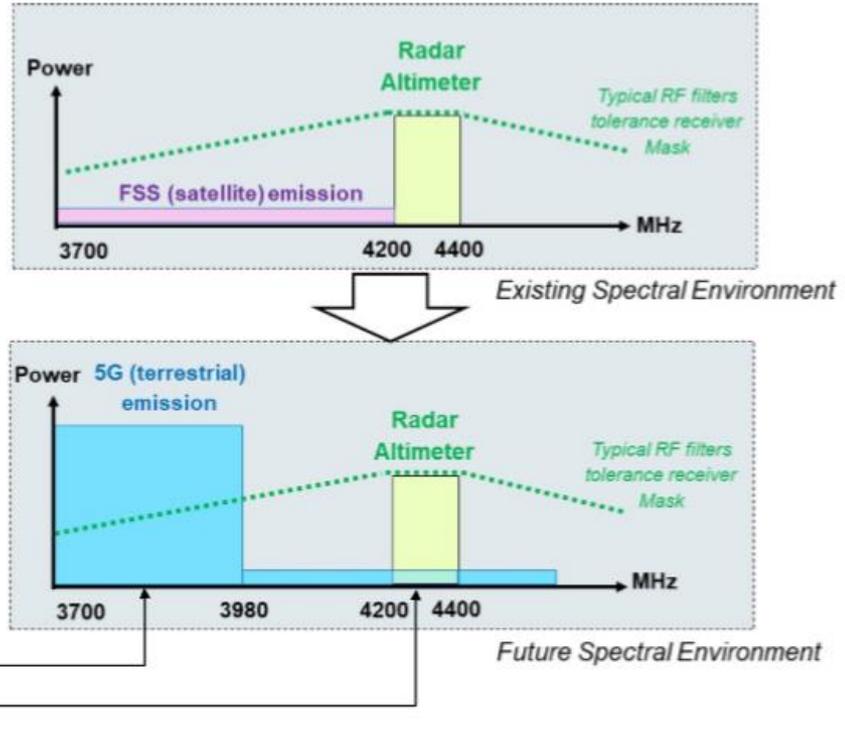
If not mitigated, then a huge step backwards...

-  • **Limitation/Suspension of precision approach and landing capabilities** – This limitation/suspension will reduce airlines access to airports in low-visibility conditions.
-  • **Limitation/Suspension of night operations**, particularly for airports with challenging terrain – The radio altimeter is critical for the terrain awareness and warning system which is mandatory for all air transport aircraft.
-  • **Issue of State regulations mandating retrofits and re-certification** of aircraft radio altimeters and other related functions.

Using the US 5G proposal as a reference, Airbus approximates that, without mitigations, **11,000 altimeters** on its own commercial aircraft are potentially impacted by 5G interference. It is anticipated that the number represents just under **half of all altimeters** on commercial aircraft globally.

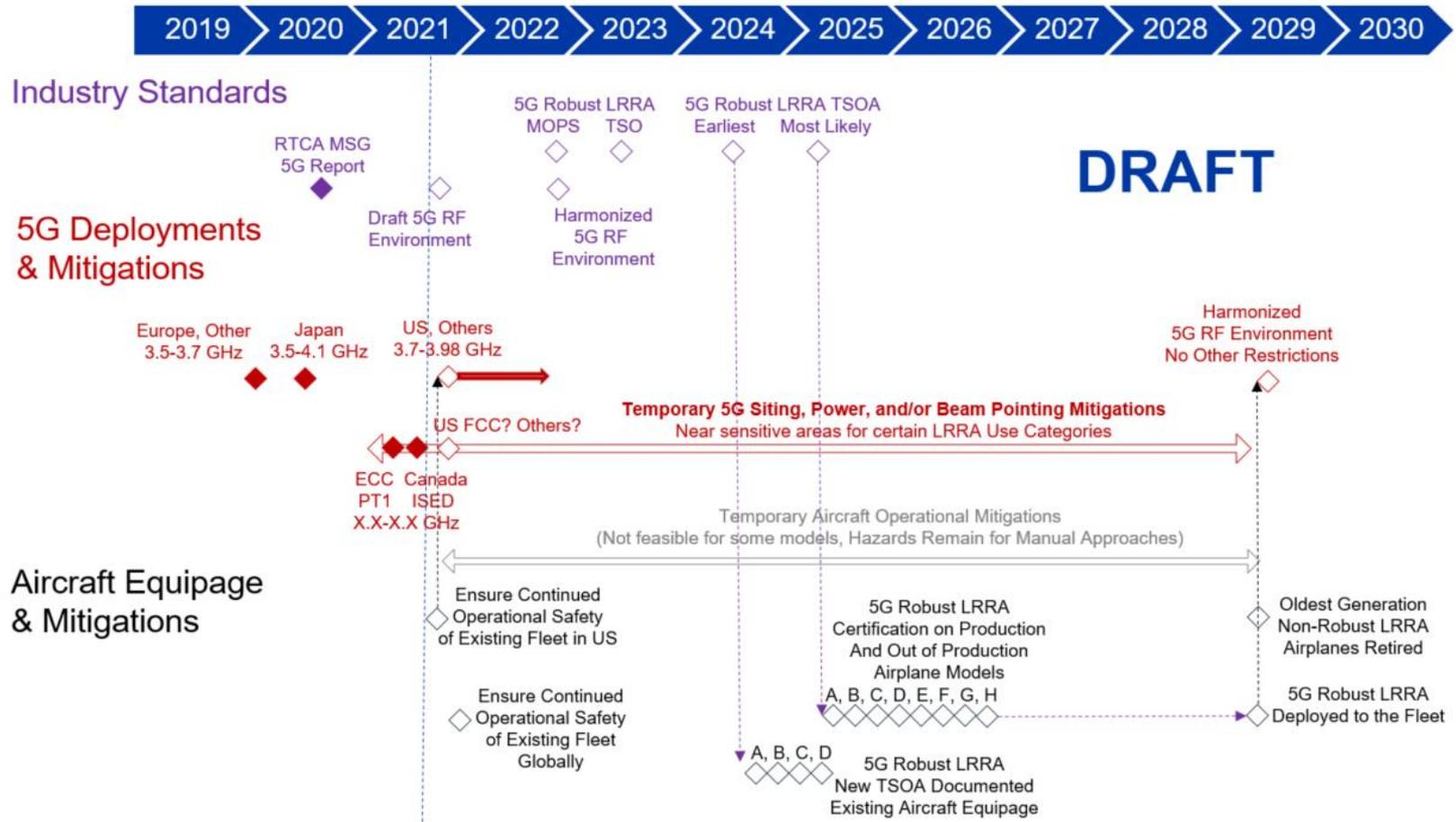
On-going Long-Term Actions

RA receivers have not been designed to support such level of terrestrial interferences in its adjacent and nearby bands (previously allocated to satellites) while being compliant with applicable regulations at time of certification



- New RTCA/EUROCAE MOPS expected end of 2022.
- ICAO FSMP task agreed in 2016 to include the new equipment standards into the ICAO Annexes and to assist with coordination with ITU for appropriate legal protections for future radio altimeters. This task will be progressed and finalized asap, dependent on the work being performed within RTCA/EUROCAE.

Notional mitigations plan and timeline



Timeline for Radio Altimeter Upgrades and Continued Operational Safety during Transition (reference, FSMP WG/12 WP/17)

References and links

- **ICAO State Letter 21/22:**
<https://www.icao.int/MID/Documents/2021/FM%20WG2/74-1e.pdf> the
SL includes several useful links, including Report by RTCA and reports of several national studies and mitigations.
- **A better presentation on the actual Radio Altimeter and its use:**
<https://www.icao.int/NACC/Documents/Meetings/2018/RPG/RPGITUWRC2019-P08.pdf>
- **Frequency Spectrum Management Panel, Working Group/12 (4-15 October 2021)**
 1. WP/17 “ICCAIA updates on Industry Assessment of 5G Cellular Compatibility with Radio Altimeters”
https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG12/WP/FSMP-WG12-WP17_ICCAIA_5GLRRA%20Input.docx
 2. IP/03 “Status on replanning the 3700-4200 MHz band in Australia” https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG12/IP/FSMP-WG12-IP05_Status%20on%20replanning%20the%203700-4200%20MHz%20band%20in%20Australia.docx
 3. IP/07, ENRI Japan, “Interference Susceptibility Evaluations of Pulsed Radio Altimeters Due to 5G Mobile Base Station Signal”
https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG12/IP/FSMP-WG12-IP07_Interference%20Susceptibility%20Evaluations%20of%20Pulsed%20Radio%20Altimeters%20Due%20to%205G%20Mobile%20Base%20Station%20Signal_rev1.pptx
- IP/12 “Brazil 5G auction”
<https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG12/IP/FSMP-WG12-IP12%20-%20Brazil%205G%20Auction.pdf>
- **Frequency Spectrum Management Panel, Working Group/14 (25-29 April 2022)**
 1. IP/01 “National efforts to implement broadband mobile near 4200-4400 MHz - Report from correspondence group on radio altimeters (CG-RA)”
https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG14/IP/FSMP-WG14-IP01_CG-RA%20Report%20April%202022%20V1.03.docx

Questions





THANK YOU!