International Civil Aviation Organization
Asia and Pacific Office

Twelfth Meeting of the Regional Aviation Safety Group – Asia and Pacific Regions (RASG-APAC/12)

Bangkok, Thailand, 17-18 November 2022 (Hybrid Platform)

Agenda Item 4: ICAO / Member State / Industry Presentations

5G/RADIO ALTIMETERS ISSUE AND FREQUENCY INTERFERENCE – OUTCOMES FROM CNS SG/26 MEETING

(Presented by the Secretariat)

SUMMARY

This paper presents the discussion in the 26th Meeting of the Communications, Navigation and Surveillance Sub-group of APANPIRG (CNS SG/26) and its contributory bodies about 5G implementation and potential impacts on aircraft radio altimeters, as well as frequency interference issue in the region.

1. INTRODUCTION

1.1 The Twenty Sixth Meeting of the Communications, Navigation and Surveillance Sub-group (CNS SG/26) of APANPIRG was held from 5 to 9 September 2022 via video teleconference. The meeting was attended by 247 participants from 26 States/Administrations, 4 International Organizations and some industry partners. The CNS SG/26 working papers, information papers, and other resources can be accessed at https://www.icao.int/APAC/Meetings/Pages/2022-CNS-SG-26.aspx

1.2 A number of contributory bodies of APANPIRG have held their meetings listed below which contributed discussion outcomes to CNS SG/26, and webinars/workshops held to increase awareness and understanding on various topics for the Region to support their planning and implementation. All these activities were held via video teleconference:

No.	Meeting/Seminar/Workshop in 2022
1	CRV OG/9 (25-27 January)
2	SRWG/6 (1-3 March)
3	SURSG/2 (15-17 March)
4	PBNICG/9 (22-24 March - RSO)
5	Mode S Workshop (22 March)
6	DAPs WG/ (23-25 March)
7	CRV OG/10 (18 April)
8	ACSICG/9 (19-21 April)
9	GBAS/SBAS ITF/4 (11-12 May - RSO)
10	SWIM TF/6 (17-20 May)
11	SURICG/7 (24-27 May)
12	ATMAS Webinar (7 June)
13	ATMAS TF/3 (8-10 June)
14	CRV Webinar (29 June)
15	5G&RA webinar (23 August)

1.3 The outcome of CNS SG/25 regarding the potential interference to radio altimeters was presented to RASG-APAC/11 meeting through WP15 in November 2021. This paper is prepared to summarize the regional activities after CNS SG/25 and the recent developments on frequency interference that may be of interest to the safety group, with focus on the scope of CNS SG/26 meeting.

2. DISCUSSION

5G Interference to Aircraft Radio Altimeters

2.1 In SRWG/6, IATA and Thailand jointly presented the recent lessons learned concerning the deployment of 5G telecommunication networks and outlined recommendations to mitigate the potential risks to flight safety by 5G deployments. It also reviewed risk mitigation strategies and next steps for implementation. As a minimum, actions and regulatory measures need to be taken and put in place to safeguard the use of radio altimeters. Examples from States were noted on cooperating with 5G network providers about the provision of location information for their stations, as well as details of the transmission characteristics required. It cited that maintaining current safety levels for aircraft, passengers, and flight crews must be of the highest priority. States should ensure that every frequency allocation/assignment is comprehensively studied and is well proven not to adversely impact aviation safety and efficiency, and States must provide the necessary leadership and act as a fair facilitator to ensure open and positive information sharing between the two industries and national aviation and telecommunication regulators.

2.2 As such, the meeting was invited to review and acknowledge the safety concerns and potential operational impacts of 5G telecommunication system deployment to radio altimeter, to consider incorporating "C-Band mobile telecommunications interference impact on aviation operations" into the ToR of the SRWG, to request ICAO APAC office to consider issuing a State letter to States within the Asia/Pacific Region in a similar manner to the NACC letter; and to consider adopting actions taken by some States to mitigate 5G interference and suggest additional actions as necessary and appropriate. This paper also requested ANSPs and aviation safety regulators to brief relevant government and telecommunication regulatory/management agencies about the potential impact of 5G deployment on aviation safety, and propose necessary provisions for the spectrum auctioning/allotting process that will ensure the radio altimeter frequency is free from harmful interference at and around airports.

2.3 To address these proposals, the Secretariat introduced the original ToR of SRWG on studying necessary work for introducing 8.33kHz channel spacing and later included the topic of frequency spectrum planning. Due to the cross-domain and multi-facet nature of the issue involving frequency spectrum and flight safety, the ICAO recommended that the terms of reference of SRWG remain unchanged but the concern raised in this paper could be addressed through a dedicated Agenda Item for discussion in future meetings as the need arises. The meeting noted that ICAO HQ is preparing a State Letter or Electronic bulletin to be issued in 2022, hence APAC Region would not need to issue its own State Letter on the same subject. The Secretariat invited IATA to review and make improvements to existing Action Item to adequately address the concerns raised, and APAC States were informed *to take necessary follow-up action at the regional level, to support CAAs working with State's spectrum regulators to avoid future safety issues on radio altimeter due to 5G implementatio*n.

2.4 Considering the two RASG-APAC/11 Conclusion/Decision, i.e. **Conclusion RASG-APAC 11/3** and **Decision RASG-APAC 11/6** regarding *Potential Interference to Aircraft Radio Altimeter by 5G Telecommunications System* have already covered the scope of intended proposal, it would be a duplication of effort should the same issue be under APANPIRG that have already been addressed under RASG-APAC. The meeting was further informed that the issue has been communicated and brought for attention to the ITU Regional Radiocommunication Seminar 2020 for Asia & Pacific held on 28 October 2020, as well as to the Twenty-Sixth Meeting of the Regional

Interagency Working Group (IAWG) on Information and Communication Technology (ICT) held on 17 January 2022. The Secretariat reminded States/Administrations and industry to provide feedback to RASG-APAC and APANPIRG, and its sub-groups, on reports of interference from 5G networks as detailed in Decision RASG-APAC/11/6.

2.5 Eventually, this discussion led the effort to set up the APT-ICAO Webinar on 5G Implementation and Radio Altimeter, refer to paragraph 2.13.

Radio Altimeters and 5G Administration C-Band Deployment

2.6 United States presented a flimsy to SRWG/6 on the synopsis, intra-agency and industry coordination on the 5G deployment, and actions taken by Federal Aviation Administration (FAA) via Airworthiness Notices (AD), Alternative Methods of Compliance (AMOC) and NOTAMs. The FAA expressed that they believe the expansion of 5G C-band and aviation will safely co-exist. The FAA continues to work closely with the Federal Communications Commission (FCC) and wireless companies, and they are making progress toward safely implementing the 5G C-band expansion. They are confident with the ongoing collaboration we will reach this shared goal. The flimsy introduced relevant ADs issued, as well as the AMOC process which allows anyone to propose to the FAA an alternative method of compliance or a change in the compliance time, if the proposal provides an acceptable level of safety. NOTAMs will be maintained to identify locations with 5G C-band base station deployments. Further information could be referred to the FAA website https://www.faa.gov/5g.

Outcome of FSMP WG on Radio Altimeter Issues

2.7 SRWG/6 reviewed the outcome of the Thirteenth Working Group Meeting of the Frequency Spectrum Management Panel (FSMP-WG/13), held between 21-25 February 2022, on potential interference to Radio Altimeter from 5G for information and reference by the meeting.

2.8 The Report from correspondence group on radio altimeters (CG-RA) has been updated and presented regularly presented as information paper to FSMP WG meeting, which is the best overall fact-finding reference available today, the latest updated version of this report was presented as IP/08 to FSMP WG/15, which is available at: https://www.icao.int/safety/FSMP/Pages/default.aspx, and also provided in **Appendix A** to this paper for easy reference.

2.9 The Secretariat also suggested the RTCA Technical Webinar: *Interference Risk on Radar Altimeters from Planned 5G Telecommunication* as a good reference at http://www.youtube.com/watch?v=OpYhjK2MDqM.

Potential Impacts from 5G Implementation on Aircraft Radio Altimeters – Outcomes in Relevant Meetings and Regional Updates

2.10 To serve as a summary of discussion on the topic of 5G implementation and potential impacts on aircraft radio altimeters, this CNS SG/26 paper presented the discussion in APAC after CNS SG/25, and relevant regional updates, including Thirty-second Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/32), 11th Meeting of Regional Aviation Safety Group – Asia and Pacific (RASG-APAC/11), 13th and 14th Meetings of Frequency Spectrum Management Panel Working Group (FSMP WG/13 and FSMP WG/14) and certain discussions in other bodies.

5G Network within Airport Boundary

2.11 Malaysia presented to CNS SG/26 on the safety concerns and safety recommendations for 5G network within airport boundary in response to ICAO State Letter on Potential safety concerns regarding interference to radio altimeters. The proposal for 5G network in Malaysia, categorized as new equipment or technology to be introduced within the airport boundary, has triggered the change factor and therefore, an SMS tool used (Management of Change and Safety Assessment) shall be established to identify safety concern of 5G network on the safety of aircraft operations. The paper introduced their management of change process and the safety assessment outcome, which determined safety recommendations to be taken up by the installer prior 5G network can be made available within the airport boundary. The safety recommendations are to furnish Malaysia Airports Holding Berhad (MAHB) with a report from Malaysia Communication and Multimedia Commission (MCMC) confirming the 5G signal allowed in Malaysia have no interference to aircraft operations and surveyed drawing of the 5G network coverage encroach onto aircraft approach path and radio altimeter protected area. As for aerodrome operators, a safety circular issued to all airports alerting 5G network shall not be allowed to be installed within airport boundary and to refer to Safety Office, MAHB.

2.12 On further enquiry, Malaysia stated that their 5G implementation frequency band do not exceed the use of those frequencies of radio altimeter. The Secretariat supplemented that the 5G potential interference issue to radio altimeter depends on various factors, including the radio altimeter itself, installation of base station, and frequency bands used, which all contributed to the potential issue. In addition, Hong Kong China shared with the meeting their proactive work, which included formulation of a dedicated working group with the Hong Kong Civil Aviation Department, local telecommunication authority and local airport authority as members, who has been closely monitoring global development of this matter and the local situation. Although so far there has been no reported cases and no evidence that the local 5G base stations installed have caused interference to radio altimeters, the working group would continue their close coordination with the industry and local airlines to monitor the situation and ensure proactive measures are timely implemented to mitigate the possible interference from 5G to radio altimeters in Hong Kong China.

Outcomes of APT-ICAO Webinar on 5G Implementation and Radio Altimeter

2.13 Asia-Pacific Telecommunity (APT) is an intergovernmental organization established in February 1979 with the aim of promoting ICT development in the Asia-Pacific region. APT has 38 member administrations (“Member”), 4 administrations who are under the category of “Associate Members”, and 135 private companies and academia (“Affiliate Members”) whose works are relevant to ICT field.

2.14 As the only intergovernmental organization focusing on ICT field in the Asia-Pacific region, APT provides important platforms for ICT policy and regulatory coordination, and for consolidating regional voices for international fora such as Conferences of International Telecommunication Union (ITU). APT also organizes variety of capacity building programs related to ICT topics, and implements several pilot projects to promote ICT development in the region.

2.15 As a joint effort of international agencies, the APT-ICAO Webinar on 5G Implementation and Radio Altimeter (also known as *APT-ICAO Regional Dialogue: Radio Altimeters at 4200-4400 MHz band and implementation of 5G in adjacent bands*) was held on 23 August 2022 via Video Tele-Conferencing (VTC) on Zoom which was hosted on APT platform. The Webinar was intended to promote the common understanding among the spectrum regulators, the airlines and telecommunication industries on the operation of Radio Altimeters in the band 4.2 – 4.4 GHz and the implementation of 5G in the adjacent bands ensuring aviation safety in the Asia-Pacific region. The Webinar has registered with about **250** participants.

2.16 There were four topics presented by spectrum regulators (APT), aircraft manufacturers (Airbus), aviation (ICAO) and telecommunication industries (GSMA), covering the each-different viewpoints and concerns from these entities, potential mitigation measures and future roadmap of complete resolution of the issue of co-existence of 5G implementation and radio altimeters. The webinar was well received by the participants, noting that the event served as a platform to bring together the national spectrum regulators, telecommunications service providers, and the aviation community for direct engagement. Presentation slides are available on the ICAO Webinar website at https://www.icao.int/APAC/Meetings/Pages/2022-Webinar-on-5G-Implementation-and-Radio-Altimeter.aspx. The recording is accessible at https://youtu.be/c5sKrHc-wh8 .

ITU Circular Letter CR/488 on Prevention of Interference to GNSS

2.17 The ICAO Secretariat shared information about the Circular Letter CR/488 issued by the International Telecommunication Union (ITU) on prevention of interference to GNSS. With great concern about the increasing number and range of impact of such harmful interference on safety-of-life radiocommunication services used for the navigation of aircraft, the ITU issued the Circular Letter CR/488 with the subject *Prevention of harmful interference to Radio Navigation Satellite Service Receivers in the 1559 – 1610 MHz frequency band* on 8 July 2022. Consequently, the ICAO Regional Office issued the State Letter Ref.: T 8/5.10 : AP099/22 (CNS) dated 21 July 2022, Subject: *Prevention of harmful interference to Radio Navigation Satellite Service Receivers in the 1559 – 1610 MHz frequency band* to highlight the information with operators, service providers, and all stakeholders, sensitize the national radio regulatory Authority to the risk encountered by the civil aviation, and encourage States/Administrations to take actions to address this critical issue as appropriate. The State Letter AP099/22 is provided in **Appendix B** to this paper for easy reference.

Aeronautical Spectrum Utilization and Protection

2.18 The ICAO Secretariat presented a Discussion Paper DP/4/3 to the 57th Conference of Directors General of Civil Aviation (DGCA), Asia and Pacific Regions, which summarized the work required on Aeronautical Spectrum Utilization and Protection in the Asia and Pacific Regions by supporting the ICAO Position on the various agenda items to be addressed during the International Telecommunication Union (ITU) World Radiocommunication Conference in 2023 (WRC-23). The paper also discussed the need to enhance the regional coordination process on Aeronautical Spectrum, the necessary monitoring of 1090 MHz congestion and addresses the 5G and Radio Altimeter issue.

2.19 Aeronautical frequency interference or SSR interrogators with overlapping coverage operating on the same Interrogator Code (IC) are projecting operational risk to air transportation due to the lack of coordination before implementation. The ICAO APAC Regional Office acts as the only centralized portal for aeronautical frequency and IC coordination. In any case, ICAO holds the view that frequency and IC assignments that have been coordinated with ICAO have priority over those that have not been coordinated. The Discussion Paper is provided in **Appendix C** for easy reference.

2.20 The CNS Section of ICAO APAC Regional Office has received some interference coordination requests by States, including VHF Air to Ground voice communication, Satellite communication, but zero report on interference into radio altimeter from the Member States or IATA so far. As a reminder of established practice, Member States are encouraged to report events of interference on aeronautical spectrum relevant to international operation. In parallel, it was advised that Member States CAA and airworthiness office may collect all relevant information and past issues reported, if any, and inform RASG-APAC in case of any significant concern.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note with concern on the information in this paper and in the **Appendix A, Appendix B** and **Appendix C**;

b) report to the relevant contributory bodies of the ICAO RASG-APAC in a timely manner for events on frequency interference; and

c) discuss any relevant matter as appropriate.

— END —

International Civil Aviation Organization

FSMP-WG/15 IP/08
2022-08-17

INFORMATION PAPER

FREQUENCY SPECTRUM MANAGEMENT PANEL (FSMP)

Fifteenth Working Group meeting

Montreal (hybrid meeting), 22 Aug – 1 Sep 2022

Agenda Item 4a : National efforts to implement broadband mobile near 4200-4400 MHz - Report from correspondence group on radio altimeters (CG-RA)

The update of the CG-RA Report FSMP-WG/14 IP01 are highlited in yellow and in blue for those received during the FSMP

(Presented by Christian Fleury)

SUMMARY

In June 2020, ICAO secretary brought to the attention of FSMP members, a Liaison Statement informing ECC about the issue of potential interference to aeronautical Radio Altimeters operating in the frequency band 4200 - 4400 MHz, caused by IMT systems currently operating or planned to operate in the frequency band 3400 - 3800 MHz in Europe. This Liaison Statement explained that there is no specific limit of unwanted emissions from IMT base stations within the frequency band 4200-4400 MHz.
The recent RTCA Report SC-239 raised another risk from MFCN (5G in the band 3.7-3.98 GHz) into some radio altimeters.

This IP compiles all the information on the subject since the publication of the RTCA Report.

1. INTRODUCTION

The aim of this information paper is to give a "full" picture of the issue and provide some guidance examples that could minimise the impact on Radio-Altimeter for all stakeholders.

A presentation published by Honeywell provides an overview of operation, design, and performance of Radar Altimeters.[1]

1.1 History

1.1.1 WRC15

Aviation used the analyses contained in working papers 14[2] & 17[3] to the 29th meeting of the Aeronautical Communication Panel, Working Group-F to help defend against late proposals to implement IMT in frequency bands near 4000-4200 MHz in response to WRC-15 agenda item 1.1. After that successful effort, aviation recognized the need for additional information on radio altimeters, and a job card[4] was instituted for FSMP to develop minimal SARPS for those systems, including receiver selectivity limits. Data was collected under the auspices of the WAIC standardization work that would form the basis for those altimeter SARPS. Results were briefed to FSMP starting in January 2019.

1.1.2 February 2020

The United States Federal Communications Commission (FCC) approvals a final Report and Order allocating 3.7-3.98 GHz to 'Flexible Use Licensees' that will include 5G services.[5] This includes limits of up to 85 dBm EIRP from 5G towers and with minimal restrictions on antenna placement or their respective beams with respect to aircraft.[6] The FCC decision concluded the power and emission limits set for the 3.7 GHz Service and the spectral separation of 220 megahertz should offer all due protection to services in the 4.2-4.4 GHz band. However, it did agree that further analysis is warranted on why there may even be a potential for some interference given the measure it had put in place and encouraged an industry multi-stakeholder group to assess the issue. The FCC also expected the aviation industry to take account of the RF environment that is evolving below the 3980 MHz band edge starting in Dec 2021 and take appropriate action, if necessary, to ensure protection of such devices. Under this direction, RTCA SC-239 took the initiative formed a multi-stakeholder group to do the analysis.[7]

1.1.3 June 2020

ICAO secretary brought to the attention of FSMP members, a Liaison Statement informing ECC[8] about the issue of potential interference to aeronautical Radio Altimeters operating in the frequency band 4200 - 4400 MHz, caused by IMT systems currently operating or planned to operate in the frequency band 3400 - 3800

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[1] https://avsi.aero/wp-content/uploads/2021/12/Radar-Altimeter-Overview-of-Design-and-Performance.pdf
[2] https://www.icao.int/safety/acp/ACPWGF/ACP-WG-F-30/ACP-WGF30-WP14%20Radio%20Altimeter%20Adjacent%20Bands%20Compatibility%20Study%20with%20IMT-FINAL%20Rev1.docx
[3] https://www.icao.int/safety/acp/ACPWGF/ACP-WG-F-30/ACP-WGF30-WP17_radio%20altimeter%20analysis.doc
[4] https://www.icao.int/safety/FSMP/Documents/Job%20Cards/FSMP_JobCard.07.01.pdf
[5] https://www.fcc.gov/ecfs/filing/0303046335999, paragraphs 390-395, dated 28 Feb 2020
[6] The FCC does have generic limits on tower and antenna placement in its CFR 14 - Part 17 rules that apply to all services.
[7] https://www.fcc.gov/ecfs/filing/104202099224796, dated 20 Apr 2020
[8] https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG10/WP/FSMP-WG10-WP13-Annex%202%20-%20ECC_PT1_66th_meeting%20-%20ICAO%20Input%20on%20Radioaltimeters%20vs%205G.docx

MHz in Europe. This Liaison Statement mainly focused on the fact that there is no specific limit of unwanted emissions from IMT base stations within the frequency band 4200-4400 MHz.

1.1.4 October 2020

RTCA published Report SC-239[9] on the "Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations" highlighted the following issues with the operation of mobile/fixed communications network using 5G technology in the frequency band 3.7-3.98 GHz.[10]

- That "*5G base stations present a risk of harmful interference to radar altimeters across all aircraft types, with far-reaching consequences and impacts to aviation operations*"
- That fundamental emission (3,7 - 3.98 GHz signals) from 5G Base Station using active antenna systems could cause harmful interference to Usage Category 1 (Commercial Air transport Aircraft) in certain circumstances. Noting that fundamental emission creates effects on Radio-Altimeter like blocking, saturation, intermodulation....
- For Usage category 2 (Regional Business Aviation and General Aviation) and Usage Category 3 (Helicopter) every 5G base station configuration will result in harmful interference, from both fundamental and spurious emissions, being present in virtually all operating scenarios and geometries
- That 5G User Equipment (UE) operating on the ground are not expected to cause harmful interference to radio altimeters
- That 5G UE operating on board Usage Category 2 & 3aircraft could cause harmful interference to radar altimeters.

1.1.5 November 2020

In France, 5G was authorised and the first base stations were activated. Considering the RTCA SC-239 report, France has taken immediate action[11] to mitigate possible interference with radio altimeters.

1.1.6 Documents published on the subject in 2021

1.1.6.1 CEPT ECC-PT1

ECC PT1 #67 January 2021 ECC

There were 3 contributions on the subject:

Airbus ECC PT1(21)022[12] The airframer wanted to make the PT1 aware of the radio altimeter issue, of the existence of the RTCA report SC-239 and of the planned tests.

[9] https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report_274-20-PMC-2073_accepted_changes.pdf

[10] US 5G operators and manufacturers were openly invited to participate in the group, but voluntarily withdraw after the first few meetings without explanation. 5G parameters were instead provided via another forum that allowed for some data exchange on 5G and radar altimeter parameters (see RTCA report Appendix B - TWG-3 Information Exchange). Representatives of 5G operators did provide feedback to the final draft report during the public comment process and disagreed with the conclusions made (see RTCA report Appendix C – Public Comments), but were unable to provide any technical information to support their opinion. However, they did provide a correction to the 5G base station parameters they had originally provided (see RTCA report Appendix D – Additional Analysis).

[11] https://portal.icao.int/FMG/Documents/FMG%20CM%202021%20-%20RAFT19/FMGCM2021%20RAFT19%20IP07.pdf

[12] https://cept.org/Documents/ecc-pt1/62425/ecc-pt1-21-022_airbus-radio-altimeters-interference-from-5gmfcn-in-34-38-ghz

France ECC PT1(21)006 [13]Protection of radio altimeters from MFCN in 3.4-3.8 GHz.

France invites ECC/PT1 to study, as a matter of urgency and taking into account the safety aspect, the risk of interference from 5G in the 3.5 GHz band into radio altimeters. France also presented immediate measures for the protection of radio altimeters .

Bouygues Telecom, Orange ECC PT1(21)027[14]

C-band 5G networks have been deployed in different parts of the world, and there was no interference case reported. The source of problem suggested by the RTCA report was Radio-Altimeter receiver out of band blocking (…) There is no evidence this RTCA report represents the real situation in Europe or elsewhere (…) If some Radio-Altimeter models have receiver blocking problems, a replacement or repair plan must be set up as an urgent matter.

PT1 agreed on a new work Item (PT1_40[15]): "Compatibility between MFCN operating in frequency band 3400-3800 MHz and Radio Altimeters operating in the frequency band 4200-4400 MHz"
The scope of this work item is the following: *Assessment of susceptibility of deployed receivers operating in 4200-4400 MHz, while taking into account any civil aviation initiatives on Radio-Altimeter receivers, in order to study the following compatibility scenarios:*

1) *Unwanted emissions from MFCN operating in 3400-3800 MHz into 4200-4400 MHz radio altimeters band*
2) *Impact of blocking of radio altimeters from 3400-3800 MHz MFCN in-band emissions*

ECC PT1 #68 April 2021 - There were 3 contributions on the subject:

GSA ECC PT1(21)122 [16]MFCN characteristics for WI on Radio Altimeters. *GSA invites ECC PT1 to take the MFCN characteristics (as in Annex) into account for the studies of radio altimeters while noting that final information will be provided for the September meeting of ECC PT1.*

France ECC PT1(21)117 [17]WI 5G radio altimeters. *France invites ECC PT1 to consider the attached draft skeleton for an ECC report on "Compatibility between MFCN operating in 3400-3800 MHz and Radio Altimeters (RA) operating in 4200-4400 MHz*". This proposal was accepted by ECC PT1.

Eurocontrol ECC PT1(21)115 [18]EUROCONTROL ICAO State Letter on Potential safety concerns regarding interference to radio altimeters. *Eurocontrol invites Administration to consider as a priority, public and aviation safety when deciding how to enable MFCN (5G) services in radio frequency bands near the bands used by radio altimeters.*

ECC PT1 #69 September 2021 - There were 3 contributions on the subject:

[13] https://cept.org/Documents/ecc-pt1/62166/ecc-pt1-21-006_france-protection-of-radio-altimeters-from-mfcn-in-34-38-ghz
[14] https://cept.org/Documents/ecc-pt1/62432/ecc-pt1-21-027_bouygues-telecom-orange-mfcn-and-radio-altimeters-co-existence
[15] http://eccwp.cept.org/WI_Detail.aspx?wiid=775
[16] https://cept.org/Documents/ecc-pt1/64077/ecc-pt1-21-122_gsa-mfcn-characteristics-for-wi-on-radio-altimeters
[17] https://cept.org/Documents/ecc-pt1/64066/ecc-pt1-21-117_france-wi-5g-radioaltimeters
[18] https://cept.org/Documents/ecc-pt1/64064/ecc-pt1-21-115_eurocontrol-icao-state-letter-on-potential-safety-concerns-regarding-interference-to-radio-altimeters

France ECC PT1(21)192 [19]*Outcome from preliminary trial on one type of radio altimeter fitted on helicopter.*

GSA ECC PT1(21)188 [20]*MFCN characteristics for WI on Radio Altimeters* .

Norway ECC PT1(21)184[21] - *Results of the preliminary test of compatibility between MFCN operating in 3400-3800 MHz and Radio Altimeters operating in 4200-4400 MHz.*

ECC PT1 #70 January 2022 - There were 7 contributions on the subject:

EUROCAE and RTCA ECC PT1(22)017 LS response to ECC on radio altimeters parameters.

EASA and Eurocontrol ECC PT1(22)020 Input to ECC Report on MFCN-RA compatibility

France ECC PT1(22)041 ECC Report on Compatibility between MFCN operating in 3400-3800 MHz and Radio Altimeters (RA) operating in 4200-4400 MHz.

France ECC PT1(22)048 Preliminary outcome of second de-risking trial on the second type of radio altimeter fitted on helicopter of the French gendarmerie.

GSA ECC PT1(22)058 Comments on altimeter characteristics for coexistence

FAA ECC PT1(22)INFO01 request for radio altimeter parameters

ECC ECC PT1(22)INFO02 LS to aviation bodies and DGs of Commission

Two virtual meetings were held for the PT_CG_Radio_Altimeters_4.2-4.4GHz on March 23 and April 13, 2022. Discussions focused on the aviation community's response to questions from the Mobile community.

For the short term, the main questions from the Mobile community were on the Worst-Case Landing Scenario and the loop loss. For the Worst-Case Landing Scenario aviation explained that it is a real operational case (Go Around or Missed APproach) and that it is a negligible factor for Usage category 1 (UC 1). For the loop loss aviation recommended wireless to study the paper from Honeywell on the topic to better understand how a radar loop loss is built. Discussion on the UC1, 2, 3. Mobile community questioned the relevancy of those Usage Categorization because there are various RF performance amongst this categorization.
For the long term, RTCA/EUROCAE presented the top down plan for the delivery of the "DO/ED Technical standard on RF Environment for RA" which consists for the RADALT manufacturers to define the maximum tolerable RF performance and then to infer some examples of compatibility with current 5G deployment.
Mobile community has still not communicated the elements requested by the Aeronautical community

[19] https://cept.org/Documents/ecc-pt1/65970/ecc-pt1-21-192_france-radioaltimeter
[20] https://cept.org/Documents/ecc-pt1/65959/ecc-pt1-21-188_gsa-mfcn-characteristics-for-wi-on-radio-altimeters
[21] https://cept.org/Documents/ecc-pt1/65941/ecc-pt1-21-184_norway-results-of-the-preliminary-test-of-compatibility-between-mfcn-operating-in-3400-3800-mhz-and-radio-altimeters-operating-in-4200-4400-mhz

58th ECC Plenary - 28 February-04 March

The 58th ECC Plenary meeting updated the scope of work item PT1_40 with an additional task: “provide relevant long-term MFCN operational parameters for the development of the future MOPS for radio altimeters”.

ECC ECC(22)023 Annex 18 Update of PT1 Work Item 5G-RA

ECC PT1 #71 May 2022 Hybrid Copenhagen

The group attempted to discuss relevant long term MFCN parameters for the development of the updated MOPS for Radio Altimeters (RA). It was further clarified that RTCA/EUROCAE is attempting to design a new radio altimeter system that will be operational for more than 30 years. To do that RTCA/EUROCAE will need some detailed parameters on all future MFCN, including maximum power, network loading limits, base station uptilt, waveforms, etc. However, if RTCA/EUROCAE considers that this is not possible to obtain then RTCA/EUROCAE are looking to specify the new RA system based on its best effort of rejecting signal from systems operating in the adjacent bands (about 1 GHz on either side of the RA operational frequency band) while still maintaining the core RA functions.
The need for an effective cooperation between ECC PT1 and RTCA was highlighted during the meeting and several administrations indicated that the work on the MFCN parameters is important and should be continued and be taken into account in MOPS work.
The group was informed that development and update of MOPS includes a public consultation phase which is open for public.
Finally, the group invited RTCA/EUROCAE to participate in future ECC PT1 meetings and kindly requests to present the generic MOPS development process in detail.

CG Radio Altimeters ECC PT1(22)098r3 Progress report.

France ECC PT1(22)104 Estimation of the potential interference from an aerial UE (user equipment/drone) to Radio Altimeter.

ICAO ECC PT1(22)107 Recs and info from ICAO on work and references for interference assessments against radar altimeters

Norway ECC PT1(22)108 Outcome from trials on impact of 5G NR BS in 3.6 GHz band on radar altimeters on helicopter.

GSA ECC PT1(22)115 Method of working in PT1 for updated MOPS for Radio Altimeters.

Eurocontrol ECC PT1(22)117 - Technical Characteristics of a typical State Aircraft Radio Altimeter.

ECC ECC PT1(22)077 LS to Aviation bodies

ECC ECC PT1(22)078 Update of PT1 Work Item 5G-RA

ECC PT1(22)151_Annex VIII-22 ToR CG on radio altimeters

ECC PT1(22)151_Annex VIII-20 Working doc for draft ECC Report on Radio altimeters

ECC PT1(22)151_Annex VIII-21 Working doc on RA parameters

SWG C 14 draft new ECC Report on Radio altimeters

SWG C 15 working doc on RA parameters

SWG C 22 DG progress report (RA)

ECC PT1 XO web meeting - 17 June 2022 - Radio Altimeters

Extremely divergent views meant that ECC PT1 was unable to resolve these differences despite extending the meeting for an hour beyond the allotted time.
The main diverging view are

- On the one hand, some participants wanted the text to indicate that the higher base station power levels may imply specific additional restrictions on base station operation, and the following examples were proposed: operational restriction in scanning angle, main beam steering above the horizon, which could be applied in specific areas, for example airport runways and helipads. On the other hand, some other participants were of the view that it was too early at this stage to be suggesting in an external liaison statement measures that might (or might not) be imposed on MFCN, when the studies had not yet determined whether or not there would be a coexistence issue.
- Separately, while some participants wanted to provide specific values for current typical or maximum base station power levels, some other participants wanted to avoid locking in today's power levels in case equipment developments and evolving deployment requirements led to a need to use higher power levels in the future, noting that the MOPS could apply to altimeters in use for the next 30 years.
- There was a comment that it is unhelpful to specify a transmit power in 40-100 MHz bandwidth: if it is in 40 MHz bandwidth the spectrum power density would be 2½ times the same transmit power in 100 MHz bandwidth.

The ECC PT1 Chair expressed his regrets that he had not been able to facilitate a conclusion on the draft liaison statement and the proposals for modification received in input contributions

ECC PT1 Chair ECC PT1(22)156 Compilation of inputs on radio altimeters

GSA ECC PT1(22)153 Relevant long term MFCN operational parameters

Sweden ECC PT1(22)155 Long-term MFCN parameters for the MOPS update

France ECC PT1(22)154 long term MFCN operational parameters

CG Radio Altimeters ECC PT1(22)152 Long-term MFCN parameters for the MOPS update

ECC PT1 ECC PT1(22)158_Annex 1 Draft text proposed for LS on radio altimeters to RTCA/Eurocae.

59th ECC Plenary - 28 June-01 July – Hybrid

The ECC PT1 Chair presented text for ECC to consider for inclusion in a liaison statement to the RTCA and EUROCAE Joint Working Group which is developing minimum operational performance specifications (MOPS) for radio altimeters (ECC(22)036 Annex 13). The liaison statement would include factual information on the base station power levels for current deployments in some CEPT countries and to mention that higher power levels were possible in the future but ECC decided not to suggest a possible upper limit on base station power.

GSA ECC(22)037 MFCN IMT parameters wrt development of MOPS for Radio Altimeters

PT1 ECC(22)036Annex13 Draft text considered for LS on radio altimeters

ECC TEMP 19R1 Draft LS to EASA

ECC TEMP 18R1 Draft LS to RTCA and EUROCAE

1.1.7 ICAO

1.1.7.1 ICAO FSMP

1.1.7.2 FSMP WG11 – March 2021

There were 3 contributions on the subject

- FSMP-WG11-WP27_Mobile vs Radalt REv.1 UK Deployment of Mobile Systems in the Frequency Range 3.6-4.2 GHz and the Theoretical Impact on Radio Altimeters
- FSMP-WG11-WP30_5G Japan: The compatibility study between 5G base stations and radio altimeters in Japan and update of the result of measurement campaign.
- FSMP-WG11-WP19 ICCAIA Working Paper on radio altimeters to Encourage ICAO and Panel Member Participation in Country Regulatory Activities that Could Cause Interference to Radio Altimeters
- Elements for a proposed State Letter on possible interference to radio altimeters were drafted (see Section 2.2)

1.1.7.3 FSMP WG12 – October 2021

There were several contributions on the subject

- FSMP-WG12-WP17_ICCAIA_5GLRRA Input ICCAIA presents "*an updates on Industry Assessment of 5G Cellular Compatibility with Radio Altimeters*» and asks to provide feedback for a new update.

- FSMP-WG12-IP05_Status on replanning the 3700–4200 MHz band in Australia. Australia presents the current status of activity in Australia to address the potential impact of deployment of wireless broadband services in the 3.4-4.0 GHz band on Aviation safety.
- FSMP-WG12-IP07_Interference Susceptibility Evaluations of Pulsed Radio Altimeters Due to 5G Mobile Base Station Signal_rev1 Enri (JAPAN) presents laboratory tests on "*Interference Susceptibility Evaluations of Pulsed Radio Altimeters Due to 5G Mobile Base Station Signal*" on two Honeywell RT300
- FSMP-WG12-IP12 - Brazil 5G Auction provides information on 5G auction in Brazil and technical parameters.

1.1.7.4 ICAO High Level Conference On COVID-19 (HLCC 2021)

One WP30[22] co-signed by Air Transport Association (IATA), the International Business Aviation Council (IBAC), the International Coordinating Council of Aerospace Industries Associations (ICCAIA), the International Federation of Air Line Pilots' Associations (IFALPA) and RTCA was presented on "Safety concerns regarding interference to aircraft radio altimeters". This Working Paper asked that States *mitigate the risk of 5G implementation to safety-critical radio altimeter functions.*

The HLCC agreed to the following Recommendation.

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.

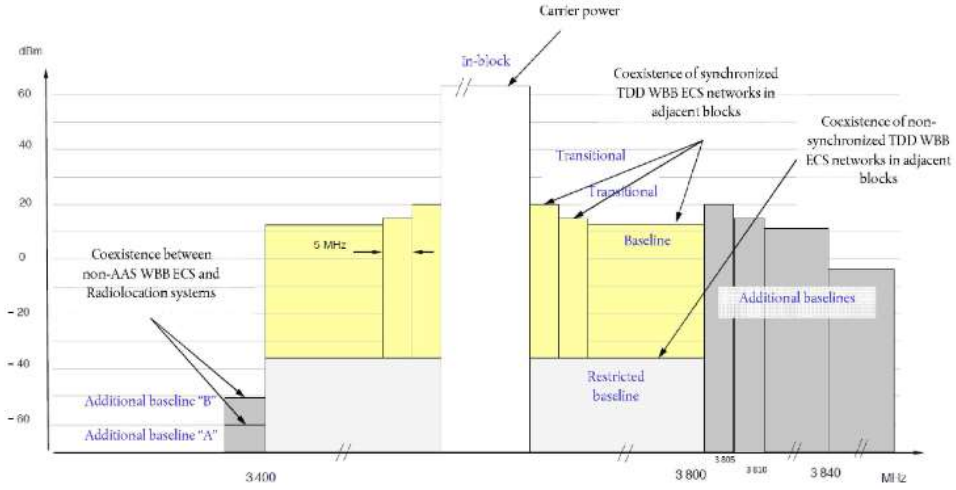
1.2 Information and Frequencies bands used for 5G around 4.2-4.4GHz worldwide.

1.2.1 European Union law

Commission Implementing Decision (EU) 2019/235[23] of 24 January 2019 on amending Decision 2008/411/EC as regards an update of relevant technical conditions applicable to the 3400-3800 MHz frequency band.

[22] https://www.icao.int/Meetings/HLCC2021/Documents/WP/EN/SAF/wp_030_en.pdf
[23] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019D0235

Example of base station BEM elements and power limits



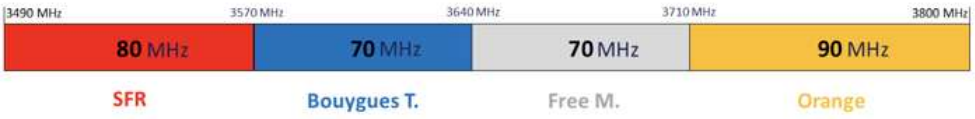
Definition of Block Edge Mask (BEM) elements

BEM element	Definition
In-block	Refers to a block for which the BEM is derived.
Baseline	Spectrum within 3 400-3 800 MHz used for WBB ECS, with the exception of the block assigned to the operator and the corresponding transitional regions.
Transitional region	Spectrum within 0 to 10 MHz below and 0 to 10 MHz above the block assigned to the operator. Transitional regions do not apply to TDD blocks assigned to other operators, unless networks are synchronised. The transitional regions do not apply below 3 400 MHz or above 3 800 MHz.
Additional baseline	Spectrum below 3 400 MHz and above 3 800 MHz.
Restricted baseline	Spectrum used for WBB ECS by networks unsynchronised or semi-synchronised with the operator's block in question.

No Power limitation In-block assigned to the operator for non-AAS and AAS base stations

1.2.2 France

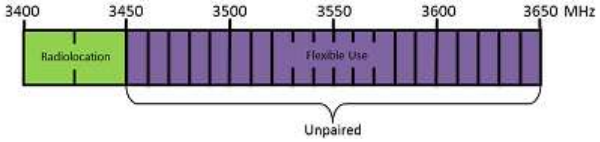
The power spectral density (PSD) of the base stations varies according to the operators between 62.44dBm/5MHz to 67.34 dBm/5MHz.



[24]

1.2.3 Canada

This figure bellow shows the 3500 MHz band deployment in Canada as of Dec 2021, which includes the frequency range of 3400 to 3650 MHz. The frequency range of 3400 to 3450 MHz is allocated for radiolocation. The frequency range of 3450 to 3650 MHz is divided into 20 unpaired blocks of 10 MHz each and allocated for fixed and mobile (flexible use).



[24] https://www.arcep.fr/la-regulation/grands-dossiers-reseaux-mobiles/la-5g/frequences-5g-procedure-dattribution-de-la-bande-34-38-ghz-en-metropole.html

1.2.4 USA

The USA has allocated 3.7-3.98 GHz to services including 5G in Feb 2020 in 20 MHz license blocks that can be aggregated by the same operator up to 100 MHz. The FCC limited the power to 65 dBm/MHz maximum EIRP for rural areas, and 62 dBm/MHz in urban areas, though no limits were placed on antenna positioning or direction. 5G operators won the subsequent auction in Dec 2020 for over $80 bn USD with additional money going to the SATCOM operators fund satellite migration and ground station filtering. Given the need to migrate existing SATCOM users over time, the first 100 MHZ (3.7-3.8 GHz) was planned for implementation in Dec 2021, and the remaining 3.80-3.98 GHz in Dec 2023. Licensees are also only in certain Partial Economic Areas (PEAs) in the US, not nationwide.

1.3 Worldwide actions

1.3.1 Japan

At the last FSMP, Japan presented measures for the deployment of 5G base stations around runway. These measures were put in place a long time before the French mitigation measures were implemented. Both measures are similar.
Apart from the fact that Japan uses a different frequency band than Europe (closer to the radio altimeter frequency band), in time when Japan implemented these mitigation measures, AAS antennas were not allowed. The maximum EIRP (macro cells 68dBm or small cells 48dBm) was therefore much lower than EIRP (with AAS antennas) allowed in Europe and in the U.S. For these reasons, Japan requires smaller separation distances while being closer to the radio altimeter frequency band.

1.3.2 New Zealand

In November 17th 2020, CAA published a safety message that require to "Do not use 5G devices inflight if you have a radar altimeter".

1.3.3 United Arab Emirate

United Arab Emirate also published a Safety Alert[25] at the attention of United Arab Emirate Aircraft Operator, informing them about the likelihood of 5G interferences on aircraft system. This safety alert also recommends to monitor and report any 5G interference events.

1.3.4 France

France published a Safety info leaflet[26] while mitigation measures are still in place around Airports where ILS CAT III are implemented.
Extensive tests were planned but the mobile operator involved left the table after few weeks of preparation. This test is still on hold.
France conducted and provided the preliminary outcome of de-risking trials, performed by test pilots, on two type of radio altimeter one fitted on an AS350 helicopter of the French gendarmerie. (ECC PT1(22)048) and another fitted on an EC 135 helicopter also of French gendarmerie (ECC PT1(21)192). It has been observed

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[25] https://www.gcaa.gov.ae/en/epublication/admin/Library%20Pdf/Safety%20Alerts/SAFETY%20ALERT%202021-03%20-%20REQUIREMENTS%20TO%20MITIGATE%205G%20INTERFERENCE%20OPERATIONAL%20RISKS%20-%20ISSUE%2001.pdf
[26] https://www.ecologie.gouv.fr/sites/default/files/Safety_Info_Leaflet_2021_01_5G_interferences.pdf

that there was no unexpected behaviour of the type of radio altimeters fitted onboard helicopters of the French gendarmerie during the retained trial, which gives reasonable level of confidence on the resilience of these type of radio altimeters.
This two de-risking trials on radio altimeters embedded on helicopters of the French gendarmerie lead France to consider that all the different types of radio altimeters used by helicopters of the French gendarmerie and civil protection in France are now covered where the emissions characteristics of 5G base stations are similar. Indeed, the tests were performed with a base station whose 5G antenna tilt was negative. Therefore, although the tests provide a representative scenario, the absence of unexpected behaviour cannot alone guarantee that the radio altimeter will remain free from harmful interference from 5G NR emissions in all configurations.
It has also to be noted that, subject to confirmation by the radio altimeter manufacturers, the two types of radio altimeters fitting helicopters of the French gendarmerie are in conformity with the blocking level of Usage Category -1 radio altimeters as assumed in the RTCA report. Therefore, the results of these trials cannot be used to address the cases of other type of radio altimeters much more sensitive to interferences and which have been considered under the Usage Category -3 of the RTCA report.
Additional trials may be envisaged with other types of radio altimeters.
.
France also started consultation with mobile operator in order to define the roadmap of 5G in order to have the deployment perspective of 5G in order to have baseline for future MOPS for radio altimeter offering resilience to IMT 5G and other applications. Indeed, France considers that it is the highest priority task to conduct in close cooperation with all the stakeholders within ECC PT1.

The “Fédération Française des Télécom » and members have written to the Prime Minister to complain about the severe and unprecedented constraints imposed on the use of frequencies in the 3.4-3.8Ghz frequency band. According to this letter, although the US had put in place similar restrictions to France at the end of 2021, a new agreement has been reached to remove these restrictions by July 2023, while the Radio Altimeters on aircraft flying in the US are retrofitted. The “Fédération Française des Télécom” is asking that a similar timetable be put in place to remove all current restrictions. A regional aircraft manufacturer told me that they were working on the addition of a filter but that the work had been delayed and that the certification program had not yet been sent to EASA. The date of July 2023 is therefore illusory.

1.3.5 Australia

The Australian spectrum regulator (the ACMA) has formed a technical liaison group (TLG) to review/develop spectrum and apparatus licence technical frameworks for the 3400-4000 MHz band. Public consultation on the proposed rules that are informed by the TLG are expected in March / April 2022. The Australian Civil Aviation Safety Authority (CASA) published an Airworthiness Bulletin[27] asking to report any Radio-Altimeter interference that occurs below 2500 feet.
In late December 2021 CASA issued an exclusion from the Operation of Airworthiness Directives FAA AD 2021-23-12 and FAA AD 2021-23-13. This Exclusion applies to any Australian registered aircraft when it as operated outside the airspace of the United States of America.

In March 2022 the ACMA opened two consultations for proposals that cover the band of interest.
IFC 10/2022 - Proposed spectrum re-allocation declaration for the 3.4 GHz and 3.7 GHz bands:
IFC 10/2022 has no proposed restrictions or controls to protect radio-altimeters.

IFC 11/2022 - Allocation of AWLs in the 3.4–4.0 GHz band in remote Australia - IFC 11/2022:

[27] https://www.casa.gov.au/search-centre/airworthiness-bulletins/potential-5g-interference-radio-altimeter-systems

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Deleted: https://www.casa.gov.au/files/awb-34-020-issue-3-potential-interference-radio-altimeter-systems

IFC 11/2022 includes proposals for compatibility with radio-altimeters when the transmitter is operating above 3700 MHz. This proposal is an option only and is square bracketed in the draft RALI (Radiocommunications Assignment and Licensing Instruction). The proposals for compatibility include an "exclusion zone" defined as 910 metres laterally either side of a runway edge of an identified runway and 2100 metres beyond the runway thresholds; and a restricted zone defined, the same width as the exclusion zone, but extending another 2100m beyond the ends of the exclusion zone.
The proposal also restricts transmitters where:

- The transmitter is located in an exclusion zone.
- The transmitter is located in a restricted zone, is a non-AAS transmitter and its peak EIRP is more than 41 dBm/MHz.
- The transmitter is located in a restricted zone, is a non-AAS transmitter and is not operating its antenna system/s at a negative angle with reference to the horizon.
- The transmitter is located in a restricted zone, is a non-AAS transmitter and its peak total EIRP of unwanted emissions is more than -3 dBm/MHz in the 4200-4400 MHz range.
- The transmitter is located in a restricted zone, is a AAS transmitter and its peak EIRP is more than 58 dBm/MHz.
- The transmitter is located in a restricted zone, is a AAS transmitter and is directing its highest gain above the horizontal plane when forming beams.
- The transmitter exceeds a PFD of -16 dBm/m2/MHz on the primary surface of a helipad associated with an identified heliport.
- The transmitter is not located in an exclusion or restricted zone, is a non-AAS transmitter and its peak EIRP is more than 53 dBm/MHz.
- The transmitter is not located in an exclusion or restricted zone, is a AAS transmitter and its peak EIRP is more than 62 dBm/MHz.

1.3.6 Canada

Innovation, Science and Economic Development Canada (ISED) is the spectrum regulator in Canada. ISED allows Flexible Use networks and technology (including 5G) in the frequency band 3450-3650 MHz (auctioned in June 2021 and deployed in Dec 2021) and has decided to allow Flexible Use wireless systems to operate in the frequency band 3650-3980 MHz starting in 2023.

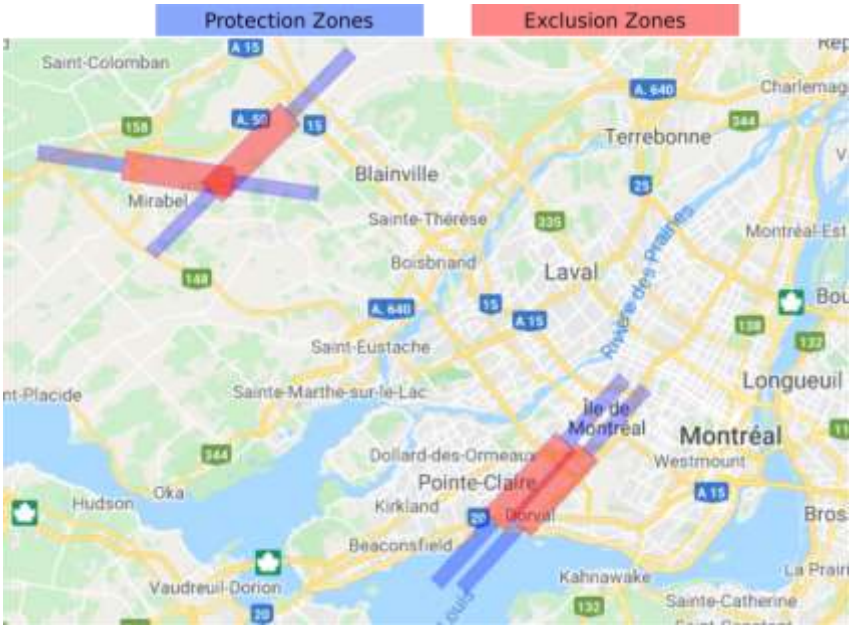
Transport Canada Civil Aviation (TCCA) has published a Civil Aviation Safety Alert[28] (CASA) (2021-08) Potential Risk of Interference of 5G Signals on Radio Altimeters (June 2021 and Dec 2021) to raise awareness of the potential risk of 5G interference worldwide and to recommend precautionary operational measures before confirmation of the impact of 5G to Radio Altimeters. It also recommends switching off all 5G passenger/flight crew devices and in case of interference, to report the event to the Air Traffic Service as soon as possible and to file a Radio Altimeter disturbance/interference report on a provided form.

In August 2021, ISED consulted the telecom and aviation industry on the interim technical mitigations to protect Radio Altimeters from 5G interference in the 3450-3650 MHz band. On Nov 18th, ISED established temporary restrictions to 5G based on available information and mitigations taken in France and Japan. ISED protection measures include:

- exclusion and protection zones to mitigate interference to aircraft around certain airport runways where automated landing is authorized

[28] https://tc.canada.ca/en/aviation/reference-centre/civil-aviation-safety-alerts/potential-risk-interference-5g-signals-radio-altimeter-civil-aviation-safety-alert-casa-no-2021-08

- a national antenna down-tilt requirement to protect aircraft used in low altitude military operations, search and rescue operations and medical evacuations all over the country.
- Outdoor non-AAS and AAS fixed point-to-point and multipoint stations with a positive angle with reference to the horizon with limiting power.
- Airborne operations (e.g. drones) are not permitted in the 3450-3650 MHz band.
- Active antenna system (AAS), Non time division duplexing (TDD) systems, fixed point-point stations restriction.
- Frequency divided into 20 unpaired blocks of 10 MHz each.
- Maximum power is 68 dBm/5 MHz up to 305 metres and 61 dBm/MHz for channel bandwidth less than 5 MHz. Antenna above 305 m need to calculate the maximum power emission



Montreal example

1.3.7 Thailand

CAA Thailand issue the document "Continued Airworthiness Notification" to Thailand's Aircraft Operators to provide recommendations on the issue. The document could be found in the attachment or could be reached by this address with reference number CAAT-CAN-2021-02[29]

CAA Thailand issue an official letter to NBTC-Thailand's Spectrum Regulator to raise their awareness on the potential interference from 5G to Radio altimeter issue. As of now, Thailand is in the auction process on the C-band spectrum (3 400 - 3 700 MHz) while still have a discussion of the suitable guard band between IMT and FSS.

1.3.8 Sultanate of Oman

Sultanate of Oman published an Aeronautical Information Circular (AIC)[30]. The purpose of this Civil Aviation Safety Alert is to raise awareness of the potential risk of 5G interference and to recommend precautionary operational measures before confirmation of impact of 5G radio waves on radio altimeters.

1.3.9 Czech Republic

November 2021, Czech Republic in their Safety Brief[31] inform that "Prague Airport respects the safety zones and precaution zones specified by the French Civil Aviation Authority DGAC and keeps them free of any 5G transmitters. And kindly asked to the pilots to report any radio altimeter issues.

1.3.10 USA

The United States Federal Aviation Administration (FAA) on 23 December 2021 issued a Special Airworthiness Information Bulletin (SAIB) on the Risk of Potential Adverse Effects on Radio Altimeters and also two Airworthiness Directives (ADs): Airworthiness Directive on altimeter interference and airplanes, and an Airworthiness Directive on altimeter interference and helicopters. The FAA has also facilitated data sharing between avionics manufacturers and wireless companies, and recent dialogue has helped to establish information sharing between aviation and telecommunications sectors and newly agreed measures to reduce the risk of disruption, but these issues are ongoing and will not be resolved overnight.[32]

2. DISCUSSION

The problem of radio altimeters is not specific to 5G but rather to high field susceptibility. We can take the example given by ATR in its presentation to the FSMP[33]. But of course, since 5G is being deployed massively and globally around the radio altimeter frequency band 4.2-4.4 GHz, it makes 5G the main part of the problem.

The mid-band frequencies ranges discussed here have become central to 5G operators plans to rollout new technologies, balancing capacity and coverage. The priority the 5G operators place in this spectrum range is reflected by the multiple billions offered in different national auctions. This is contrasted by radar altimeters

[29] https://www.caat.or.th/en/archives/56597
[30] https://www.caa.gov.om/upload/files/AIC%2004-21.pdf
[31] https://www.prg.aero/sites/default/files/obsah/O-letisti/O%20spole%C4%8Dnosti/Bezpecnost%20na%20letisti/Safety/Safety%20Brief/SAFETY%20BRIEF%20LKPR%2093%20Interference%20of%205G%20networks%20with%20radio%20altimeters.pdf
[32] https://www.faa.gov/5g
[33] https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG11/IP/FSMP-WG11-IP06_RA_interference.pdf

being a highly sensitive system, needed to achieve the necessary performance and accuracy, reacting to a dramatic change in the RF environment. Radar altimeters are deployed on most aircraft for many essential air safety functions of modern aircraft given its capability and years of interference free performance. Therefore, both industries are highly invested in the outcome, but also use different standards and metrics to assess the risk of interference. Combined with the significant sums of money and political interests, this creates a source of friction that appears difficult to solve.

2.1 Why C-band 5G networks have been deployed in different parts of the world, and there was no interference case reported?

This question is often asked, but the risk cannot be generalised. The risk of interference to a Radio Altimeter depends on many parameters such as:

- Maximum Effective Isotropic Radiated Power (E.I.R.P = power of the 5G base station (xxx) + antenna gain (yy))
  - Power of the 5G base station (xxx dBm) call TRP (True Radiated Power)
  - Antenna gain (yy dBi) depending on the type of antenna.
- the location of the Base station antenna
- the antenna tilts.
- The vertical scan (Scan angle)
- the rate of use of a base station
- The ground scattering and altitude
- the frequency band used.
- aggregated unwanted emission level

From one country to another, all these parameters are different even in CEPT countries.

2.1.1 E.I.R.P

The tests carried out by Norway are interesting.
If we consider the power parameter (EIRP) as a parameter and estimate the "zone de sécurité" (safety zone) as defined in the French mitigation measures.
If we use the power of 60.68dBm EIRP from Norway: the “zone de securité” is in red (123m each part of the runway);
If we use the power of 78dBm EIRP from France: “zone de sécurité” is in green (910m each part of the runway).

As we can see, using an EIRP of 60.68dBm for the 5G Base station, the runway easements are sufficient to protect radio altimeters, using an EIRP of 75dBm for the 5G Base station: implementing 5G antenna on the air terminal would be problematic.
E.I.R.P is the main problem, but within the European regulations, there is no limit of EIRP! Because there are not limit on the antenna Gain, only the TRP is limited (E.I.R.P = TRP +.Antenna Gain). AAS antennas are a huge problem, because in theory there is no limit to the antenna gain and therefore no regulation on the limit to the EIRP. Without EIRP limits, we will never be able to develop standards that allow radio altimeters to be resilient!

2.1.2 Type of antennas used

Two different technology are available for 5G antennas with different antenna gain and therefore acts directly on E.I.RP

- AAS antenna (*advanced antenna* systems) is the general term used to describe antenna using adaptive beamforming. Depending on the information available, the gain can exceed 25dBi
- Non AAS antennas are antennas with a fixed beam, usually 120° where the gain where the gain is constant around 15dBi.

2.1.3 Antenna tilt

In some countries, the tilt must always be below the horizon, and therefore the maximum gain towards the aircraft is lower (about 5dB) than the maximum gain of the antenna. But for example, in France, this constraint has been removed by a ministerial decision. Negative tilt is only imposed in the precautionary and safety zones around aerodromes with CAT III approaches (there is no CAT II in France).
The desire to use the 5G for the UTM will question the limitation of negative tilt in other countries.

2.1.4 The vertical scan (Scan angle)

The vertical scan of an AAS Antenna has the ability to steer the main beam of the AAS antenna upward toward an aircraft above the horizon. There are no restrictions on the vertical scan angle in the Telecommunication regulations. The main beam is steered above the horizon depending on User Equipment demand in the vicinity and network management policy of the operators and the antenna manufacturers.
RTCA report details the consequences on radio Altimeters in such cases (refer to §10.1.3). Also, high negative vertical scan angles can also create significant grating lobes upward.

2.1.5 The rate of use of a base station

The power radiated by a base station depends on the data traffic passing through it. According to the information available: in France, data transmitted in 5G represents less than 1.5% of mobile data. This can be explained by the price of 5G subscriptions, which is tending to fall. At the same time, the rate of 5G compatible phones that will be available for the population is going to increase, knowing that but the average renewal period for a phone is 2 years. This means that, within 2 years, most of the phones will be 5G capable and the 5G mobile data traffic will be higher.

2.1.6 The ground scattering and altitude.

The susceptibility of radio altimeters also depends on the ratio of the 5G signal to the radio altimeter return signal. The higher the ground scattering is, the more resistant the radio altimeter is. But this coefficient is not constant, it depends on the type of soil (sand, pure water or sea, agricultural land, vegetation…) and the soil moisture content. A very interesting document[34] produced by Honeywell (page 33 to 40) deals with this complex subject and helps to understand the issue.

The altitude of the aircraft increases the path loss of the Radio altimeter signal, and therefore makes its receiver more sensitive, but at the same time the altitude of the aircraft moves it away from the 5G base stations and increase 5G the path loss. Studies and simulations have shown that the most unfavourable altitude is around 200ft.

2.1.7 Aggregated unwanted emission level

RTCA report indicated that the conducted PSD (Power Spectral Density) of Spurious Emissions from a 5G Base Station is -20 dBm/MHz. It also indicates that the peak output PSD of this spurious level at the output of the antenna (EIRP) corresponds to a conducted PSD through a single element of an AAS antenna. So the Peak Output PSD spurious (EIRP) can reach -12.9 dBm/MHz. RTCA Report relies on data provided by Telecommunication community (as per Appendix B)

2.1.8 The frequency band used

The new uses of 5G worldwide are concentrated in the frequency band 3-5 GHz. A wide guard band does not make it safe, but it is part of the equation to protect radio altimeters. That is why the availability of data on the susceptibility for all type of Radio-Altimeter over the whole frequency band 3-5 GHz, will allow us to establish specific rules for each 5G frequency band.

2.2 Stakeholder organisation

2.2.1 ICAO

2.2.1.1 FSMP

ICAO sent a state letter (drafted by FSMP) to raise awareness in the aviation community.
During FSMP WG11, a correspondence group on radio altimeters (CG-RA) was formed to collect information on a number of topics related to 5G/altimeter compatibility (FSMP WG11 Report[35] Appendix H).

2.2.1.2 Flight Operations Panel (FLTOPSP)

During FLTOPSP/8 an information paper 6 updated the position on interference by 5G communications in the aircraft radio altimeters (FLTOPSP/7 Decision 5/2).
The panel were informed that the original statement had been presented to the frequency spectrum management panel (FSMP), and that the FSMP had requested any specific examples of interference to be shared
with them.

[34] https://avsi.aero/wp-content/uploads/2021/12/Radar-Altimeter-Overview-of-Design-and-Performance.pdf
[35] https://www.icao.int/safety/FSMP/MeetingDocs/Forms/AllItems.aspx?RootFolder=%2fsafety%2fFSMP%2fMeetingDocs%2fFSMP%20WG11%2fReport&FolderCTID=0x012000556AC038F4589F4281B27ABB7E901CAE

Regarding updating of the industry standards for radio altimeters, the panel noted that work was underway with RTCA to develop more robust systems, but that this would be a long term fix as the new standards would not be completed until Q4 2022 and would then need to be adopted by equipment manufacturers to be implemented. Reports from the 5G industry suggested there was considerable interest in looking at improvements and mitigations to allow 5G development to continue without impacting on aircraft safety.

2.2.1.3 FMG Europe

The European FMG is following the issue and invites its members to express ICAO's concerns to their respective frequency regulator.

2.2.2 EASA

Following the CARI (Continuing Airworthiness Review Item) sent by EASA to all aviation stakeholders on the subject, the partial data received until now by EASA (initial deadline in February 2021) did not allow to conclude on a risk assessment for all possible combinations of radalt/aircraft models. Further data are still expected .
During ECC PT1 #68 Meeting (April 2021), EASA has taken the lead in the collection, compilation and anonymisation of radio altimeter data from the different manufacturers. These data are needed to be implemented into the draft ECC Report (CEPT PT1 SWG C TEMP 13 / ANNEX VIII-13) for conducting studies, and only EASA (within Europe) has the authority/legitimacy to request this data from manufacturers. EASA did not contribute nor participate in the following ECC PT1 #69 meeting (sept 2021).

2.2.3 EASA / EC DG MOVE / EUROCONTROL

On 25 February 2021, a joint workshop was hosted by EASA, the European Commission and EUROCONTROL for aviation stakeholders. Presentations were given by EASA, RTCA / EUROCAE, Airbus, Thales, DGAC and EUROCONTROL. The presentations were made available to all registered participants.

2.2.4 EUROCONTROL

On 2 October 2020, the EUROCONTROL Airport Operations Team was informed about the 5G and RADALT issue. The airports community was requested to be vigilant about 5G deployments near aerodromes and to ensure caution when deploying 5G infrastructure themselves.

On 23 February 2021, EUROCONTROL presented the potential for RFI to RADALT from 5G emissions to the 4th meeting of SAFOPS, which is part of the network manager working arrangements. It also published a safety bulletin with an information message to operators. The bulletin is to make sure that if events related to RADALT are reported, that they are made available to EVAIR, the EUROCONTROL Voluntary ATM Incident Reporting System, for further analysis. As of end September 2021, no such reports have been received.

On 12 March 2021, an action paper on Possible 5G Interference to Radio Altimeters was presented to the NDTECH meeting, the Network Directors of Technology Working Group (agenda item 4.6). The paper summarizes the issue and associated developments and calls for cooperation between airport operators, ANSP,

aviation and radio regulatory authorities, military and all airspace user organizations to cooperate on the matter. It establishes three priorities for such activities, which are to 1) maintain safety, 2) limit the economic impact to the aviation industry and 3) engage with the 5G industry to facilitate 5G developments as far as possible while maintaining safety and a viable transition to operations with equipment built to improved RADALT standards. NDTECH continues to be informed on this matter through the "matters arising" agenda item.

2.2.5 CEPT PT1

At the beginning of the year 2021, when the issue was brought to the attention of PT1, there was a lot of tension. But since the ITM community has realised that the aeronautical community is not able to provide technical characteristics, they are more confident. Some of them asked to put the subject on hold, others said that if EASA doesn't react then there are no problems, and therefore the work item must be closed…
The ECC PT1 report on the Radio-Altimeter topic was planned to be delivered for March 2022
Important involvement of the aviation industry at the PT1 meeting of 11-12 and 17-21 January 2022. Base on documents (cf. §1.1.5.1 CEPT PT1 /ECC PT1 #70 January 2022), the meeting agreed to establish a Correspondence Group (CG), chaired by Mr Alexander Deder (Germany), until the next ECC PT1 meeting (with the Terms of Reference in ECC PT1(22)074 ANNEX VIII-28). The CG convener should provide an update to ECC PT1 chairman on the progress of CG activity one week prior upcoming ECC meeting in order for PT1 chairman to inform ECC accordingly.
The CG continued developing the draft ECC Report on compatibility between MFCN operating in 3400-3800 MHz and Radio Altimeters operating in 4200-4400 MHz (ECC PT1(22)074 ANNEX VIII-27).
Material from relevant input documents was included in appropriate places into the working document but there was not sufficient time to discuss it, so it was inserted with square brackets and further considerations are required. Questions by the mobile industry were raised on whether received parameters for Radio-Altimeter were the most appropriate and a list of clarifying questions was drafted. ASRI kindly agreed to work on responses to these questions. Recognising that there is a range of Radio-Altimeter performance, participants stressed the need to agree first on realistic assumptions and scenarios before starting any compatibility studies. It was also highlighted that assumptions should represent the CEPT situation.
During the discussions it was pointed out that there are still missing parameters required for the simulations. AVSI informed the meeting that additional parameters are intended to be published in March this year. It was highlighted that a reply to Eurocae/RTCA on received Radio-Altimeter parameters and questions regarding 5G performance would be essential.
The draft ECC Report had been scheduled to be finalised for submission to ECC for approval for public consultation from this ECC PT1 meeting but this was the first time the group received information regarding radio altimeter characteristics, therefore more time is needed to progress the work and an extension to the deadline by 3 additional ECC PT1 meetings to work item PT1_40 will be requested from ECC (draft report for public consultation to be approved at ECC PT1 #73 in January 2023 for submission to ECC #61 in March 2023; resolution of public consultation comments at ECC PT1 #74 in April/May 2023 and final approval at ECC #62 in June/July 2023).

The PT1 website has opened a forum[36] dedicated to "CG Radio altimeters 4.2-4.4 GHz" on which a lot of information and exchanges between the different stakeholders are available.

[36] https://www.cept.org/ecc/groups/ecc/ecc-pt1/client/forum/topic/619

April 2022 ,AVSI has published it's third and final volume of the AFE 76s2 Project Report. The three volumes of the report include:

1. **Volume I** - contains the introduction, AVSI test procedures, and test results from out-of-band interference representative of 5G fundamental signals in the 3700-3980 MHz frequency band. Volume I can be downloaded here: AVSI AFE 76s2 Project Report - Volume I

2. **Volume II** - contains the AVSI test results from in-band interference representative of 5G spurious signals in the 4200-4400 MHz frequency band and identifies changes to the test conditions and analysis for spurious tests. Volume II can be downloaded here: AVSI AFE 76s2 Project Report - Volume II

3. **Volume III** - contains manufacturer-provided test results, including additional altimeter models, additional interference signal frequencies, and investigation of additional experimental conditions. Volume III is attached and can be downloaded here: AVSI AFE 76s2 Project Report - Volume III

2.2.6 FAA (Federal Aviation Administration U.S.A)

See Section 1.3.10[TBC]

2.2.7 RTCA-EUROCAE

Following the US national regulator's decision to allow 5G services in the 3.7-3.98 GHz, additional study was encouraged given the questions raised by the aviation community. From this, RTCA created a public multi-stakeholder group under its SC-239 committee that conducted an extensive theoretical study of the simulated 5G interference, assessing it against radar altimeter performance data from the major manufacturers in common and real-world scenarios. With the regulatory limits defined by the US national regulator for base stations and handsets, combined with data from the 5G interests, the RTCA SC-239 Report[37] found that all aircraft types and multiple operations received interference from both simulated fundamental and spurious 5G emissions. The RTCA Report concluded that *"5G base stations present a risk of harmful interference to radar altimeters across all aircraft types, with far-reaching consequences and impacts to aviation operations"*. Although they did not participate in the public RTCA work, 5G interests have challenged the findings stating it is overly conservative and there is no interference potential. Since publication of the RTCA Report, no decision has been yet made by the U.S national regulatory.

Deleted:

In December 2020, RTCA made an interesting **Youtube presentation of the Radio Alitmeter issue**[38].

RTCA and EUROCAE (SC-239/WG-119) have jointly initiated the drafting of new Mops for the Radio Altimeter, the completion of the work is planed for the end 2023.

[37] https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report_274-20-PMC-2073_accepted_changes.pdf
[38] https://www.youtube.com/watch?v=OpYhjK2MDqM

2.2.8 Arab Civil Aviation Organization (ACAO)

Air Navigation committee meeting No 45 on 30-31 March 2022. The committee endorsed the following recommendation (English Translation):

- Urge the member states of the organization to take appropriate measures to reduce the impact of the installation of 5G cellular networks on the movement of aircraft in coordination with the concerned authorities of each country (national telecommunications regulatory bodies) to ensure that the levels of use of 5G cellular networks near airports and their future plans.

- Task the General Administration of ACAO in coordination with the recently established 5 G Working Group by ICAO Middle East Regional Office to work on the development of a mechanism at the national and regional levels to report and analyse interference reports resulting from the use of 5G networks

- Urge member states to support ICAO's position during the 2023 World Telecommunications Conference WRC-23 meeting to be held on 2023 through coordination with the nation

2.2.9 DGCA (Directorate General of Civil Aviation) India.

DGCA India opens a consultation with RADALT and aircraft manufacturers to assess coexistence before awarding 5G licenses. The country has currently earmarked 3.3-3.6 GHz range for 5G.

3. Conclusion

Radio altimeters were developed at a time when:
- mobile telecommunication industry didn't exist.
- coexistence with systems in adjacent frequency bands had little or no impact.

The increase demand for wireless technology to enable connectivity has come to surround of some aeronautical frequency bands, including the Radio Altimeter frequency band 4.2-4.4GHz. It was clearly never anticipated by the Radio altimeters industry in 1980s.

Although the aviation community is developing new standards as fast as possible, but States shall ensure the safety of life during this transitional period. The aeronautical community must make "the best effort" but can do it only if the limits of RF environment are perfectly known and stable for decades.

– END –

International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Ref.: T 8/5.10 : AP099/22 (CNS) 21 July 2022

Subject: Prevention of harmful interference to Radio Navigation Satellite Service Receivers in the 1559 – 1610 MHz frequency band

Action Required:

1) Note the information contained in the ITU RB Circular Letter CR/488;
2) Note the information contained in the ICAO State Letter Ref.: AN 7/5-20/89; and
3) Take actions as appropriate.

Dear Sir/Madam,

I wish to draw your attention to the prevention of harmful interference to Radio Navigation Satellite Service Receivers in the 1559 – 1610 MHz frequency band.

The Radiocommunication Bureau (RB) of International Telecommunication Union (ITU) has been informed of a significant number of cases of harmful interference to the radio navigation satellite service (RNSS) in the 1559 – 1610 MHz frequency band affecting receivers onboard aircrafts, causing degradation or total loss of the service for passenger, cargo and humanitarian flights, and leading to misleading information provided by RNSS receivers to pilots in some cases. Based on in-flight monitoring of air transport category aircraft global navigation satellite system (GNSS) receivers by one major aircraft manufacturer, 10843 radio-frequency interference events were detected globally in 2021. The majority of these events occurred in the Middle East region, but several events were also detected in the European, North American, and Asian regions.

With great concern about the increasing number and range of impact of such harmful interference on safety-of-life radiocommunication services used for the navigation of aircraft, the ITU RB issued the Circular Letter CR/488 with the subject of *Prevention of harmful interference to Radio Navigation Satellite Service Receivers in the 1559 – 1610 MHz frequency band* on 8th July 2022 which is provided in **Attachment A**.

The Circular Letter also highlighted the recommendations and measures on prevention and mitigation of harmful interference to GNSS agreed by the International Civil Aviation Organization (ICAO) at 40th Assembly in October 2019 and disseminated by ICAO State Letter Ref.: AN 7/5-20/89 dated 28th August 2020 with Subject of *Strengthening of communications, navigation, and surveillance (CNS) systems resilience and mitigation of interference to global navigation satellite system (GNSS)* provided in **Attachment B**.

Your State/Administration is strongly encouraged to share above mentioned information with operators, service providers and all stakeholders, sensitize the national radio regulatory Authority to the risk encountered by the civil aviation, and take actions to address this critical issue as appropriate.

Accept, Sir/Madam, the assurances of my highest consideration.

Tao Ma
Regional Director

Enclosures:
Attachment A – ITU RB Circular Letter CR/488
Attachment B – ICAO State Letter Ref.: AN 7/5-20/89

Radiocommunication Bureau (BR)

Circular Letter
CR/488

8 July 2022

To Administrations of Member States of the ITU

Subject: **Prevention of harmful interference to Radio Navigation Satellite Service Receivers in the 1559 – 1610 MHz frequency band**

Following its initial report to the 2019 World Radiocommunication Conference, the Radiocommunication Bureau has been informed of a significant number of cases of harmful interference to the radionavigation-satellite service (RNSS) in the 1 559 – 1 610 MHz frequency band affecting receivers onboard aircrafts and causing degradation or total loss of the service for passenger, cargo and humanitarian flights. In some cases, this has also led to misleading information provided by RNSS receivers to pilots. Based on in-flight monitoring of air transport category aircraft GNSS receivers by one major aircraft manufacturer, 10 843 radio-frequency interference events were detected globally in 2021. The majority of these events occurred in the Middle East region, but several events were also detected in the European, North American and Asian regions.

The Bureau has noted with great concern the increasing number and range of impact of such harmful interference on safety-of-life radiocommunication services used for the navigation of aircraft (see No. **4.10**[1]). In accordance with RR No. **13.2**, the Bureau reported such cases to the Radio Regulations Board (RRB), together with its recommendations.

At its 89th meeting in March 2022, the ITU Radio Regulations Board (RRB) considered the situation and instructed the Bureau to issue a circular letter to the Member States to disseminate its decisions and other background information about the prevention of harmful interference to RNSS receivers.

Following this instruction, the Bureau has prepared the present circular letter. It summarizes the RRB's decisions on the issue, formulates recommendations concerning mitigation of harmful interference to the radionavigation-satellite service and provides the list of the relevant ITU-R reference documents.

---

[1] *"Member States recognize that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference; it is necessary therefore to take this factor into account in the assignment and use of frequencies."*

The relevant decisions of the 89th RRB meeting

In accordance with No. 13.2, the Board decided to request Member States to ensure that their operating agencies complied with the applicable provisions of the ITU legal instruments, as emphasized below:

- *"All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of the Radio Regulations."* (Article 45 of the ITU Constitution)

- *"to take the steps required to prevent the transmission or circulation of false or deceptive distress, urgency, safety or identification signals, and to collaborate in locating and identifying stations under their jurisdiction transmitting such signals."* (Article 47 of the ITU Constitution)

- *"1 Member States retain their entire freedom with regard to military radio installations.*

2 Nevertheless, these installations must, so far as possible, observe statutory provisions relative to giving assistance in case of distress and to the measures to be taken to prevent harmful interference, and the provisions of the Administrative Regulations concerning the types of emission and the frequencies to be used, according to the nature of the service performed by such installations.

3 Moreover, when these installations take part in the service of public correspondence or other services governed by the Administrative Regulations, they must, in general, comply with the regulatory provisions for the conduct of such services." (Article 48 of the ITU Constitution)

- *"Recognizing that transmissions on distress and safety frequencies and frequencies used for the safety and regularity of flight (see Article 31 and Appendix 27) require absolute international protection and that the elimination of harmful interference to such transmissions is imperative, administrations undertake to act immediately when their attention is drawn to any such harmful interference."* (RR No. **15.28**)

The Board further decided to request Member States to continue to exercise their utmost goodwill and mutual assistance in the application of the provisions of Article 45 of the Constitution and of Section VI of Article **15** of the Radio Regulations.

Recommendations on prevention and mitigation of harmful interference to RNSS

With respect to unnecessary transmissions, which represent one of the important sources of interference to RNSS, the Bureau would like to point out that the use of devices commonly referred as "GNSS jammers" or any other illegal interfering equipment, which may cause harmful interference to aircraft, are prohibited by provision No. **15.1** of the Radio Regulations:

> *15.1 § 1 All stations are forbidden to carry out unnecessary transmissions, or the transmission of superfluous signals, or the transmission of false or misleading signals, or the transmission of signals without identification (except as provided for in Article **19**).*

In addition, the administrations are encouraged to consider the following additional measures to address this critical issue:

a) reinforcing navigation systems resilience to interference;
b) increasing collaboration between radio regulatory and enforcement authorities;
c) reinforcing civil-military coordination to address interference risks associated with RNSS testing and conflict zones;
d) increasing coordination between aviation, military and radio-regulatory authorities;
e) retaining essential conventional navigation infrastructure for contingency support in case of RNSS outages, and developing mitigation techniques for loss of services.

The above measures were decided by the International Civil Aviation Organization (ICAO) at its 40th Assembly in October 2019 and disseminated by ICAO State Letter AN 7/5-20/89 dated 28 August 2020.

Relevant ITU-R reference documents

In order to get an overview of the usage and protection requirements of systems operating in the radionavigation-satellite service, administrations may consult the following ITU-R Recommendations and Reports:

- Recommendation ITU-R M.1787-4 – Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164-1 215 MHz,1 215-1 300 MHz and 1 559-1 610 MHz
- Recommendation ITU-R M.1901-3 – Guidance on ITU-R Recommendations related to systems and networks in the radionavigation-satellite service operating in the frequency bands 1 164-1 215 MHz, 1 215-1 300 MHz, 1 559-1 610 MHz, 5 000-5 010 MHz and 5 010-5 030 MHz
- Recommendation ITU-R M.1903-1 – Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) and receivers in the aeronautical radionavigation service operating in the band 1 559-1 610 MHz
- Report ITU-R M.2458-0 – Radionavigation-satellite service applications in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands

The Bureau thanks Administrations for disseminating this information among their different operating agencies to raise awareness of the situation and to remind them of their obligation to prevent any harmful interference in accordance with ITU's Legal Instruments.

Mario Maniewicz
Director

Distribution:

- Administrations of ITU Member States
- Members of the Radio Regulations Board

International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Tel.: +1 514-954-8219 ext. 6717

Ref.: AN 7/5-20/89

28 August 2020

Subject: Strengthening of communications, navigation, and surveillance (CNS) systems resilience and mitigation of interference to global navigation satellite system (GNSS)

Action required: Note the criticality of the issue and the importance of action by States to address it by making use of the ICAO guidance provided in Doc 9849, *Global Navigation Satellite System (GNSS) Manual* and by taking any other measures as appropriate

Sir/Madam,

1. I have the honour to inform you that the Council, at the ninth meeting of its 220th Session on 22 June 2020, agreed with the proposal to bring to the attention of States the actions agreed by the 40th Session of the Assembly (24 September – 4 October 2019) with regard to communications, navigation, and surveillance (CNS) systems resilience and mitigation of harmful interference to global navigation satellite system (GNSS).

2. The agreed actions were pursuant to proposals contained in Assembly working papers A40-WP/82, A40-WP/352 and A40-WP/188, presented respectively by Finland on behalf of the EU and its Member States[1], by Saudi Arabia and jointly by the International Federation of Air Traffic Controllers' Associations (IFATCA), the International Federation of Air Line Pilots' Associations (IFALPA) and the International Air Transport Association (IATA). The papers identified issues related to the evolution of CNS systems and the associated threats and vulnerabilities, with particular regard to satellite-based CNS systems, such as GNSS. They highlighted, in particular, the impact from harmful interference to GNSS on the safety and efficiency of aircraft and ATM operations, and identified the need to strengthen the protection of GNSS signals from harmful interference and degradation of performance through actions by States and ICAO in coordination with industry.

[1] Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom.

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3. The Assembly noted the essential commonality of purpose among the three papers and agreed with the proposals contained therein (*Assembly Fortieth Session, Technical Commission Report*, Doc 10137, A40-TE, 30.15 refers). The attachment to this letter compiles the proposals that are relevant for action by States. In summary, they include: reinforcing CNS system resilience to interference, preventing the use of illegal interfering devices, increasing collaboration with radio regulatory and enforcement authorities, reinforcing civil-military coordination to address interference risks associated with GNSS testing and conflict zones, increasing coordination between aviation and radio-regulatory authority and military, retaining essential conventional navigation infrastructure for contingency support in case of GNSS outages, and developing mitigation techniques for loss of services.

4. In particular, all three papers stress the importance of applying the GNSS radio frequency interference mitigation plan outlined in the ICAO *Global Navigation Satellite System (GNSS) Manual* (Doc 9849). The framework recommended to implement the mitigation plan includes a continuous three-step process, comprising threat monitoring, risk assessment and deployment of mitigation measures. Checklists of preventive and reactive measures aimed at mitigating the interference risk, as far as practicable, are also provided.

5. May I request that you note the criticality of the issue and the importance of action by States to address it by making use of the ICAO guidance provided in Doc 9849, and by taking any other measures, as appropriate.

Accept, Sir/Madam, the assurances of my highest consideration.

Fang Liu
Secretary General

Enclosure:

Actions agreed by the 40th Session of the Assembly to strengthen CNS systems resilience and mitigate interference to GNSS

ATTACHMENT to State letter AN 7/5-20/89

Actions agreed by the 40th Session of the Assembly to strengthen CNS systems resilience and mitigate interference to GNSS

From *A40-WP/82,* States are urged to:

"1) transition from a CNS system-based concept towards secure CNS services, mainly based on a satellite-based infrastructure while addressing its resiliency to interference through independent minimum operational networks based on ground and/or airborne components;
2) apply necessary measures to avoid the commercialisation / proliferation and the use of illegal transmitters such as jammers which may impact satellite-based CNS systems;
3) ensure, considering that the use of radio frequency spectrum by aeronautical safety services requires special measures, close collaboration between aviation authorities, service providers, radio regulatory and spectrum enforcement authorities to ensure that this spectrum is free from harmful interference;
4) reinforce civil-military collaboration regarding global navigation satellite system (GNSS) testing and other activities, which may impact satellite-based CNS systems, with the air navigation services provider (ANSP) responsible for the affected airspace; and
5) consider, when assessing the interference risks associated with conflict zones, that the use of satellite-based CNS systems can potentially be impacted beyond that zone."

From *A40-WP/352*, States are urged to:

"1) assess the likelihood and effects of global navigation satellite system vulnerabilities in their airspace and apply, as necessary, ICAO mitigation methods;
2) provide effective spectrum management and protection of global navigation satellite systems (GNSS) frequencies to reduce the likelihood of unintentional interference or degradation of GNSS performance; and
3) cooperate for design, development and realization of Ground and on-board mitigation techniques of GNSS loss of service;"

From *A40-WP/188*, the Assembly is invited to:

"a) to implement appropriate mitigation measures as contained in the *Global Navigation Satellite System (GNSS) Manual* (Doc 9849) as a matter of high priority and to report progress and any difficulties to ICAO;
b) to recognize the unintended impact of harmful interference to civil flight operations and to exercise caution to the maximum extent possible to protect the safety of civil aircraft during military exercises and operations;
c) to establish and ensure appropriate frequency regulations are in place and maintained to protect allocated GNSS frequencies from harmful interference in line with ITU Radio Regulations;
d) to ensure that contingency procedures are established in coordination with air navigation service providers and airspace users and that essential conventional navigation infrastructure, such as Instrument Landing System (ILS), are retained when operationally beneficial; and
e) to support the multi-disciplinary development of alternative positioning, navigation and timing (APNT) strategy and solutions to complement the use of GNSS in aviation in coordination with ICAO and airspace users."

— END —

57th CONFERENCE OF DIRECTORS GENERAL OF CIVIL AVIATION ASIA AND PACIFIC REGIONS

Incheon, Republic of Korea
4 – 8 July 2022

AGENDA ITEM 4: AIR NAVIGATION

AERONAUTICAL SPECTRUM UTILIZATION AND PROTECTION

Presented by the International Civil Aviation Organization (ICAO)

SUMMARY

This Discussion Paper presents the work required on Aeronautical Spectrum Utilization and Protection in the Asia and Pacific Regions by supporting the ICAO Position on the various agenda items to be addressed during the International Telecommunication Union (ITU) World Radiocommunication Conference in 2023 (WRC-23). The paper also discusses the need to enhance the regional coordination process on Aeronautical Spectrum, the necessary monitoring of 1090 MHz congestion and addresses the 5G and Radio Altimeter issue. The Conference is invited to ensure that States/Administrations work hand-in-hand with the ICAO Asia and Pacific Regional Office on the utilization and protection of aeronautical spectrum in the Region.

AERONAUTICAL SPECTRUM UTILIZATION AND PROTECTION

1. INTRODUCTION

1.1 Considering the key components of aviation with a focus on radio technology and spectrum, there is a large number of Aeronautical Radiocommunication, Navigation and Surveillance systems that are necessary to provide functions critical to the safe flight of aircraft. An average size commercial aircraft is fitted with close to or over 30 antennas. Communications, Navigation and Surveillance (CNS) technology elements rely on a common resource - continued and interference-free access to frequency spectrum, for aviation safety, capacity and efficiency.

1.2 ICAO has been working closely and effectively in cooperation with its Contracting States and stakeholders to address the challenges in aeronautical spectrum utilization and protection through making and maintaining SARPs, promoting harmonized implementation of ICAO provisions at global and regional levels, introducing new technology to optimize the robustness and the efficiency in using spectrum, monitoring hotspots and being alert for potential safety risks.

1.3 A positive outcome from this joint effort of ICAO and its Contracting States will only be enabled by the active participation and implementation of States, in particular in the promotion and defense of the ICAO Position to ITU WRC, by enhancing coordination of aeronautical frequency and SSR Interrogator Codes (IC), by actively monitoring frequency congestion and taking appropriate action with emerging issues caused by the implementation and rollout of new non-aviation technologies in the neighbouring bands at regional level.

2. DISCUSSION

Support the ICAO Position to ITU WRC-23

2.1 The ITU is the specialized agency of the United Nations for telecommunication matters where international agreements are made on the use of the radio frequency spectrum. At World Radiocommunication Conferences (WRCs), convened about every four years, changes are made to the ITU Radio Regulations, including the Table of Frequency Allocations (Article 5 of the ITU Radio Regulations), on the basis of proposals made by States.

2.2 A consequence of this process is that a coordinated aeronautical position (the ICAO Position) must be established for every ITU WRC and finalized well in advance of the ITU conference itself, in order to be of maximum use to aviation authorities. The ICAO Position for the WRC-23 was approved by the ICAO Council on 14 June 2021. States and international organizations are requested to make use of the ICAO Position, to the maximum extent possible, in their preparatory activities for the WRC-23 at the national level, in the activities of the regional telecommunication organizations and in the relevant meetings of the ITU.

2.3 A number of WRC-23 Agenda Items address issues where aviation is seeking action by the WRC. To mention a few, Agenda Item 1.6 addresses spectrum used by sub-orbital vehicles, Agenda Item 1.7 is about allocation for aeronautical VHF over satellite, Agenda Item 1.8 is about successful finalization of a satellite allocation enabling beyond radio line-of-sight C2 link for RPAS.

2.4 The Asia Pacific Telecommunity (APT) is an inter-governmental regional telecommunication organization. APT conducts conference preparatory group (APG) meetings to develop regional proposals for WRCs. As WRC decision on Agenda Items will be relying more on regional discussions, it is very important to ensure that the aviation position on various agenda items of WRC-23 is duly reflected in the States' position papers to be submitted to the APG meeting. Aviation regulators of States which have not yet submitted their national positions on WRC-23 agenda items in support of the ICAO position need to coordinate the position with their respective telecommunications regulators before the States' positions are finalized and submitted to the APT APG. The 4th Meeting of the APT APG (APG23-4) will be held from 15 to 20 August 2022 in hybrid mode in Bangkok, Thailand.

Enhance the Regional Coordination Process on Aeronautical Spectrum

2.5 The Third Asia/Pacific Regional Air Navigation (ASIA/PAC/3 RAN) Meeting (1993) agreed that the frequency lists prepared by the ICAO Asia and Pacific (APAC) Regional Office will be the frequency planning documents for the Regions. The ICAO APAC Regional Office was charged to continue to maintain its frequency selection and coordination role, including the maintenance and promulgation of Frequency List Nos. 1, 2 and 3 at appropriate periodic intervals.

2.6 The ICAO tool Frequency Finder, including its global database, was formally introduced to the APAC region in 2015 for efficient frequency management across ICAO Regions, consequentially the publication of Frequency List No. 3 (117.975 - 137 MHz) has been discontinued. However, the ICAO APAC Regional Office continues to update and publish the Frequency List No.1 (190-526.5 kHz – NDB) and Frequency List No.2 (108 - 117.975 MHz and 960 - 1215 MHz; VOR/DME, ILS and VDL Mode 4) through a State Letter every year. It is foreseen that Frequency Finder will in the near future also be utilized for the management and registration of NAV systems.

2.7 While implementing SSR Mode S, States should ensure that SSR interrogators with overlapping coverage are not operated using the same Interrogator Code (IC), coordinate with the ICAO APAC Regional Office and the neighbouring States when the coverage of the interrogator extends beyond the boundaries of the State and inform the ICAO APAC Regional Office of the assigned IC for the installations.

2.8 The ICAO APAC Regional Office acts as the only centralized portal for aeronautical frequency and IC coordination, providing a one-stop solution for States. The current process has served the APAC community well over the years, minimizing any bureaucracy and overhead when performing the coordination and registration. The efficiency and accuracy of the process rely on the support from States to the Regional Office by submitting all frequency and SSR/IC assignments for international coordination in a timely manner. In any case, ICAO holds the view that frequency and IC assignments that have been coordinated with ICAO have priority over those that have not been coordinated.

Monitoring 1090 MHz Congestion

2.9 1090 MHz is utilized by SSR transponders for SSR interrogation replies, aircraft broadcast of ADS-B downlinks, and ACAS. The utilization of the 1090 MHz frequency has greatly increased in certain areas of the world. The impact of high channel occupancy is the consequential corruption of messages. This can ultimately result in reduced detection probability for both ground systems as well as ACAS, ADS-B IN and Space-based ADS-B. If no action is taken in areas where severe congestion is experienced, the situation will reach an unacceptable level that may cause harmful corruption or loss of information to the aeronautical surveillance and collision avoidance systems.

2.10 The density of congestion at 1090 MHz depends on many factors, the level of congestion in various parts of Asia Pacific is currently unclear (pre-COVID traffic levels). Some States have reported that 1090 MHz occupancy is not high, less than 10% at busy airports, based on their measurements at radar sites, while some other States have highlighted the need to implement directional antennas to ensure the performance of ADS-B ground stations.

2.11 The use of Mode S Extended Squitter for ADS-B by an increasing number of UAS may seriously affect the continued use of ICAO standardized surveillance systems, due to the resulting congestion of the 1090 MHz frequency. Additionally, States should be aware that widespread 1090ES-capable Mode S transponder equipage by a large population of UAS may not be feasible due to the limited number of available 24-bit aircraft address allocations.

2.12 When examining 1090 MHz channel occupancy, it is necessary to consider both terrestrial receivers and airborne receivers. States are urged to follow the guidance provided in SARPs and associated guidance material to keep the frequency utilization healthy, and always seek to minimise 1090 MHz channel occupancy commensurate with their operational needs and environment. States with the necessary

capabilities are encouraged to make periodic measurements, so that the environment status of 1090 MHz congestion is known, and perform 1090 MHz channel occupancy monitoring at operating Flight levels (e.g. near FL300) and at ground level.

Addressing the 5G and Radio Altimeter issue

2.13 Radio Altimeter (RA) is a mandated critical aircraft safety system used to determine an aircraft's height above terrain. The information from the RA is an essential enabler for several safety-related flight operations and navigation functions on all commercial aircraft as well as a wide range of other civil aircraft, in particular the use of RA is essential during the final approach and landing of an aircraft. The RA operates at 4 200 - 4 400 MHz band under the Aeronautical Radionavigation service. The frequency bands adjacent to 4 200 - 4 400 MHz were previously mainly used for downlinks from geostationary satellites, and have traditionally been "quiet" until the recent introduction of 5G cellar networks in those bands.

2.14 The frequency bands just below the Aeronautical RA band are well suited for the provision of 5G cellular networks, optimizing both range and speed of the service provided. A number of studies suggest that there could be potential harmful interference to RA operations if high-powered 5G base stations, at distances close to airports/runways, when these are operating in the bands adjacent to 4 200 - 4 400 MHz. If not properly mitigated, harmful interference into the RA may pose a serious safety risk. Additionally, if the mitigation measures taken will result in operation of RA being prohibited at certain airports, then this may infer the necessary shutdown of those airports, in particular during foul weather (i.e. Instrument Flight Rules) conditions, which in turn may lead to widespread disruptions.

2.15 The 5G rollout strategies in the various APT Member countries are different in terms of key parameters such as how close the frequency band used is to the 4 200 - 4 400 MHz band, the total transmitting power of the base stations, as well as the antenna tilt. Hence the mitigatory strategies taken will need to be tailored to each specific situation.

2.16 As the radio altimeters are highly sensitive avionic equipment which is required to achieve the necessary performance and accuracy to enable safe flight, especially during IFR rules, any substantive change in the RF environment of this equipment may have dramatic consequences. Therefore, information sharing by national spectrum regulators, telecommunication service providers and aviation community are required to mitigate any potential risk.

2.17 On 23 August 2022, the ICAO APAC Regional Office will co-host together with APT a Webinar on 5G Implementation and Radio Altimeters, using APT's online meeting platform. This Webinar/dialogue session is intended to promote a common understanding among the spectrum regulators and industries on the operation of Radio Altimeters in the band 4 200 - 4 400 MHz and the implementation of 5G in the adjacent bands.

3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to:

a) Note the regional activities regarding preparation for WRC-23, including the fourth APT APG meeting for WRC-23, which will be held in Bangkok in August 2022;

b) Ensure active participation in WRC-23 preparatory activities of the APT APG and at WRC-23 by aviation representatives, to support the ICAO position for WRC-23;

c) Urge States/Administrations to coordinate their frequency and IC use with the ICAO APAC Office, using the Frequency Finder tool to ensure that the Frequency Lists are correct and up-to-date and list all NAV stations that are currently in operation or planned;

d) Invite States which currently have the capability to do so to monitor and report the occupancy of 1090 MHz; and

e) Request States to directly engage with their national spectrum regulators on the 5G RA issue.

— END —