GSMA

5G and Aviation Altimeters

Co-existence with IMT in 3.3-4.2 GHz and 4.8-4.99 GHz

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GSMA™

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The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

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1. Background

Currently, live 5G networks in over 53 countries are using spectrum in 3.3-4.2 GHz (the 3.5 GHz range). Roughly 80% of 5G network launches have used this band so far, totalling around 160 networks. The global media reacted to concerns from the aviation industry, in late 2021 to early 2022, that aircraft altimeters authorised to use the 4.2-4.4 GHz band would be impacted by 5G networks operating in the 3.5 GHz range. However, collaboration between industries has been taking place to reach improvements in radio altimeter equipment.

So far, there have been no instances of interference between 5G and aviation. The 3.5 GHz range has been under consideration and development for mobile services over the past 15 years. It has also been studied at the ITU and by national governments during this period.

Co-existence between different technologies is at the foundation of sound management of the radio spectrum – ensuring that citizens derive the maximum benefit from this resource. This is the case in the 3.5 GHz range where the safe co-existence between 5G networks and aviation in adjacent frequencies is important.

2. Spectrum Aspects

5G Networks and Altimeter Spectrum

While most networks currently use the lower part of the 3.5 GHz band (3.3-3.8 GHz), macro-cell networks are live in the upper part (3.8-4.1 GHz), as well. Some networks also use spectrum between 4.4-5 GHz. See the annex section at the end of this document for additional details on 5G networks in the 3.5 GHz band.

The aeronautical radionavigation service operates with radio altimeters in the 4.2-4.4 GHz band.

Sharing Spectrum

5G is an IMT technology and as such the way it uses spectrum is defined by the ITU. Mobile generations (2G, 3G, 4G, 5G and future 6G) are designed to share the spectrum with other radio systems. The technical and regulatory conditions under which they can operate are defined in the ITU's Radio Regulations, changes to which are agreed only at World Radiocommunication Conferences (WRCs).

IMT technologies either share the same spectrum or are good spectrum neighbours with TV, satellites, Wi-Fi, aeronautical, military, radio astronomy, Earth exploration, deep space exploration and other technologies and radio services.

5G is the most spectrum efficient mobile technology to date. Its efficiency is three times higher compared to 4G while it makes active use of active antenna systems (AAS).[1]

1. Rec. ITU-R M.2083-0 IMT Vision https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2083-0-201509-I!!PDF-E.pdf (see pages 8 and 14)

3. Aviation Concerns

Sharing Spectrum

The possibility of interference to radio altimeters from 5G networks was raised through a white paper by US aviation industry group RTCA. Prior to this, the US FCC examined the use of 3.5 GHz by 5G over the course of four years, including submissions by the aviation industry, and found that the technical rules adopted for 5G C-band service, as well as a 220 MHz guard band separating 5G networks from aviation operations, "are sufficient to protect [aviation] services in the 4.2-4.4 GHz band." The FCC's Order also noted that the guard band "is double the guard band supported in initial comments by [the aviation sector]".[2]

The first RTCA study was published in October 2020 and filed with the FCC immediately after that.[3] The US telecommunications industry has offered clear rebuttal of the findings of this report at various points since it was published.[4] RTCA avoided giving detailed, non-aggregated deployment information on radio altimeter models currently being used and only some anonymised information was provided publicly by RTCA's research partner in late 2021.

The white paper was subsequently raised more widely in US government circles later in 2021, leading to significant media attention. In order to ensure 5G networks launched smoothly, the US MNOs agreed firstly to delay launch of the 3.7-3.8 GHz band, and then to a set of temporary, voluntary, precautionary measures which reduced transmit power around certain airports.

The original RTCA study represented a set of assumptions based on highly pessimistic, overprotective and theoretical operational scenarios that together would not occur in live radio network implementations. As a result, the aviation industry wishes to claim protection from 5G networks for a handful of poorly designed and obsolete devices built on outdated standards from 1970s. Those devices are not designed to adequately reject signals emanating from outside their authorised frequencies.

Equipment designed against such a standard should not be usable nor acceptable in today's radio-frequency environment. For example, existing high-power radar systems up to 3.7 GHz, which have operated worldwide for decades, would significantly disrupt or damage the front-end receiver components of such a hypothetical device.

Subsequently, a considerable amount of coordinated work and progress has been made among mobile and aviation industries looking to address this concern. In October 2022, RTCA released the 'Guidance Document on Radar Altimeter RF Interference Rejection and Tolerance', for consultation and comments. The publication aims to "provide guidance to radar altimeter designers and manufacturers, aircraft manufacturers and system integrators, and others involved in the modification and development of radar altimeters for RF interference robustness on the current state-of-the-art Aircraft-Level RF Interference and Tolerance for radar altimeters operating in the 4200-4400 MHz band".[5]

RTCA/the aviation industry is now working on new specifications (MOPS) for radio altimeters that will set standards for radio altimeters for many years into the future. It is important that these MOPS will enable better coexistence between radio altimeters and other users of spectrum in neighbouring bands, and enable this valuable spectrum to be used efficiently.

2. https://ecfsapi.fcc.gov/file/0303046335999/FCC-20-22A1.pdf
3. https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report_274-20-PMC-2073_accepted_changes.pdf
4. https://www.5gandaviation.com/filings/
5. https://www.rtca.org/committees-overview/documents-under-review/

Safe Functioning of Altimeters

3.5 GHz spectrum is being widely used by 5G networks in more than 53 countries and by more than 138 operators all over the world, as detailed in the annex. To date, no instances of interference have been reported as a result of these 5G operations. The safe operation of altimeters is critical and the international mobile community is working in good faith with the aviation community to address any concerns. Such interaction will enable the aviation industry to ascertain where, if necessary, it will need to replace old and obsolete equipment with those that have adequate rejection capabilities.

Altimeters are a function of aircraft safety and as such, building appropriate margins into their protection is important. The aviation industry gave clear information on technical parameters for altimeters as part of the WRC-15 agenda, this was through the study of an in-aeroplane communications system called WAIC (Wireless Avionics Intra-Communications). RTCA's white paper, and subsequent aviation inputs into regulatory fora, apply higher safety margins to 5G services operating hundreds of megahertz from the radio altimeter band than those that it applied in evaluating a wireless intra-communications system (WAIC) operating on the same aircraft in the same frequency band.

The latest RTCA guidance document is suggesting "methods for evaluating and applying the RF rejection and tolerance levels"; however, these are still subject to further work and discussion.

4. Regulation

Regulatory Activity

Most countries using 5G in the band 3.3-4.2 GHz do so without extra restrictions and thousands of flights take off and land safely in their airports every day. Only a few countries have implemented additional or provisional measures out of an abundance of caution:

- Japan, which uses spectrum in the 3.6-4.1 GHz band (and 4.5-4.6 GHz) for 5G, applies a set of restrictions in close proximity to the airport landing strip only in the portion 4-4.1 GHz.
- France and Belgium apply a set of measures around airports in 3.4-3.8 GHz.
- US operators adopted restrictions in 3.7-3.8 GHz based on a modified version of the French model on a voluntary and temporary basis.
- Canada has also applied measures around landing strips in 3.45-3.65 GHz.
- In the US, the Federal Aviation Administration has set up an online resource detailing its own work to give additional clarity on the safe functioning of radio altimeters.[6]
- Brazil has decided to apply temporary precautionary measures around airports in 3.3-3.7 GHz.
- Australia has decided to apply precautionary measures around airports and power limits of 62 dBm in 3.8-4.0 GHz.
- India has decided to apply precautionary measures around airports: downtilting, and power limits of 58 dBm in 3.3-3.7 GHz.
- In Europe, radio altimeter coexistence with 5G operating in 3.5 GHz is being discussed in the CEPT ECC PT1.

6. https://www.faa.gov/5g

Tests around the world

France has published results of a trial on Gendarmerie helicopters using a Base Station at 3640-3710 MHz configured to a worst-case 78 dBm EIRP. The helicopters flew around the high-power BS in test loops trying to simulate interference. No disturbances were observed.

Another field test, from Norway, outlines a set of tests done at Bergen-Flesland airport (BGO) with a 3.7-3.8 GHz BS. It concludes: "The tests were carried out with a wide range of aircrafts representative for aircrafts landing at Norwegian airports". Test results showed no abnormalities on the radio altimeters during the tests.

Japan deployed laboratory testing performed for different type of altimeters. No interference complaints have been noted; however, laboratory test conditions are not reflective of real-world flight conditions.

The U.S. performed four phases of testing: lab setting; in-flight joint test and evaluation; collection of altimeters power levels; and, characterization of radiation patterns with emissions of 5G base stations at 3.3-3.6 GHz, 3..7-3.98 GHz and 3.3-3.98 GHz.

In the first report released, it was concluded that the low level of unwanted 5G emissions within the radio altimeter spectrum was negligible and would therefore be unlikely to cause potential harmful interference; "This measurement-based observation increases the likelihood that, to the extent EMC problem arise between 5G transmitters and adjacent-band radalt receivers, the technical solution to such a problem might be installation or retrofitting of more-effective RF power-rejection filters on radalt receivers for frequencies below 4200 MHz."[7]

Other countries and their regulatory bodies have initiated verification processes and tests deployments such as Canada, which has also a public consultation for protection zones ongoing.

The Czech Republic has published the results of an RA test (onboard) near a new IMT BTS installed at an airport. They used two different types of planes and two types of Helicopters. The Base Station operated at 3.7 GHz Results showed no abnormal RA function was detected.

7. https://its.ntia.gov/umbraco/surface/download/publication?reportNumber=TR-22-562.pdf

5. Quotes

"Conversations with other NAAs has established that there have been no confirmed instances where 5G interference has resulted in aircraft system malfunction or unexpected behaviour."

UK CAA, 17 January 2022

"Based on our assessment of all the information that is currently available to us, we consider that there is no immediate need for risk mitigation actions nor for States to act."

European Aviation Safety Agency, December 2020

"Results showed no abnormalities on the Radio Altimeters during the test."

Nkom Norway, August 2021

"The emission of 5G NR base station had no impact on the operational behaviour of the radio altimeter fitted on the French gendarmerie's EC135 helicopters, which gives us a good level of confidence in the resilience of this type of radio altimeter to conduct its missions."

ANFR France, September 2021

"And we continue to have no reason to believe that 5G operations in the C-Band will cause harmful interference to radio altimeters. Among other things, these altimeters operate with more than 200 megahertz of separation from the C-band spectrum currently being auctioned, more protection than is afforded in some other countries."

FCC, January 2021

"There has been no concrete influence on the instruments so far."

BNetzA Germany, January 2021

"We're aware that the aviation sector is looking at this; we've done our own technical analysis and are yet to see any evidence that would give us cause for concern."

Ofcom UK, 18 January 2021

"The ACMA considers that compatibility with radio altimeters can be successfully managed with WBB (Wireless Broadband) services introduced up to 4000 MHz."

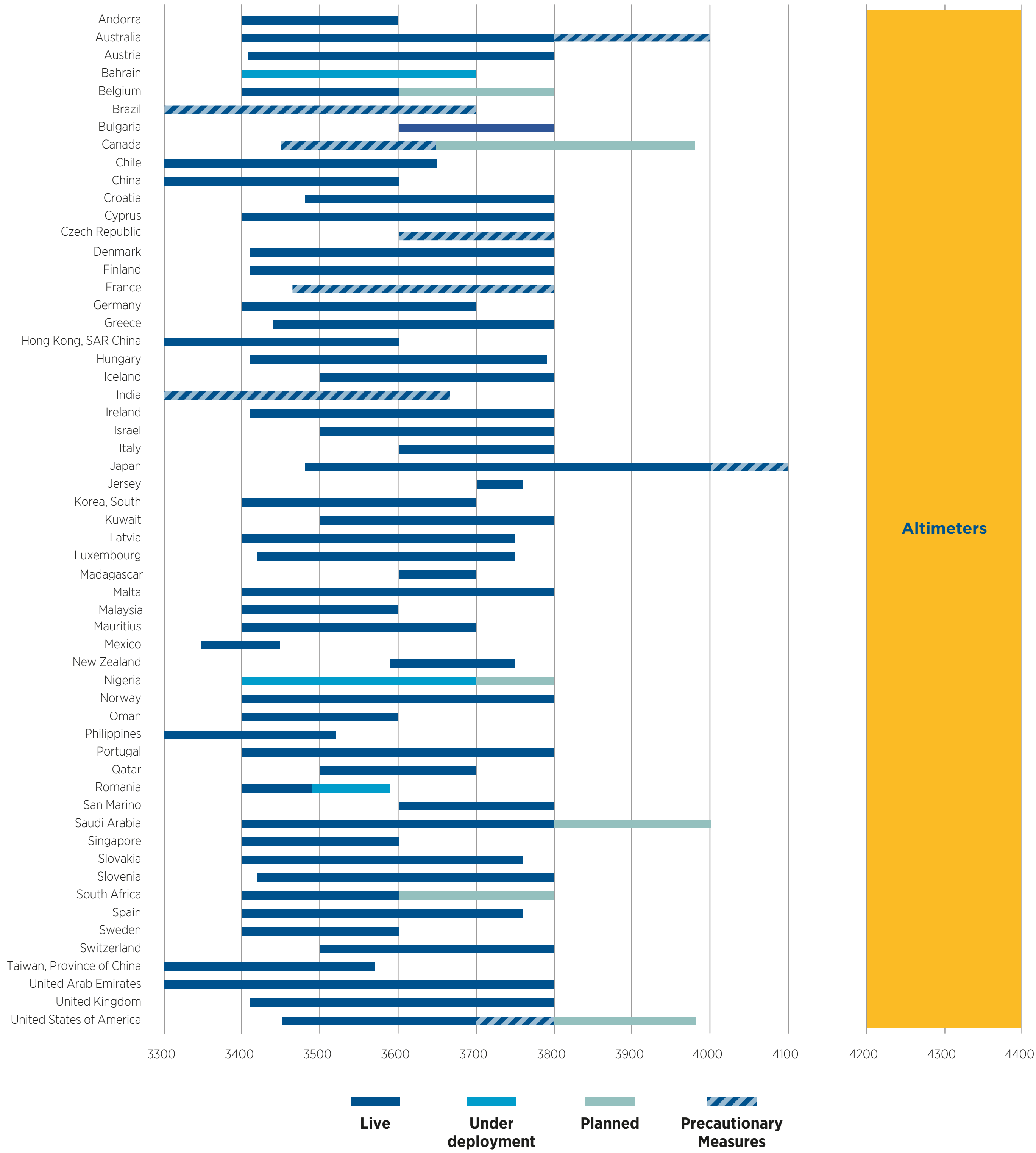
ACMA, January 2021

"Many countries around the world are already deploying wireless networks in the bands from 2200-4200 MHz. There have not yet been reports of harmful interference due to wireless broadband operations internationally."

FAA, 23 December 2021

Annex: 5G Networks operating in the 3.5 GHz range

FIGURE 1: COUNTRIES WITH 5G NETWORKS OPERATING AROUND 3.5 GHz (SOURCE GSMAi 21.04.2023)



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