

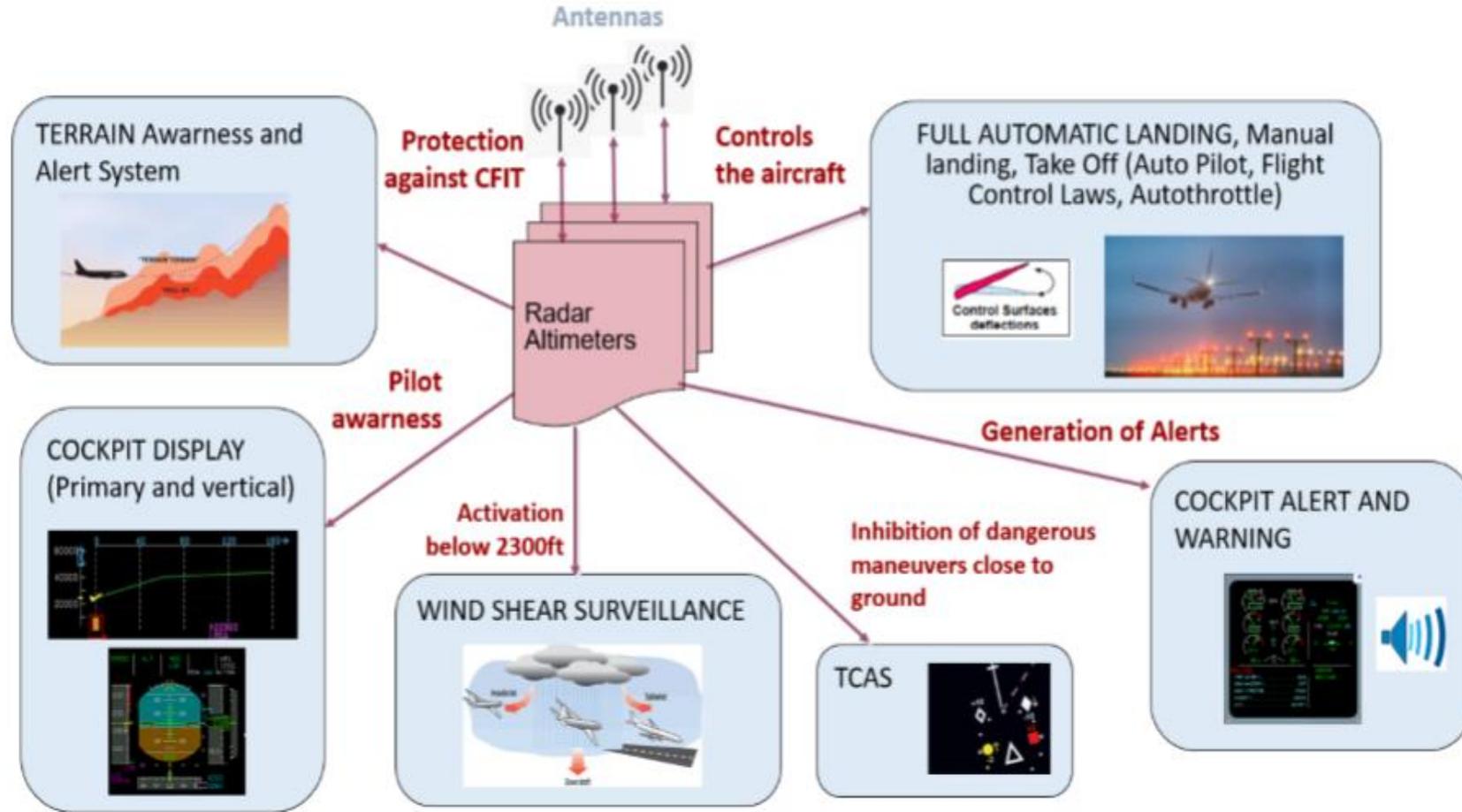
# 5G - Impact to Aviation



# Background Information

1. Radio altimeters operate at 4.2-4.4 GHz. Multiple radio altimeters on the same aircraft are operating at the same spectrum.
2. New C-band 5G frequency is close to the frequency being used by radio altimeters and potentially can interfere with the function of the radio altimeter if no mitigation is in place.
3. Interference impact is roughly a function of
  1. Power of the 5G transmitters
  2. Proximity of the 5G transmitters to aircraft
  3. Spectrum separation to radio altimeters spectrum (how close in GHz)
4. Spectrum issues and regulations are typically under the authority of State spectrum regulator.

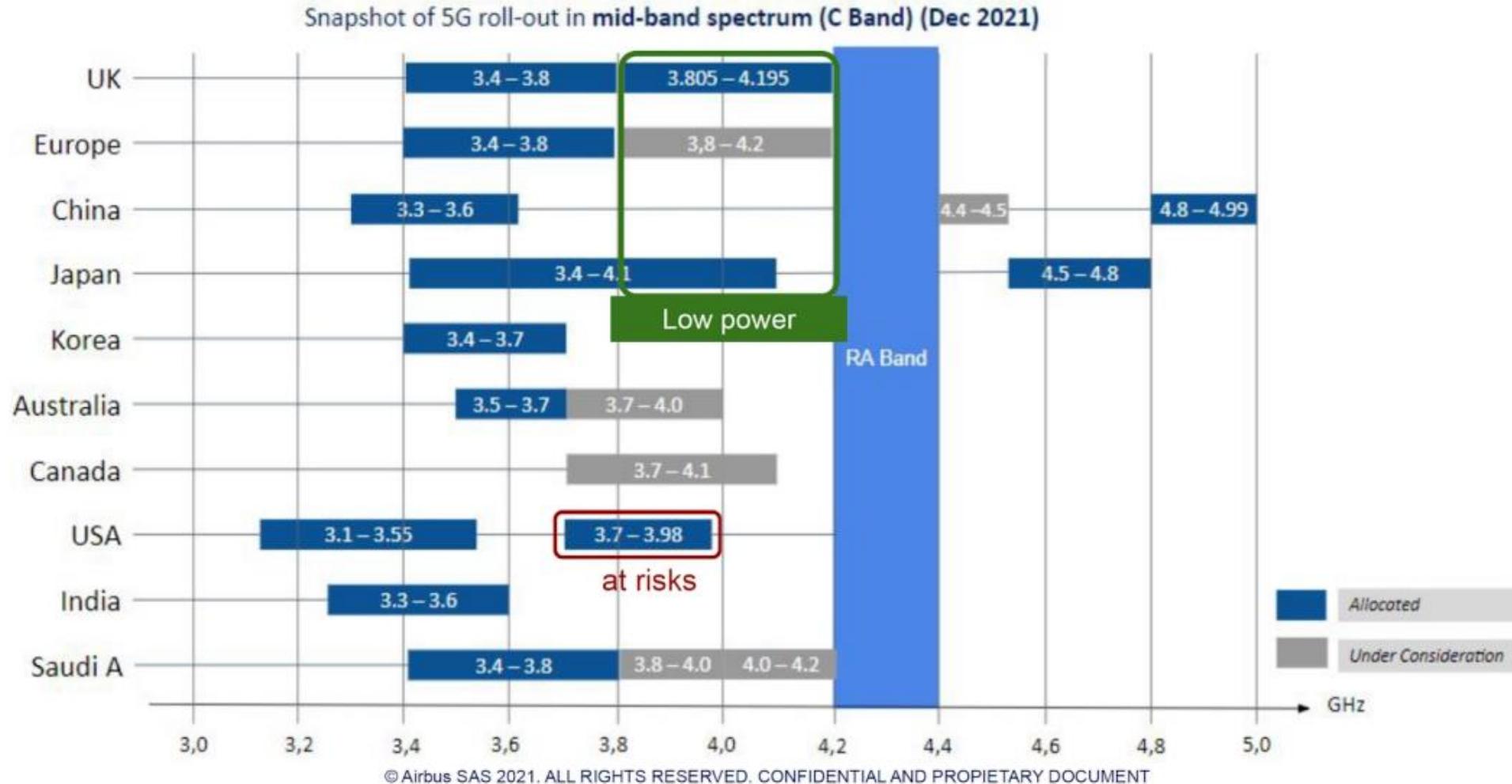
# Critical Roles of Aircraft Radio Altimeters



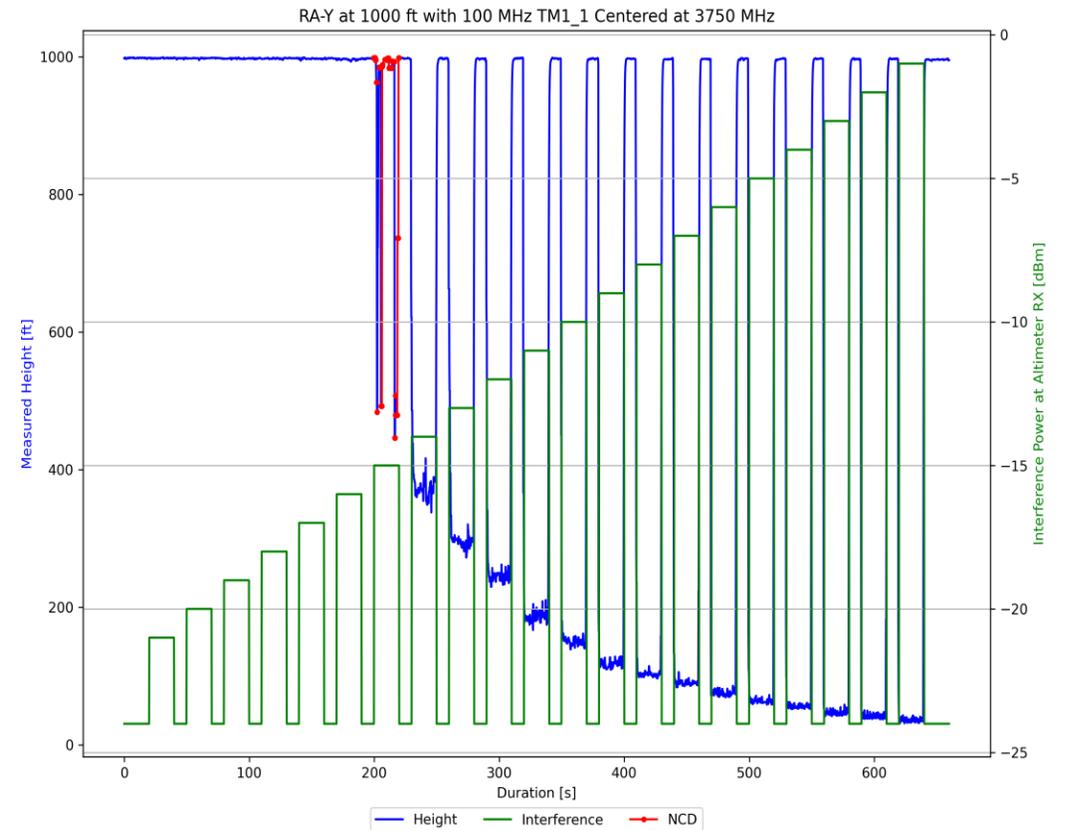
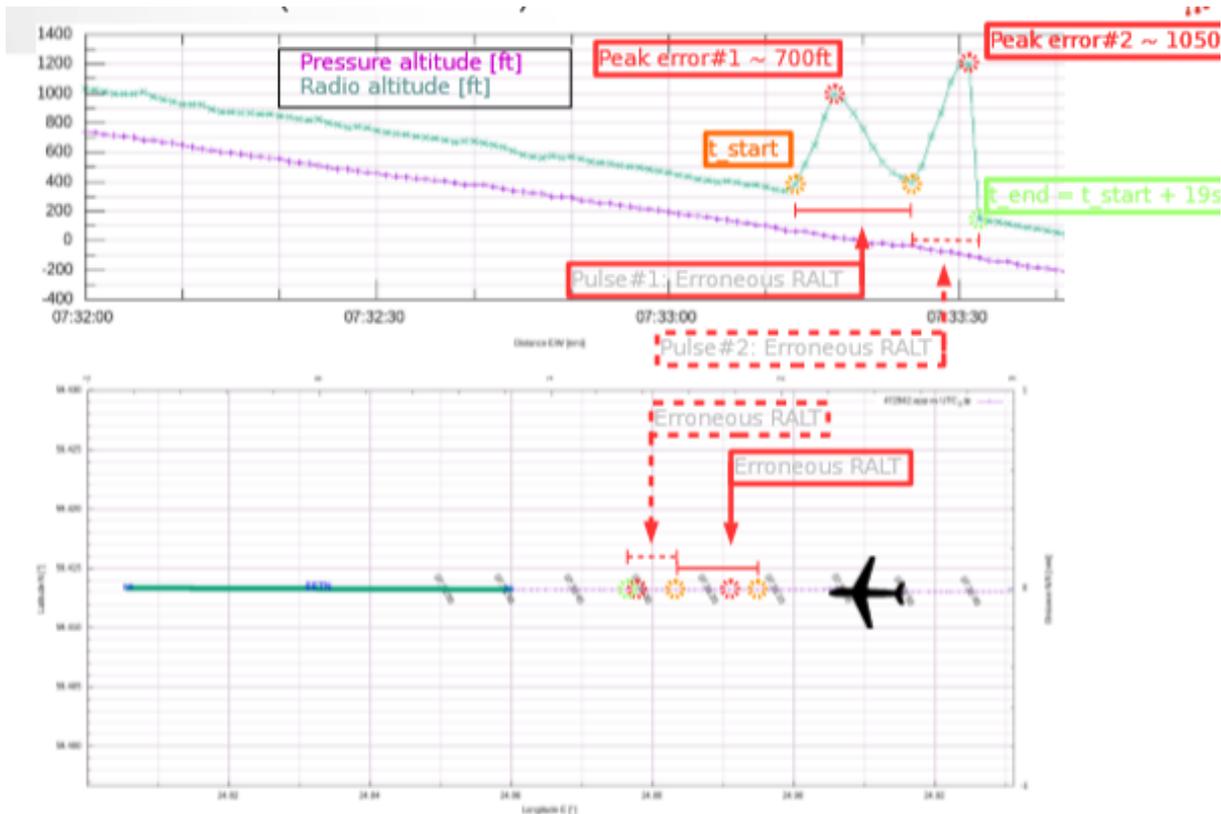
# The Radar Altimeter in Action – Low Visibility



# 5G Proposals/Deployments Across the Globe



# Examples of altimeters being interfered



Source: ICAO FSMP/11 IP06

# Examples of Key Global Events and Engagements

## Global

- ITU WRC-2015 – Russia/China/Japan/South Korea proposed 4.4 GHz for global 5G. Through joint IATA and ICAO engagement, ITU did not approve the proposal.
- At IATA request, ICAO Air Navigation Commission assigned ICAO Frequency Spectrum Panel to strengthen ICAO Spectrum Policy and develop SARPs for radio altimeters
- ICAO Flight Ops and Frequency Spectrum Panels endorsed the Statement of Concern submitted by IATA.
- Advocated by IATA, ICAO State Letter highlighting the need to protect radio altimeters issued (Mar 2021). Also, ICAO Position for WRC-2023 reemphasized the message.
- ICAO HLCC Recommendation 5-5

## Canada

- Supported by joint aviation filing (including IATA and Boeing), Canada spectrum regulator established a set to technical/regulatory constraints to 5G transmission protecting the radio altimeters

## Europe

- ICAO FSMP sent a liaison statement encouraging CEPT to protect radio altimeters



# Various National Regulatory Actions to Date



5G auctions and deployments are on-going globally: US, Europe, Middle East, Asia, Africa. Each with unique technical conditions.

Japan, France, and Canada issued sufficient technical conditions to 5G alleviating concerns by aviation.

- The technical conditions include spectrum separation, limitations of transmission power and antenna patterns, no-installation zone near approach paths.
- The conditions were issued by the State spectrum authority in coordination with States aviation safety authority.

Australia, Canada, New Zealand, South Africa, Thailand, and UAE issued safety notices, which include recommendations for

- All 5G equipment to be turned off while on-board aircraft.
- Passengers must be advised to ensure that all electronic devices in checked baggage are turned off.
- Operators must advise the air traffic service provider of any disturbance to the radio altimeter and report the occurrence to the CAA.
- Air Traffic Service Providers are encouraged to inform their controllers of the possibility of such reports by crews.



# 5G Implementation in the US



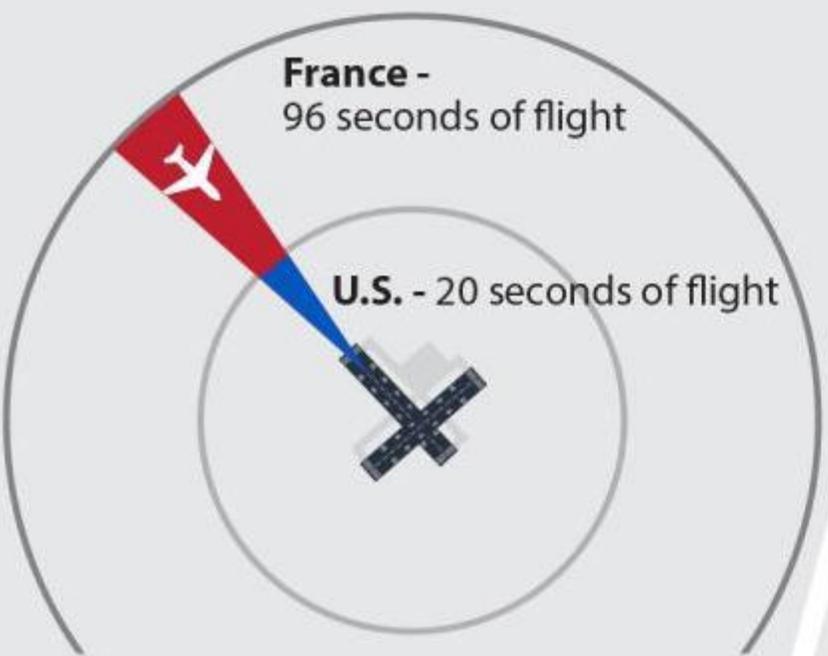
# Example of Key Events and Engagements

## USA

- Aviation coalition established since 2018
- [Aerospace Vehicles Systems Institute](#) (AVSI) testing supported by IATA, FAA and various aviation and aerospace organizations
- [RTCA report](#) published and submitted to the FCC. Consistent with AVSI testing.
- Independent testing result from OEMs is consistent with the RTCA report.
- Numerous filings including testing result and RTCA report submitted to US FCC and US NTIA
- Letter from the FAA to the FCC highlighted concerns as early as 2019
- Continuing engagements with the FCC in coordination with the FAA

# U.S. vs France: Big Differences

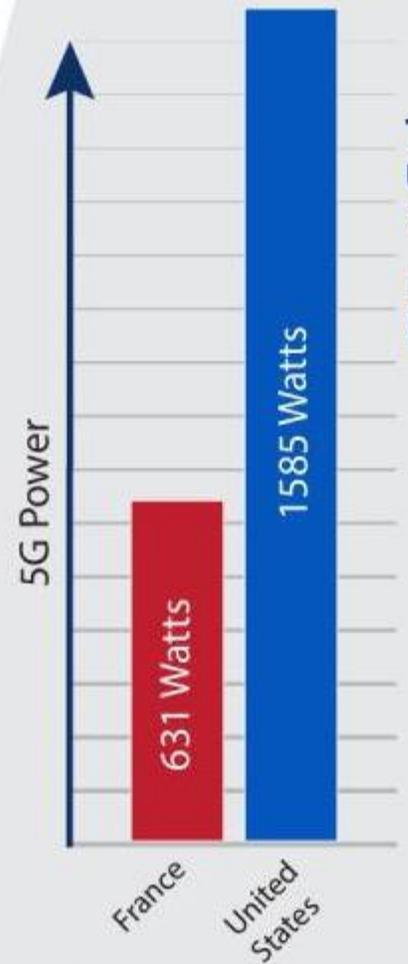
## 5G Airport Buffer Zones



U.S. - Six Month Temporary  
(50 Airports)

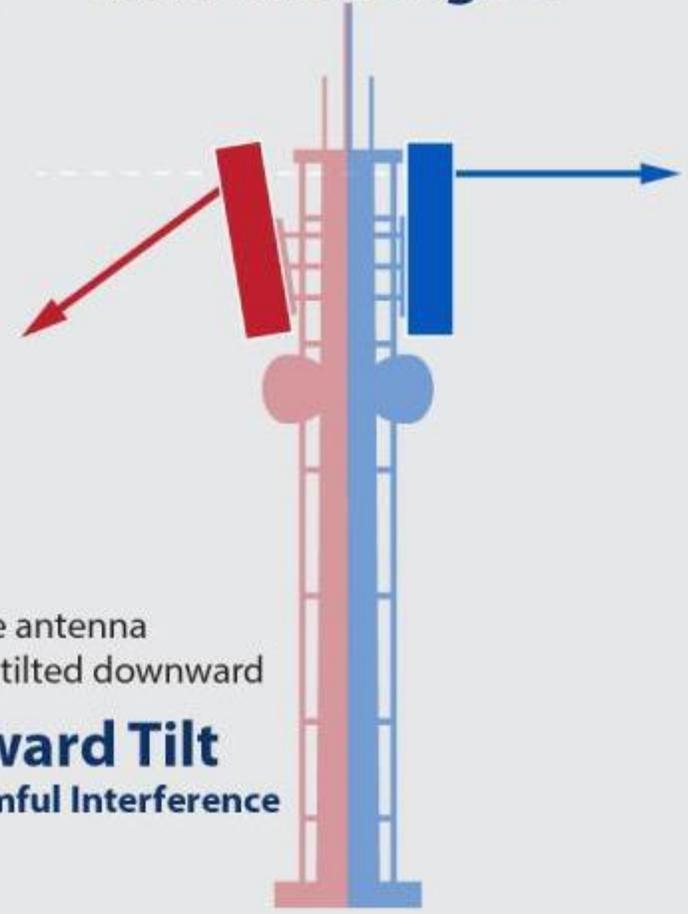
France - Permanent Safeguards

## 5G Power



Temporary  
U.S. 5G Power  
**2.5X**  
Higher

## Antenna Angles



In France antenna  
must be tilted downward

**Downward Tilt**  
Limits Harmful Interference

# Examples of FAA SAFO/SAIB/AD/CAN (1/2)

[SAIB: AIR-21-18R1](#) - Special Airworthiness Information Bulletin on the Risk of Potential Adverse Effects on Radio Altimeters

[SAFO 21007](#) - Safety Alert for Operators on Risk of Potential Adverse Effects on Radio Altimeters when Operating in the Presence of 5G C-Band Interference

[AD 2021-23-12](#) - Airworthiness Directive on altimeter interference and airplanes

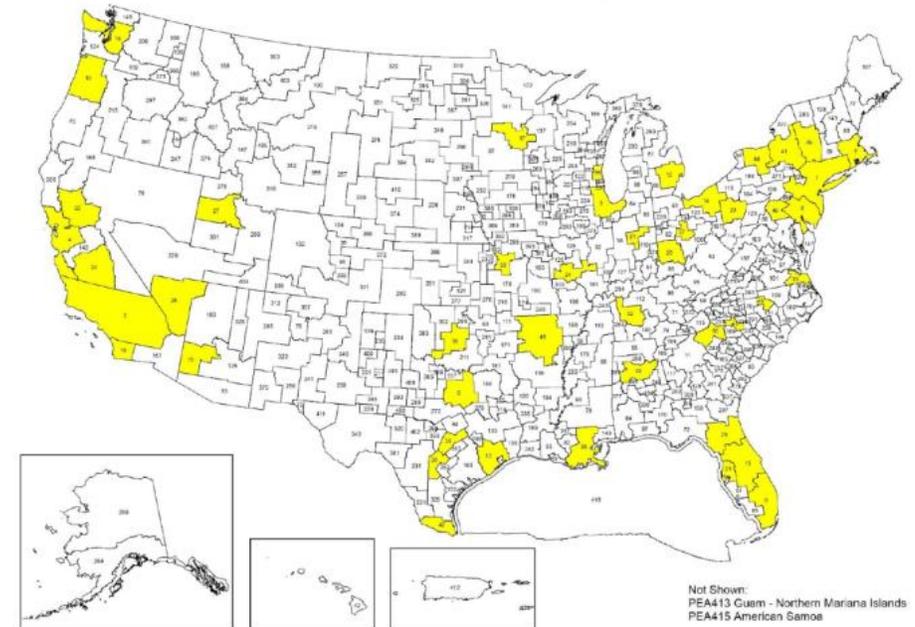
[AD 2021-23-13](#) - Airworthiness Directive on altimeter interference and helicopters

## FAA AD 2021-23-12

The FAA published on the 7th of December an Airworthiness Directive AD 2021-23-12. The AD mandates the application of NOTAMs on some US airports that prohibit precision approaches requiring Radio Altimeters data when in the presence of 5G C-Band interference. The ADs and future NOTAMs address situations specific to operations in U.S.A. airspace. In coordination with the FAA, EASA did not adopt the FAA ADs, EASA SIB 2021-16 [Ref. 4].

- **Non-US-Registered Aircraft Operators**  
No need to include the limitations in the AFM (unless explicitly required by their National Airworthiness Authorities).
- **US-Registered Aircraft Operators**  
Must introduce the limitations mentioned in the AD in their Aircraft Flight Manual before the 4th of January 2022 (as first step). This date was later delayed to 19th of January 2022.
- Operators shall assess the impact of NOTAMs for their intended operation.

## FCC Partial Economic Area (PEA) Boundaries



Valid on December 2021

# FAA SAFO/SAIB/AD/CAN (2/2)

**Fleet Specific Ads/CANs** (See also [www.faa.gov/5G](http://www.faa.gov/5G) for latest information.)

[CAN-2022-01.pdf](#): Continued Airworthiness Notification to the International Community - Boeing 787 Altimeter and 5G

[AD 2022-02-16](#): Airworthiness Directive - **for Boeing 787-8, 787-9, and 787-10** - requiring revising the limitations and operating procedures sections of the existing airplane flight manual (AFM) to incorporate limitations prohibiting certain landings and the use of certain minimum equipment list (MEL) items, and to incorporate operating procedures for calculating landing distances, when in the presence of 5G C-Band interference as identified by Notices to Air Missions (NOTAMs).

[AD 2022-03-05](#): Airworthiness Directive - **for Boeing 747-8, 747-8F and 777** – prohibiting landing at airports where 5G interference could occur.

[AD 2022-03-20](#): Airworthiness Directive - **for Boeing 737-8, 737-9, and 737-8200** - requiring revising the limitations and operating procedures sections of the existing airplane flight manual (AFM) to incorporate limitations prohibiting the use of certain minimum equipment list (MEL) items, and to incorporate operating procedures for calculating takeoff and landing distances, when in the presence of 5G C-Band interference as identified by Notices to Air Missions (NOTAMs)

[AD 2022-04-05](#): Airworthiness Directive - **for Boeing 757 and 767** - requiring revising the limitations and operating procedures sections of the existing airplane flight manual (AFM) to incorporate specific operating procedures for landing distance calculations, instrument landing system (ILS) approaches, non-precision approaches, speed-brake deployment, and go-around and missed approaches, when in the presence of 5G C-Band interference as identified by Notices to Air Missions (NOTAMs).

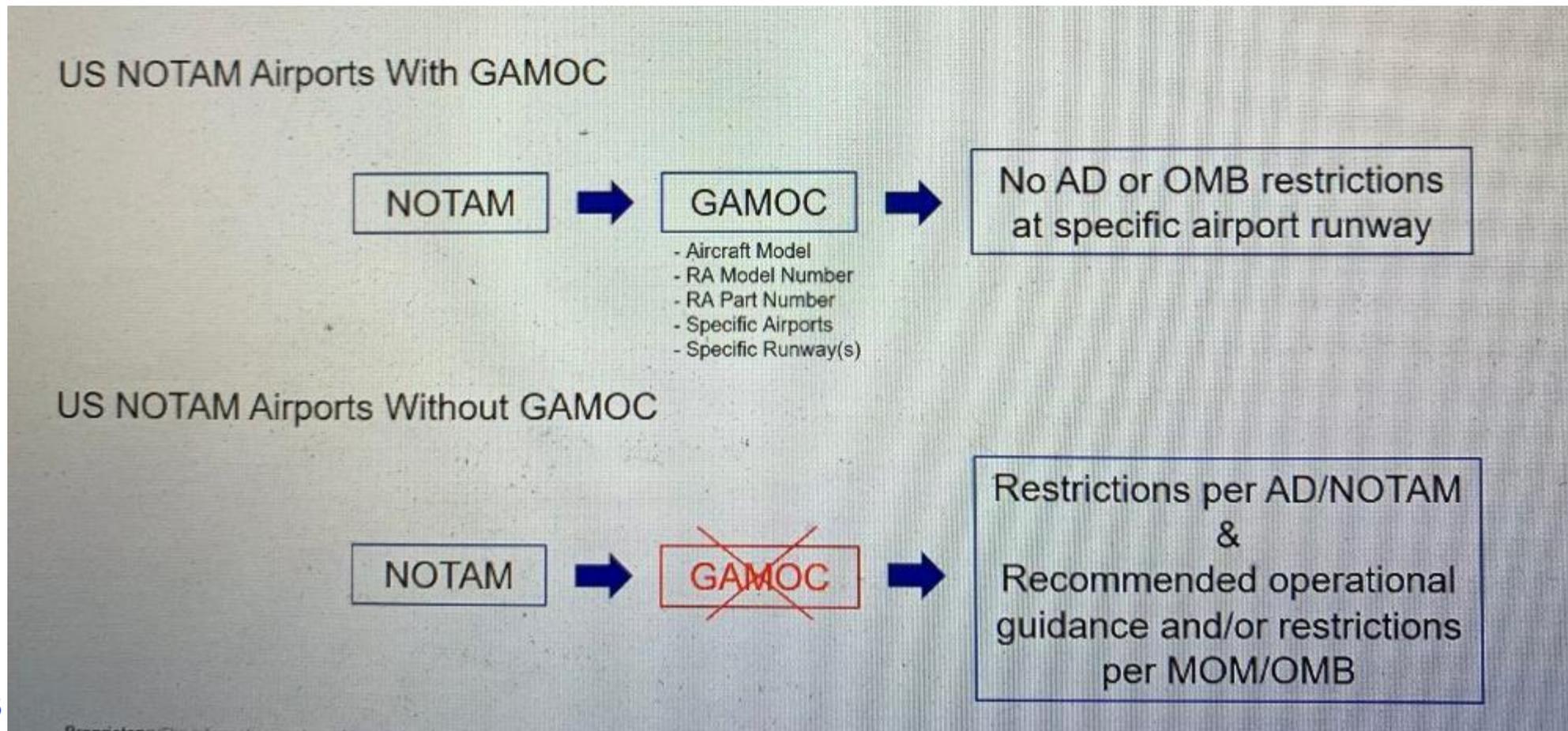


# Current Aircraft with AMOC Approved (Feb 15<sup>th</sup>, 2022)

- Current FAA AMOC evaluation is based on AMOC method Version 2.
  - The enhanced AMOC method Version 3 is being tested for future AMOC released.
- The FAA has approved 20 altimeters to perform low-visibility landings at **specific AMOC-approved** airports in the 5G deployment. The FAA anticipates that some altimeters will have to be retrofitted or replaced.
- FAA Website ([www.faa.gov/5g](http://www.faa.gov/5g)) provides current information on AMOC availability for each runway/airport.



# Global Alternative Mean Of Compliance (GAMOC) & Operational Restrictions



# Current AMOC Evaluation Method

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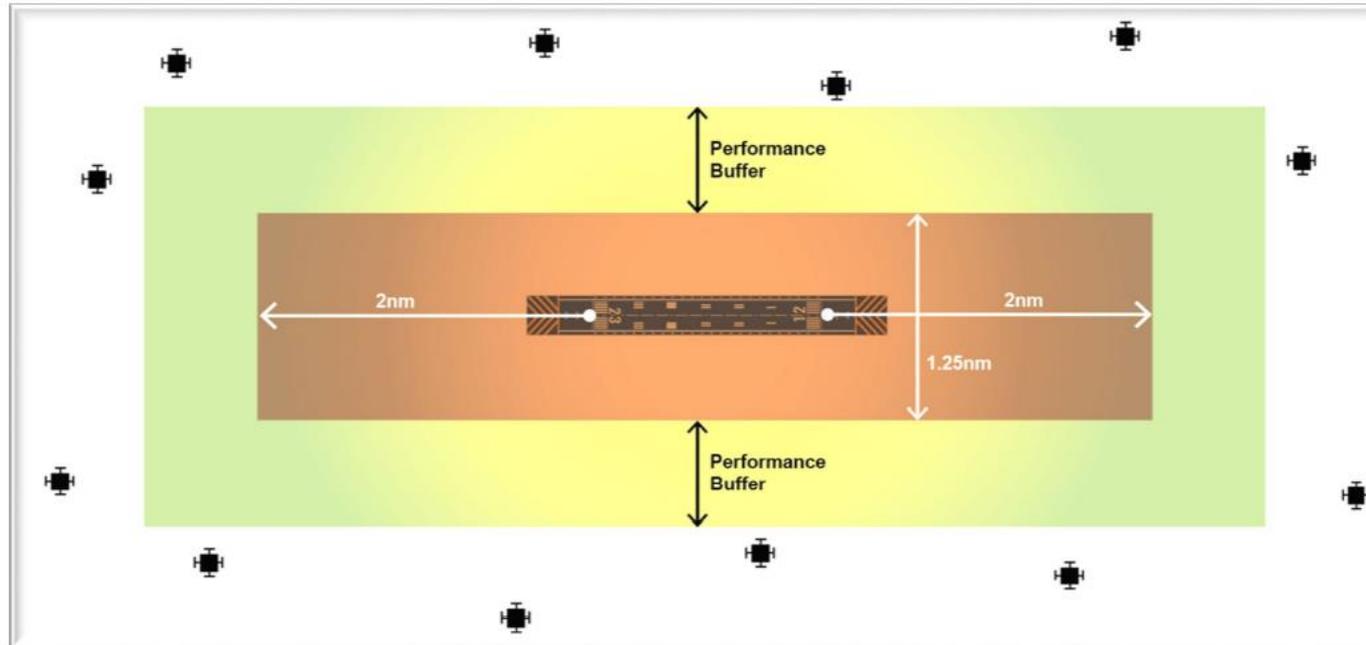
## Update: Runway Safety Model

- **Runway Safety Zone (RSZ)** – FAA’s determination of the safety area around a runway. The safety area is defined as the area where unreliable Radio Altimeter function can lead to a catastrophic outcome. Acceptance criteria: The Radio Altimeter must function accurately and reliably in 100% of the RSZ.
- **Performance Buffer (PB)** – FAA AMOCs are issued based on the performance capabilities of the Radio Altimeter. The current method is to determine the minimum distance away from a 5G antenna the aircraft needs to be to meet the acceptance criteria for the RSZ. This is described as a radius from a 5G antenna.



# Current AMOC Evaluation Method

## Runway Safety Zone with Performance Buffer (v 2.0)



Federal Aviation  
Administration



# Key Messages

- Spectrum is a scarce resource with competing interest.
- AMOC process is an unsustainable “lifeboat.”
  - VERY complex process
  - Unpredictable changes and difficult to plan
- Safety co-existence between aviation and 5G is possible, but requires
  - Early coordination and active engagements between State aviation and telecom authorities
    - Open dialogue and sharing of technical information and implementation plan
  - Leadership within governments to facilitate the interagency and inter-industry dialogue
  - Different technical culture: Safety vs Speed must be addressed early
  - Appropriate codified conditions/regulations by telecom authorities under agreement between aviation regulators and operators prior 5G auctions/deployments



# Moving Forward

- On-going collaboration between aviation and telecommunication stakeholders
- Medium-term: Through State regulation, necessary mitigations are in place:
  - recommended by ICAO and supported State aviation authorities
  - codified by State telecommunication authorities
  - include suitable combination of
    - appropriate 5G power limit and transmitting pattern
    - sufficient frequency separation from 4.2-4.4 GHz used by radio altimeters
    - appropriate protection and pre-cautionary zones around airports and flight path
  - ensure aviation safety and uninterrupted flight operations and services
  - provide stable, known implementation conditions supporting 5G deployment
- Long-term: Known, stable and plannable global spectrum environment, particularly near frequency band allocated to aviation.

