



5G C-Band Workshop

November 8, 2022

Radio Altimeters and 5G C-Band Deployment in the United States

Speakers

Di Reimold, Deputy Vice President (Acting), Flight Program Operations, FAA

Gaetano (Tom) Sciortino, Deputy Director, Compliance and Airworthiness Division, FAA Aircraft Certification Service

James Linney, Director of Operations Support, FAA Spectrum Office

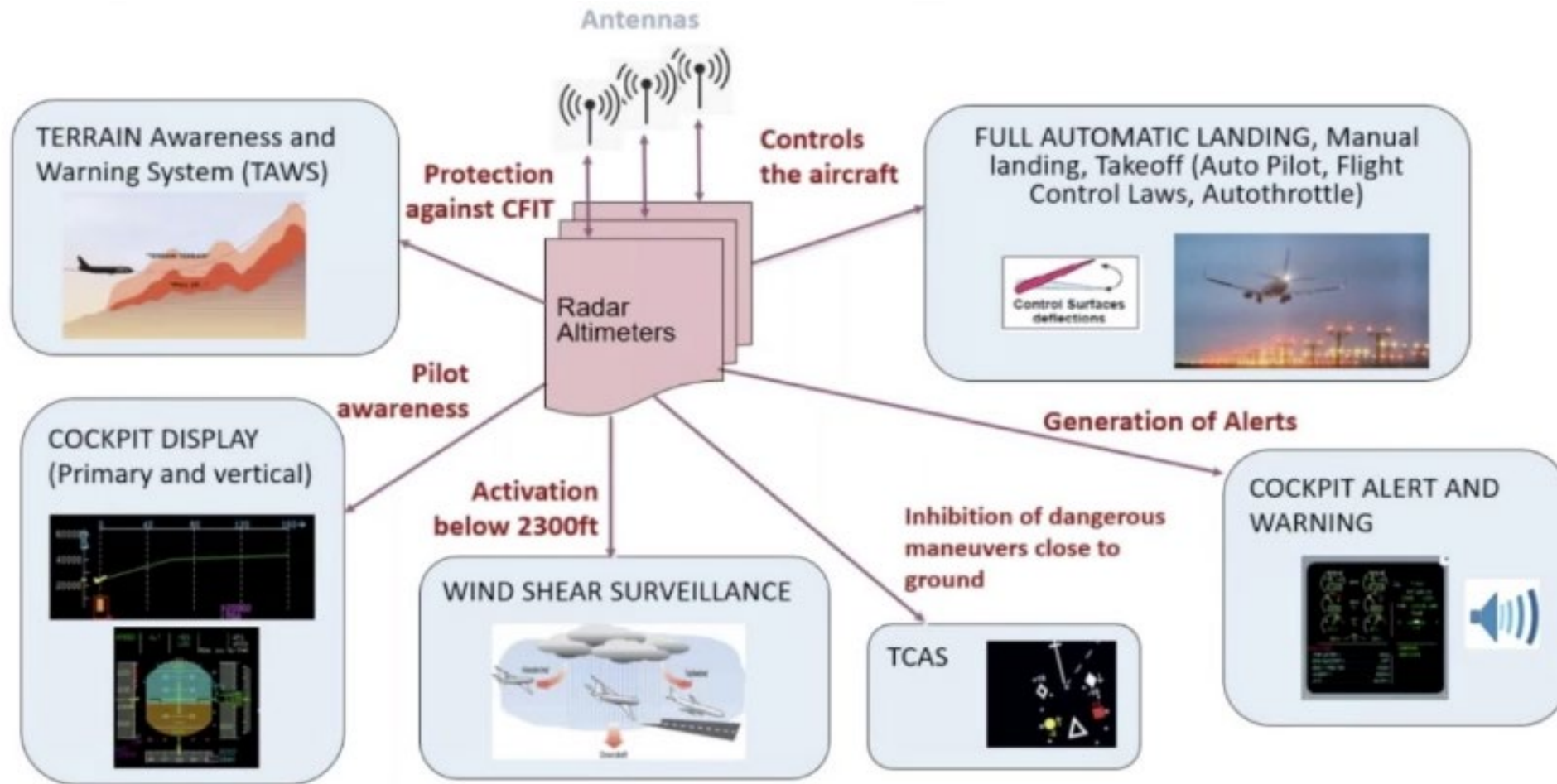
Chris Hope, Manager, Flight Technologies and Procedures Division, FAA Flight Standards Service

Setting the Stage

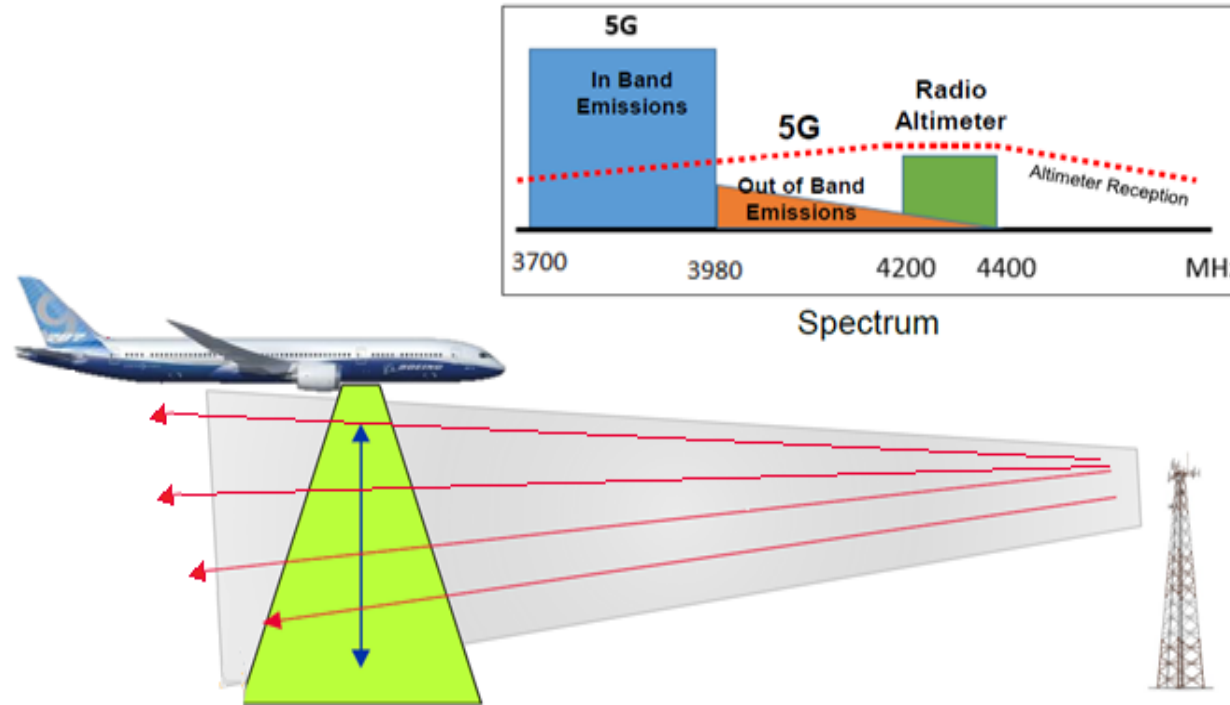
- The FAA and two major U.S. based telecommunications companies have demonstrated that 5G C-band and aviation can safely co-exist
- FAA has worked closely with aviation industry stakeholders, ANAC, EASA, TCCA, and other international partners to harmonize approaches to global deployment of 5G.
- Technology will continue to evolve...how do we leverage and apply what's been learned for the future?
- Today is a conversation among partners to share experiences and listen to other viewpoints
- We welcome thoughts and questions that will help us lay out a better path for the future



Radar Altimeters Measure Height *Above Ground Level (AGL)* and Feed into a Number of Safety Critical Systems such as:



What Makes Radio Altimeters Susceptible to Interference?



- Radio Altimeters (RA) are designed to “listen” for quiet signals which bounce back within or close to the RA band
- 5G signals broadcast close to the RA band, and may bleed over into the RA band

Scope of the Hazard

- **Radio Technical Commission for Aeronautics (RTCA) and Manufacturer Testing**
 - Loss of RA data or Misleading RA data may occur
 - Different RA models have different levels of susceptibility
- **FAA Flight Evaluations**
 - Confirmed that aircraft in the US will encounter 5G C-band signals at power levels shown to create interference
- **Affected US Fleet Sizes**
 - ~7,500 Transport Airplanes (2-3 RAs per airplane)
 - ~6,000 Rotorcraft (1 RA per aircraft)
 - ~17,000 Small Airplanes (1 RA per aircraft)
- **Foreign-registered aircraft which fly into the US**



Timeline of 5G Deployment in the US

2015

- Mobile C-band Allocations are Proposed at World Radio Communications Conference
- ICAO Job Cards Created

2019-20

- Testing by Aviation Demonstrates Potential Interference
- RTCA Report Published in 10/2020

2022

- Verizon and AT&T Begin Deploying 5G C-band Services in the US
- FAA brokers Cross-Industry Information Sharing to Manage Operational Impacts

2021

- FCC Auctions 5G C-band Spectrum

2017

- US Initiates Procedures to Allocate C-band for 5G
- Aviation Submits Comments Expressing Concerns

2020

- US Completes Allocation of C-band Spectrum for 5G

2021

- US Government Interagency Discussions
- FAA Issues Safety Mitigation Actions



FAA Actions: November-December 2021

- **Special Airworthiness Information Bulletin (SAIB): AIR-21-18 November 2, 2021;**
 - Provides recommendations for radio altimeter manufacturers, aircraft manufacturers, and operators and pilots.
- **Airworthiness Directives (AD): 2021-23-12 and 2021-23-13 December 9, 2021.**
 - Prohibits certain rotorcraft and transport category airplane operations in the presence of 5G C-band (3.7-3.98 GHz) emissions.
 - The Unsafe condition is unreliable RAs in the presence of 5G C-Band.
- **Safety Alert for Operators (SAFO): 21007 December 23, 2021**
 - Provides information and guidance to operators regarding the risk of potential adverse effects on radio altimeters when operating in the presence of 5G C-band wireless broadband signals.
- **Beginning of data exchange with AT&T and Verizon—site locations, antenna characteristics**



FAA Actions since January 2022

- Monthly assessment of new antenna locations (approximately 5-8K/month)
- Monthly Notice to Air Missions (NOTAMs), Alternative Methods of Compliance (AMOCs)
- Monthly meetings with stakeholders to increase outreach efforts
- Continued refinement of airspace protection models
- 5G Roundtable Discussions between Aviation and Telecommunications Stakeholders



Signal in Space Animation



5G C-band Mitigation Airports

Criteria used to identify 5G C-band Mitigation Airports:

- Primary commercial service (>10,000 annual enplanements), or
- Significant cargo airports (>100 million landed tons), and
- Low visibility approaches published or scheduled
- Also include airports:
 - With essential Required Navigation Performance – Authorization Required (RNP AR) vertically guided approaches
 - Diversion or regular use by aircraft types with unique provisions in their airworthiness directives related to 5G
 - Operationally significant



Radio Altimeter Interference Reporting

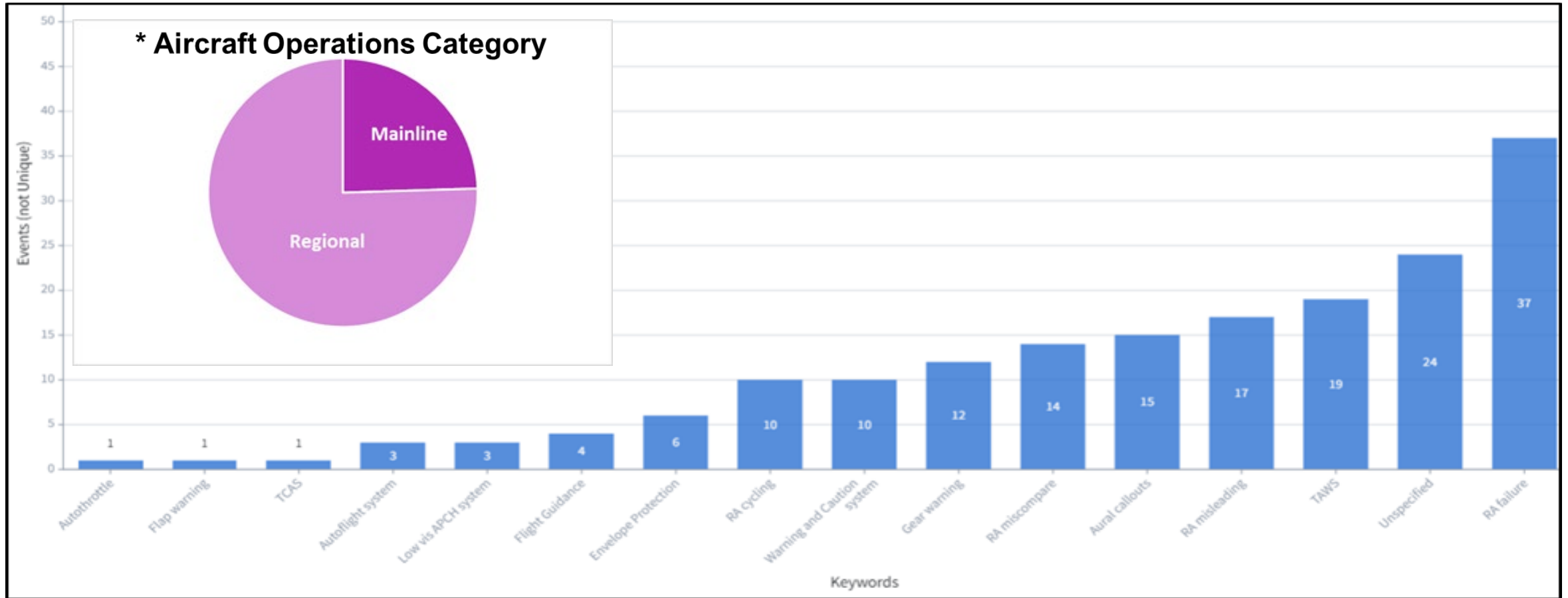
- The FAA receives reports from multiple sources
 - Focus is operations with the US, but includes partnership with other CAAs for global event monitoring
- Team has reviewed 568 reports and closed 91% since January.
 - 103 events of “possible 5G interference” (reviewed maintenance data, aircraft and airport trends, and event description).
 - Within this set, the majority were found to be direct radio altimeter impacts and nuisance alerts (e.g., Terrain Avoidance Warning System (TAWS), aural callouts, warning and caution systems).

FAA and Wireless Providers voluntary mitigations (reduced power levels, ADs, NOTAMs, AMOCs, protection of certain airports) are working

As of November 1, 2022



Radio Altimeter Interference Reporting



As of November 1, 2022



Managing Cumulative Fleet Risk

Source: ICAO Safety Management Manual (SMM) (Doc 9859)

Safety Risk		Severity				
Probability		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	Major / Minor		5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	Hazardous / Catastrophic		3C	3D	3E
Improbable	2	2A	2B	Major / Minor		2E
Extremely improbable	1	1A	1B	1C	1D	1E

- FAA ADs mitigate risks of hazardous/catastrophic outcomes
- Numerous major/minor hazards are not addressed by current ADs
- Expanded 5G deployments will increase the rate of major/minor events
- Residual risk is accumulating globally; FAA, EASA, TCCA, ANAC are discussing how to harmonize our approach to global risk management



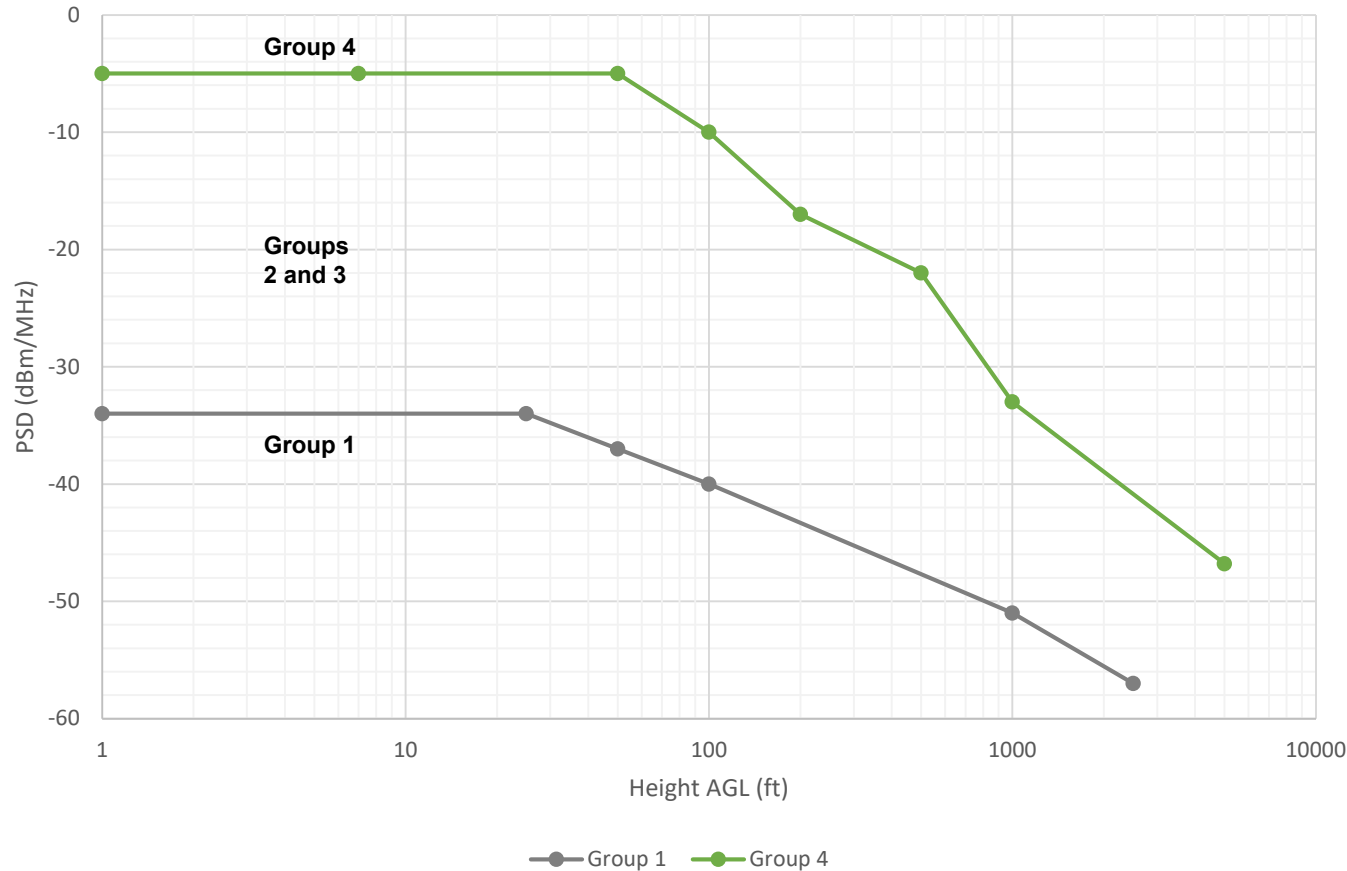
US Fleet Retrofit

- The mitigations from wireless companies around airports end in July 2023
- Filter solutions for some aircraft/radio altimeter combinations are available now
- Additional solutions available by end of 2022
- All transport airplanes must have a radio altimeter that is compatible with 5G C-Band interference without the wireless mitigations post July 2023
- FAA, Airframe Manufacturers (OEMs), Radio Altimeter (RA) Manufacturers, and Associations are tracking parts of the fleet retrofit



(Group 4) RA Tolerance Requirements Power Curve

Signal in Space Power Curves



Objectives:

- Wireless deployment unencumbered by signal-strength constraints
- Aviation maintains safe operations at all 5G C-Band Mitigation Airports (5G CMA) with a single retrofit*

Aircraft Requirement:

- Radio Altimeter installations performance in airplanes must meet or exceed the Group 4 power curve after July 2023

* Confirmed one RA requires a second retrofit (~150 airplanes)



Conditions Necessary for 5G C-Band in the US

- **Reduction in Spurious Emission Limits***
 - **Current:** High spurious emissions allowed
 - **Change Needed:** Limit spurious to a low emissions level
- **Implementation of a downward tilt requirement***
 - **Current:** Radiation in all directions allowed at full power above the horizon
 - **Change Needed:** Require reduced power limits above the horizon for all towers nationwide
- **Maintain 220 MHz Guard Band (Separation)***
- **Power Limits Near Airports**
 - **Current:** Towers can be installed anywhere up to maximum power
 - **Change Needed:** Reduced allowed power level in areas around certain Airports

**These are part of the current AT&T/Verizon deployment*



Lessons Learned Summary

- **US Approach is an example of safe integration**
- **Radio Altimeters (after modification) will perform reliably in a 3.7-3.98 GHz C-band environment, provided the following conditions are met:**
 - Maintain a Guard Band
 - Reduced emissions around airports
 - Limit spurious emissions
 - Downward Tilt requirement for antenna energy
- **If any of these conditions are not met, then further investigation is needed to assure safety**
- **New generation of performance standards to ensure technology evolutions won't impact**

