Frequency Management WG/2
(Virtual Meeting 7 June 2021 from 08:00 to 10:00 UTC)

Agenda item 5: Any other Business

Protecting Radio Altimeter Operations Electro magnetic Compatibility (EMC) Aspects related to G5

Presented by Saudi Arabia

Introduction:

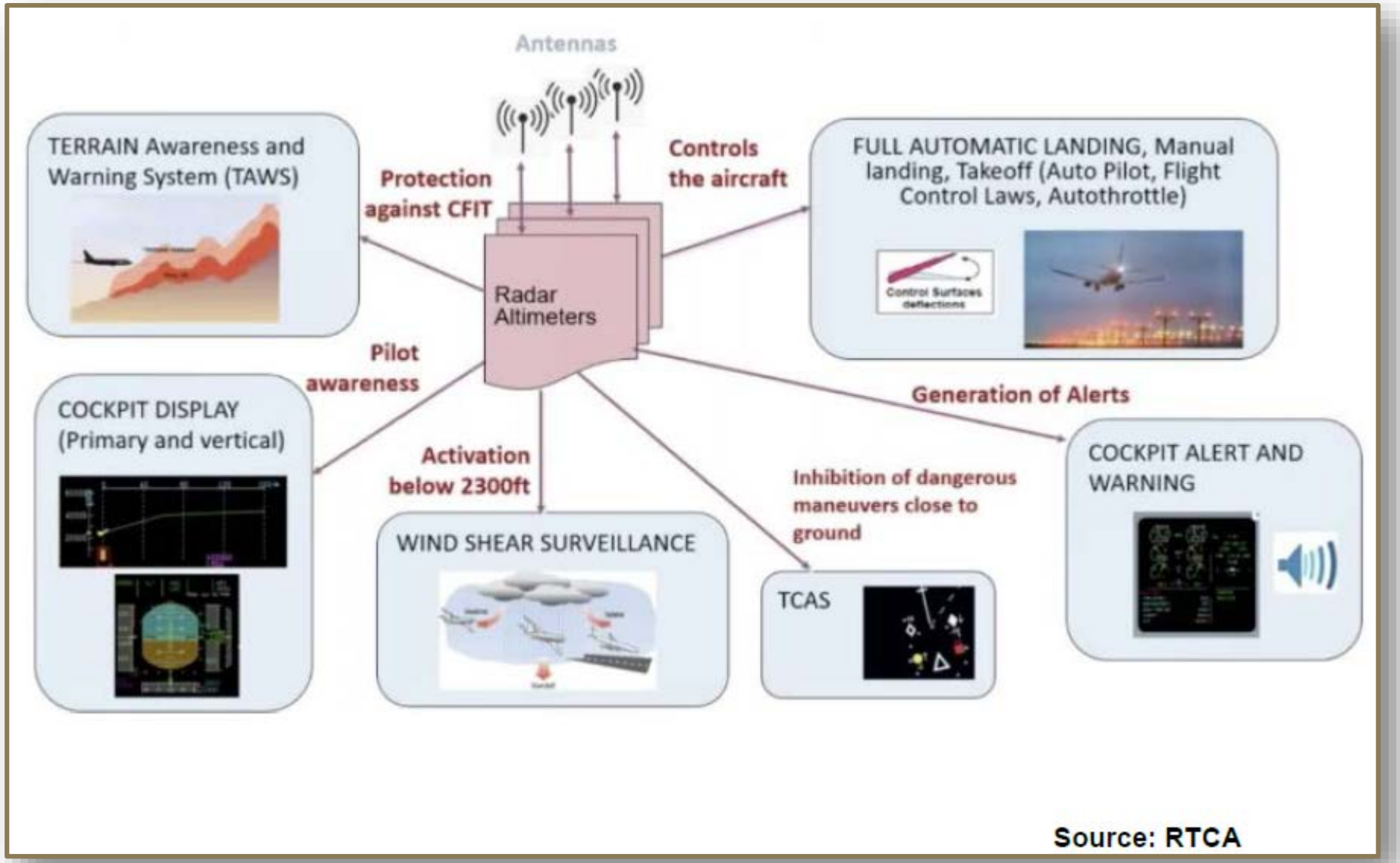
- The purpose of this presentation is to share information on the deployment of 5 G services and related safety concern that was subject of ICAO State Letter which invites States to consider as a priority, public and aviation safety when deciding how to enable cellular broadband/5G services in radio frequency bands near the bands used by radio altimeters.

- The action by the meeting is given in the last slide of this presentation.

Radio Altimeter

- The band 4 200-4 400 MHz (4.2-4.4 GHz) is currently allocated to the aeronautical radionavigation service (ARNS) and is reserved exclusively for radio altimeters installed onboard aircraft and for the associated transponders on the ground by Radio Regulations footnote No. 5.438.
- The basic function of a radio altimeter is to provide accurate height measurements above the Earth surface of 0.9 meters (3 feet) or more with a high degree of accuracy and integrity during the approach, landing, and climb phases of aircraft operation representing a wide variety of reflectivity regardless of the Earth surface.
- The elevation readings are transmitted to a pilot's visual display and to several automatic safety components. **Radio altimeters provide an essential informational component of the automatic flight control system for approach and landing, ground proximity warning system, terrain awareness and warning system, flight management guidance computer, flight control systems, electronic centralized aircraft monitoring.**
- RADALT determines the particular altitude in which the aircraft can safely land and as an input to the terrain awareness warning system (TAWS), which gives a "pull up" warning at a predetermined altitude and closure rate; and as an input to the collision avoidance equipment and weather radar (predictive wind shear system), auto-throttle (navigation), and flight controls (autopilot).

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



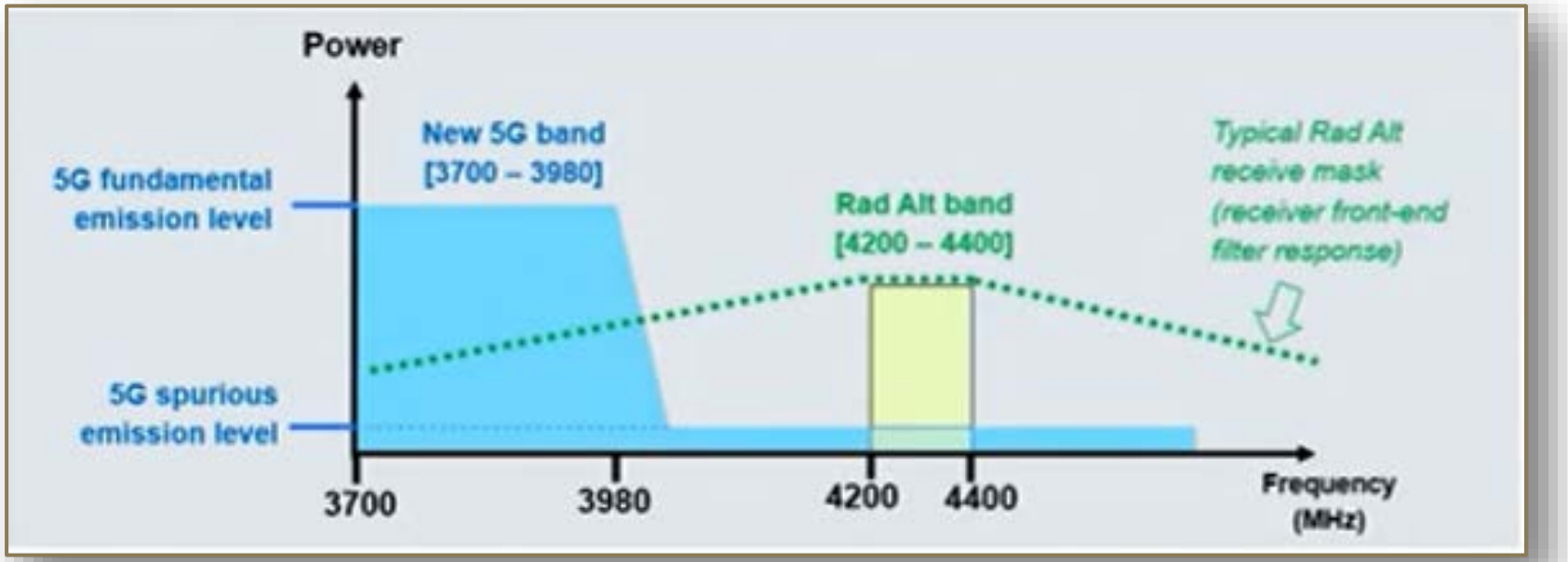
Radio Altimeter Operations

- **Use during approach and landing:**
- Determination of Decision Height for all Low Visibility OPS (DH < 200ft);
  - Primary Flight Display Indication;
  - Audio announcement;
  - Used for landing flare maneuver in Automatic Flight Control System.

- **Integral Part of GPWS:**
- ACAS Integration (Descent advisory)

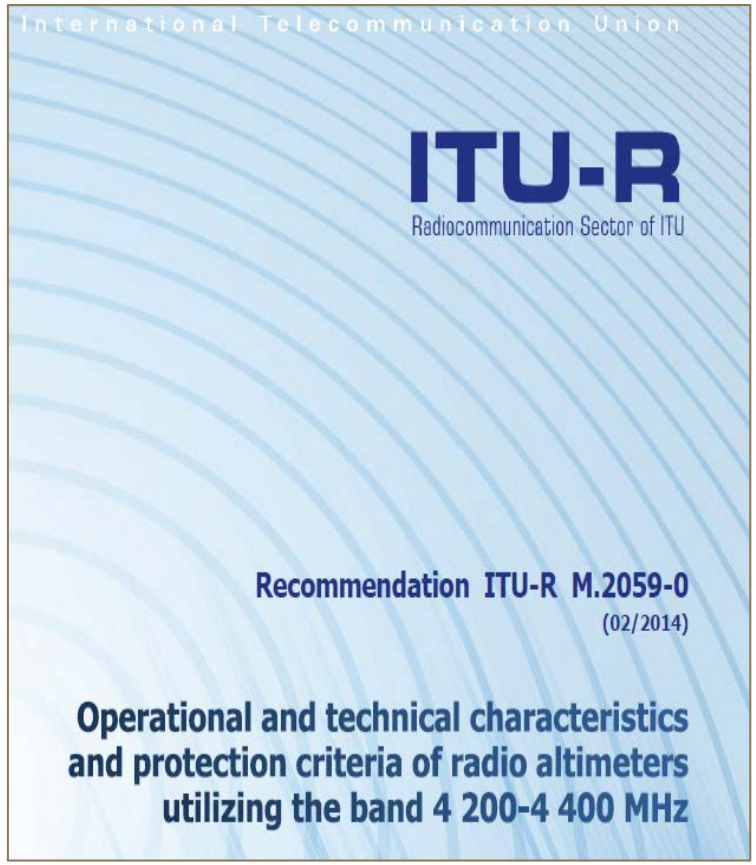
- **Current ICAO Requirements (Annex 14)**
  - Radio altimeter Operating area;
  - Pre-threshold terrain profile;
  - Criteria & guidance in AWO Manual (Doc 9365) and PANS OPS (8168).

Potential Interference with 5G deployments



- From RTCA Paper No. 258-20/SC239-006, Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations.
- Can include Telecom company-internal network to complement WIFI network.
- International Telecommunications Union recommendations (ITU-R M.2059) define protection criteria for Radio Altimeters.

International Telecommunications Union recommendations :



Protection criteria:

- Any compatibility analysis between radio altimeters and other systems must utilize protection criteria for the maximum acceptable degradation for a radio altimeter. There are three primary electromagnetic interference coupling mechanisms between radio altimeters and interfering signals from other transmitters: receiver overload, desensitization, and false altitude generation. Also, both out-of-band and in-band interference can affect a radio altimeter performance.

- New 5 G Active Antenna Systems will require separations of several KM.

- The separation distances will not be considered acceptable by 5G providers.

International Telecommunications Union recommendations Cont'd

Operational and technical characteristics and protection criteria of radio altimeters utilizing the band 4 200-4 400 MHz

(2014)

Scope

This Recommendation describes the technical and operational characteristics, and protection criteria of radio altimeters used in the aeronautical radionavigation service.

The ITU Radiocommunication Assembly,

considering

a) that radio altimeters are an essential component of aeronautical safety-of-life systems, including precision approach, landing, ground proximity and collision avoidance systems;

b) that radio altimeter systems operate in the aeronautical radionavigation service;

c) that radio altimeters have been fitted for decades to all types of aircraft;

d) that radio altimeters are operational during and must operate without harmful interference for the entire flight;

If an aircraft loses or receives erroneous radio altimeter data, several consequences can occur depending upon the aircraft type, airport landing requirements or classification, and weather. Loss of radio altimeter data will disable the autopilot resulting in the pilot and co-pilot manually flying and landing the aircraft. Some airport categories or certain weather conditions would prohibit the landing of some types of aircraft without altimeter data. If only one radio altimeter is operational, then the height above ground when the decision to land the aircraft is made must be adjusted to a higher altitude. If visibility is poor, then the aircraft might be forced to wait until the weather gets better or land at a different airport. If the radio altimeter signal receives harmful interference during the final stages of landing, then a hazardous or catastrophic situation could occur. At best, the flight crew workload increases significantly; at worst the aircraft, crew and passengers are placed in a catastrophic situation.

It should be understood then that any interference that is unpredictable and that can mix with the linear FM waveform, thereby causing the radio altimeter to mistake the mixed signal as terrain has the potential to cause a radio altimeter to report a false altitude.

The fact that all radio altimeter antennas are necessarily pointed at the Earth's surface makes the system vulnerable to all possible interference sources illuminated during approach. The altimeter antennas, due to their location on an aircraft, do not have the benefit of being shielded or screened from many of the possible interference sources on the Earth's surface. Instead it can virtually "see" all possible radiation sources as they escape buildings and via direct transmission from devices operating outside of any structure.

Potential impact on Continued Airworthiness

Safety and Operational impact

Anywhere close to terrain:

- Could inhibit some functionalities of the TAWS reactive modes which would remove a safety net related to protection from CFIT (Controlled flight into terrain.

Impact of 5G stations are located too close to airports:

- Could induce hard landing (manual and auto flare below 50ft).
- Risk of Go around as landing criteria are affected/not met.
- Diversion: No possibility to land in low visibility conditions.
- Spurious/false message in the cockpit, RA display.

ANC talks held on 22 February 2021

Presentation by States:

- France and FAA presented their views and actions during ANC talks held on 22 February 2021.

Presentation by specialized organization:

- RTCA Study & White paper: RTCA Assessment of C-Band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations.
- EASA activities and actions following RTCA study & white report.

Potential impact on Continued Airworthiness

Cont'd

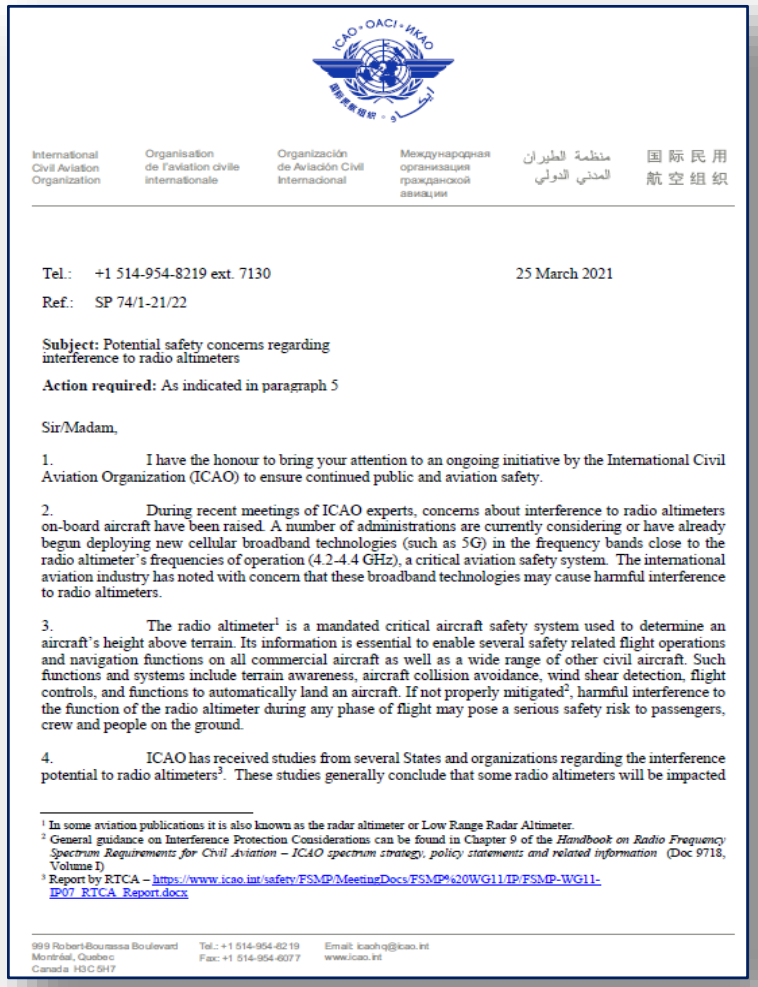
AIRBUS

BOEING

Business Impact

- More than 30 000 aircraft to retrofit (Airbus & Boeing sharing same manufactures of RADALT).
- Need several years.

Potential Safety concerns regarding interference to radio altimeters



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. 7130 — 25 March 2021

Ref.: SP 74/1-21/22

Subject: Potential safety concerns regarding interference to radio altimeters

Action required: As indicated in paragraph 5

Sir/Madam,

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

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

3. The radio altimeter[1] is a mandated critical aircraft safety system used to determine an aircraft's height above terrain. Its information is essential to enable several safety related flight operations and navigation functions on all commercial aircraft as well as a wide range of other civil aircraft. Such functions and systems include terrain awareness, aircraft collision avoidance, wind shear detection, flight controls, and functions to automatically land an aircraft. If not properly mitigated[2], harmful interference to the function of the radio altimeter during any phase of flight may pose a serious safety risk to passengers, crew and people on the ground.

4. ICAO has received studies from several States and organizations regarding the interference potential to radio altimeters[3]. These studies generally conclude that some radio altimeters will be impacted

[1] In some aviation publications it is also known as the radar altimeter or Low Range Radar Altimeter.
[2] General guidance on Interference Protection Considerations can be found in Chapter 9 of the *Handbook on Radio Frequency Spectrum Requirements for Civil Aviation – ICAO spectrum strategy, policy statements and related information* (Doc 9718, Volume I)
[3] Report by RTCA – https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG11/IP/FSMP-WG11-IP07_RTCA_Report.docx

999 Robert-Bourassa Boulevard, Montréal, Quebec, Canada H3C 5H7 | Tel.: +1 514-954-8219, Fax: +1 514-954-6077 | Email: icaohq@icao.int, www.icao.int

ICAO State letter dated on 25 March 2021

- ICAO received studies from several States and organizations regarding the interference potential to radio altimeters. These studies generally conclude that some radio altimeters will be impacted if high power cellular systems are implemented near the frequency band used by radio altimeters.
- Several States have already implemented temporary technical, regulatory and operational mitigations on new 5G systems in order to protect radio altimeters while more permanent solutions are being devised.
- Invite States to consider as a priority, public and aviation safety when deciding how to enable cellular broadband/5G services in radio frequency bands near the bands used by radio altimeters.

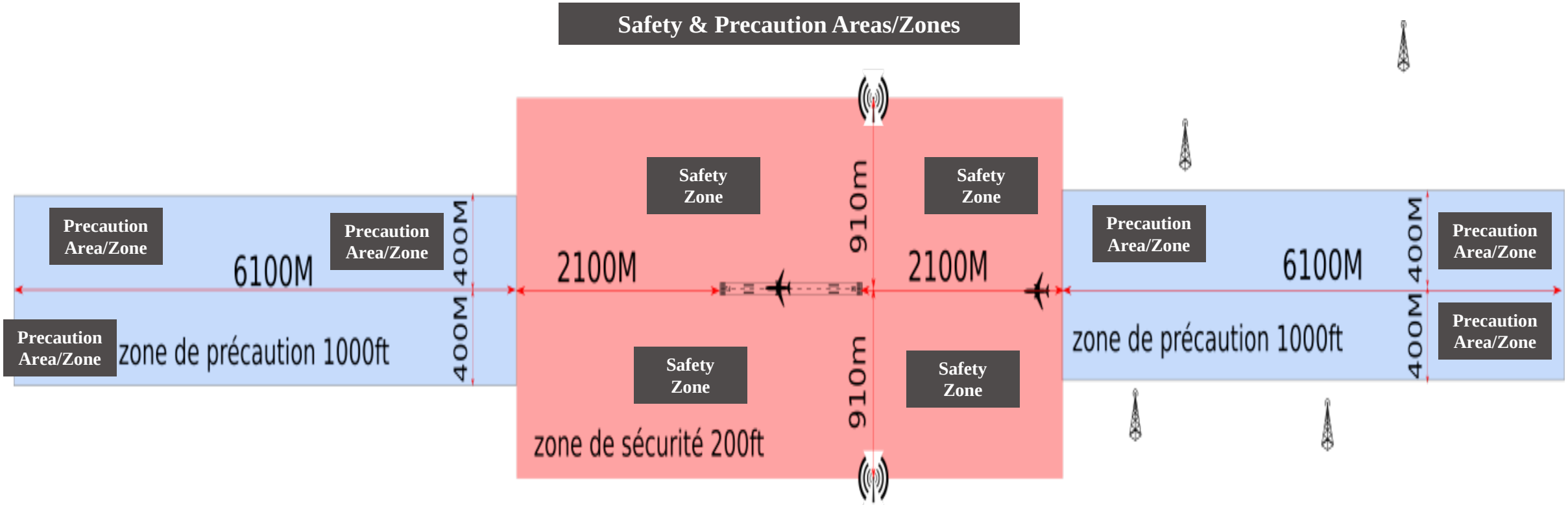
Discussion and summary on actions taken by Regional Organization and States:

- **Technical expert working groups in ICAO, ITU, CEPT, RTCA, EUROCAE are working on detailed assessment of the impact of 5 G on RADALT:**
  - 5G is a key factor of the “digital economy”.
  - 5G providers and industry will not support any mitigation/measures related to the relocation of 5G stations.
- RADALT is one of aviation’s most safety critical systems:
  - Radio frequency (RF) filtering needs to be improved. It will take time (development of Standards and equipment)
  - Safe operations depend on effective aerodrome safeguarding of the RF environment.

Discussion and summary on actions taken by Regional Organization and States:

- Actions taken by Specialized agencies:
  - EASA: Issued a Continued Airworthiness Review Item (CARI) to aircraft and equipment manufacturers to collect data on RADALT and any observed interference.
  - RTCA: Issue a report on major risk that 5G telecommunications system will cause harmful interference to RADALT of all types of civil aircraft and will continue to conduct comprehensive data-driven analysis to identify solutions.

Measures taken by French DGAC



Short term Action Plan by KSA:

➢ State Action plan is now under review and discussion:

➢ Short-Term:

- Coordination with CITC (National Authority for Telecommunications) to identify 5G stations deployed or to be deployed near KSA aerodromes.
- Mapping the locations of 5G stations deployed around the Aerodromes and sharing information on 5G potential interference with all stakeholders including the national committee dealing with aviation spectrum.

- Issue a circular to aircraft operators (AOs):
  a) on 5G potential interference on radio altimeters and invite the operators to closely monitor any interference on RADALT and immediately report any occurrence to GACA (AIR/FLTOPS/Safety & Risk).
  b) on EASA Continued Airworthiness Review Item (CARI) to aircraft operators and collect the required data on RADALT equipment (AIR/FLTOPS).
  c) to conduct Safety risk assessment on 5 G potential interference during aircraft operations and report the results to GACA (Safety & Risk Department).

Long-term Action Plan by KSA:

➢ Long-Term:

- Monitor the activities of International working groups on 5 G potential interference and keep the aircraft operators aware of the outcome.
- Plan aircraft retrofit based on approval airworthiness directives.

Action by the meeting:

The meeting is invited to:

- Take note of the information provided in this Presentation
- Discuss a proposal to establish an ad-hoc group with the following main tasks:

a) Collect and share information on the best practices implemented by States and Regional Organizations to mitigate 5G potential interference that may impact the radio altimeters.

b) Develop MID guidance material on concrete actions and steps to protect the aircraft operations from any 5G potential interference associated with the deployment of ground infrastructure to enable cellular broadband/5G services in radio frequency bands near the bands used by radio altimeters.

_____End_____

QUESTIONS, COMMENTS or SUGGESTIONS

GACA®
الهيئة العامة للطيران المدني
General Authority of Civil Aviation

رؤية VISION 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

Thanks..