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| **Radiocommunication Study Groups** |  |
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| Annex 7 to Working Party 5A Chairman’s Report | |
| WOrking DOcument towards a Preliminary Draft NEW report on Broadband Air To Ground Systems | |
| **Frequency usage in the land mobile service for broadband direct air-to-ground (A2G) communications links with passenger aircraft** | |

*[Editor’s note: At the May 2019 WP 5A meeting, it was agreed that technical and operational characteristics should be developed as a revision to Report* [*ITU-R M.2282*](https://www.itu.int/pub/R-REP-M.2282)*, and that this separate document would address frequency aspects.]*

# 1 Introduction

This report addresses the frequency usage associated with providing broadband wireless links (air-to-ground, A2G) to passenger aircraft to facilitate improved and seamless broadband access for use by both the travelling public and aircraft operators (footnote: not to be used for safety related aspects, and operation and navigation of the aircraft). A general overview and the technical and operational characteristics of these systems are addressed in Report ITU-R M.2282.

*[Editor’s Note: The following material has not been reviewed. Care should be taken to ensure that the content is strictly within the purview of WP 5A.]*

# 2 Related Recommendations and Reports

Report [ITU-R M.2282](http://www.itu.int/pub/R-REP-M.2282) – *Systems for public mobile communications with aircraft*.

[There are various ITU-R Recommendations that detail the specification of both terrestrial and satellite IMT-Advanced technology. In particular, Recommendation ITU-R M.2012 contains the detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced]

...

3 Acronyms

A2G Air-to-Ground

DA2GC Direct-Air-to-Ground Communications

**Broadband Direct-Air-To-Ground-Communications (DA2GC) System**: digital two-way radio communications system in which base stations in the land mobile service communicate with base stations on aircraft.

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*[Editor’s Note: The following text originates from the input document 5A/927 which was divided into an update to Report ITU-R M.2282 and this document. Text pertaining to A2G systems is in the update to Report ITU-R M.2282 and text from input document 5A/927 that pertains to spectrum usage is found in this document. Work should be done to improve the organization and substance of the document to compensate for the text that is now in the update to Report ITU-R M.2282, such as adding a table with frequency usage]*

# 4 Challenges of connecting aircraft to the world

The critical back-haul connection between passenger aircraft and the global telecommunications network can be implemented either via terrestrial systems (while over land) and/or via satellite systems.

However, a particular consideration is the requirement of many countries today that all telecommunications traffic originating or terminating within their national territory shall be accessible for national purposes. This requirement typically relies on a specific facility/node located within each country, to provide investigatory access, and is more readily met via direct air-to-ground communications (terrestrial) links within the country being over-flown, than by satellite links that often rely on a gateway earth station located in some other country. Nonetheless, the terrestrial versus satellite link backhaul options clearly remain complementary – and often seen as having distinct geographic roles, as shown in the following conceptual diagram:

Figure 2

Terrestrial and satellite roles in broadband links to passenger aircraft



*12nm territorial boundary*

As an aside, passenger aircraft registered in their country-of-origin (particularly the ‘flag’ carriers) are frequently considered part of the ‘national territory’ of their home country. As such, some countries may also require direct access to air-to-ground telecommunications for national purposes even when the aircraft is in-flight over international waters.

In particular, while satellite links are clearly needed for the long-haul trans-oceanic routes, they may be relatively costly and exhibit increased latency in the case of the short-haul and medium-haul routes supporting more frequent and larger numbers of passenger aircraft.

[Some ITU Administrations, notably those pertaining to European Union, have defined a harmonized mechanism for the integrated use of Satellite and Terrestrial mobile systems, which, among other services, can provide connectivity to aircraft by using specific frequency ranges in the 1 980-2 100 and 2 170-2 200 MHz.]

## 4.1 Operating environment *[Editor’s Note: Consider what material should be retained.]*

Today’s passenger airlines operate in a highly cost-competitive environment, and typically seek to maximize the efficient utilization of aircraft over both domestic and international routes. This means a strong focus on issues such as aircraft weight and fuel consumption; ground maintenance downtime and operational service availability; seat quantity and occupancy; and crew operating requirements - to note just a few. To minimize on-board equipment complexity and weight, and to avoid undue additional duties for flight crews, several matters are relevant:

• sufficient production/market scale for air-to-ground equipment/systems to encourage development efforts toward minimising both weight and cost; and

• harmonized regulatory frameworks applicable to passenger aircraft operating across national borders, particularly in relation to certification, operations and licensing; and

• harmonized frequency arrangements, to minimize systems technical design and operational complexity.

Achieving these objectives involves consideration of such issues as: adopting common technical standards covering technology, radiofrequency emission levels and antenna patterns; securing mutual recognition of technical authorizations/certifications; achieving agreement on common system operating procedures; recognition of legal/regulatory obligations while over-flying national territories; and various other matters.

The following sections offer a brief outline of these issues, along with suggested approaches aimed at harmonizing arrangements to the extent possible – and, to maximize equipment market scale, and minimize limitations on passenger airline operations.

# 5 Key operating issues

## 5.1 Altitude limits *[Editor’s Note: Consider what to retain and what to move to revision of M.2282]*

In the past, passenger use of entertainment systems and personal electronic devices (PEDs) on‑board commercial aircraft was generally restricted by aircraft operators to the ‘cruise’ portion of flight only – primarily so that passengers’ attention is not diverted from the flight safety briefing, and purportedly to protect the critical take-off and landing phases of flight (involving precision electronic navigational aids) from errant radiofrequency emissions and interference. This restriction has generally been implemented in the form of a ‘minimum altitude’ limit of 3 000 m AGL as a convenient threshold. Coincidentally, after take-off, aircraft typically achieve an altitude of 3 000 m at some considerable distance from the point of departure – and generally beyond urban zones (even for most metro airports). This circumstance is potentially relevant to coverage planning for air-to-ground systems, since it infers that air-to-ground base-stations can generally be deployed in regional areas only:

Figure 3

Achieving 3 000 m altitude levels



3000 m

Recently, however, some airline operators have begun to consider the possibility of offering ‘gate-to-gate’ connectivity for passengers, enabling reliable connection continuity on loading ramps between terminal and aircraft, and as an incentive to attract greater airline patronage. This may dictate the need for base-stations located nearby airports.

Some administrations, through studies conducted by CEPT and reported in the ECC 233 report, have analysed options for operations of aircraft stations and at different altitudes. Some administrations have further authorised operations of terrestrial mobile systems, even at ground level, when these systems are part of an integrated mobile satellite system. The authorisation is subject to implementation of mitigation techniques and/or specific planning, to provide compatibility with other co-frequency in-band and adjacent band services and systems.

# 6 Implications of common frequency arrangements

*[Editor’s note: proposed for deletion of “compliance with national technical regime”(subtitle changed to ‘benefits for cross-border operation” text, since Crossborder issues are always relevant but will vary from country to country based on agreements between those countries. This may be an operational needs to show that the system has to operate under the parameters for which it was granted by the national authority.]*

**Benefits for cross-border operations.** Where there are *differing* national regulatory and technical regimes between neighboring countries, aircraft need to track their position against national borders to trigger on-board system adjustments (power, mode, etc.), according to relevant national regulatory requirements - or even to deactivate air-to-ground systems over certain countries. While such adjustments might be undertaken by aircrew, as an additional duty, they are more usually implemented as an automatic function via a connection to the aircraft [ARINC] data bus that provides aircraft heading, altitude, air-speed and positional information (amongst other data). However, this requirement adds to complexity – since on-board passenger connectivity systems had to store relevant mapping and regulatory data to enable proper technical compliance as the aircraft passed over national borders. Clearly, differing national regulatory regimes lead to functional and processing complexity, and greater development and equipment costs. Notably, however, direct air-to-ground links located within relevant national borders can instead readily implement regulatory compliance via control channel signalling.

*[Editor’s Note: the following text in square brackets was proposed at the May 2019 meeting, and may need to be located in a better location]*

[A specific case of harmonization of spectrum has been carried out by the administrations within the European Union, which set the spectrum range 1 980-2 010 MHz and 2 170-2 200 MHz, as available in all European Union countries in a harmonized set of conditions. These frequencies can be used, among other services, for implementation of air-to-ground systems in an integrated manner of satellite and terrestrial mobile services.

However, the operation of air-to-ground systems in the 1 980-2 010 MHz and 2 170-2 200 MHz in one country, and the use of other mobile, mobile-satellite, or fixed service systems in the same band in a neighbour country requires detailed technical coordination to avoid harmful interference. Experiences of such interferences have been reported to ITU BR.]

**Customer experience implications.** Any service variability due to differing national regulatory regimes is undesirable from the perspective of passenger usage experience – for example, variable connectivity (lower bit-rates), differing connection modality, and periodic session drop-outs throughout flights. As such, harmonised licencing and regulatory regimes applicable to broadband air-to-ground systems, could contribute to a better passenger experience.

## 6.1 Frequency related aspects of routing of traffic when crossing borders

*[Editor’s note: Consider deletion/revision of this Section as topic is more relevant to national matters.]*

*[Editor’s Note: Need to address this topic as it applies to spectrum]* As noted above, many national administrations require that all telecommunications originating or terminating within their territorial boundary must be accessible for national purposes – often including not only session metadata (originating/terminating parties, time/date, duration, etc.), but also real-time traffic interception. This typically involves a requirement to route traffic via one or more ground interception centres located within the relevant country and designed to facilitate access under relevant legal authorisations and protections.

In addition, other regulatory obligations may differ between countries, and may impact the air-to-ground systems architecture and traffic routing procedures – such as:

• mandatory routing of emergency assistance calls (for example, calls to the special numbers 911, 112, 000, etc.) – requiring automatic connection of calls via shortest practical route to relevant public safety agencies (or call-handling centre) within the national territory;

• exclusive dealing prohibitions – in context of telecommunications, this generally requires that if services (e.g. roaming) are offered to one class of users, they must be equivalently offered to all other classes of users;

• third-line forcing prohibitions – in context of telecommunications, this disallows a refusal to provide services if the user does not firstly acquire some other service from the same supplier; and

• there may also be other regulatory requirements enacted in various countries that must be taken into account.

In general, existing terrestrial fixed/mobile network operators within respective countries will have already established the facilities, functional norms and operating protocols certified to meet such national regulatory obligations as a normal part of their national network operations.

## 6.2 Spectrum aspect

*[Editor’s note: This section will require further discussion and understanding. Questions were raised in the factual accuracy of text reflecting the usage of the bands (in particular 1 980-2 010/ 2 170-2 200 MHz) in countries, which require further discussion. In addition, input is invited to the next meeting for additional frequency bands.]*

The key technical aspects of air-to-ground systems discussed in this section relate to:

• harmonized spectrum utilization, including frequency bands and channel arrangements, to facilitate non-complex airline operations throughout the region, and simpler redeployment of passenger aircraft to alternative routes in response to varying passenger load demands/needs.

To allow for cross-border roaming between countries, where bands assigned to local network operators may differ, modern smart-phones typically include multiple frequency bands. However, this means designing handsets to accommodate multiple filters, amplifiers and other radiofrequency components, along with sufficient intelligence to implement scanning and search algorithms, and to allow devices to ‘discover’ valid national networks that have established roaming agreements with the handset’s home network.

Not only do these multiple filters and radiofrequency components increase complexity, but the associated development effort is only cost-effective in the case of the very large sales volumes (tens of millions of units) associated with the global cellular handset market. Such scale is unlikely to apply to the on-board air-to-ground equipment destined for the global passenger aircraft market (estimated to be a few tens of thousands). Therefore, to be viable, it is critical to agree and harmonize on a single frequency band (possibly not more than two) for use by regional/global broadband air-to-ground applications.

The European region has already explored several frequency bands for this purpose, including the 1 900-1 920 MHz (TDD) band, the 1 980-2 010/2 170-2 200 MHz (FDD) band, and the 5 855‑5 875 MHz band. The US market has also explored use of several bands including the 450 MHz band and the 800 MHz band. To enable seamless inter-regional flight operations, and unfettered day-to-day re-scheduling of aircraft to alternative routes, it seems appropriate that administrations consider harmonization of frequency arrangements with other regions.

The 1 980-2 010/2 170-2 200 MHz is identified in the ITU-R Radio Regulations (RRs) for use by terrestrial and satellite IMT systems (on an equal basis, with no priority given to either service). The European Union Administrations, plus Norway and Switzerland, have issued authorisations for integrated satellite and terrestrial systems in these frequency ranges, capable to provide in flight connectivity, as the “European Aviation Network”..

*[Editor’s note: Material is sought on additional frequency bands to the above paragraph on Frequency usage for broadband air-to-ground (A2G) communications.]*

There may also be other bands that could be considered for air-to-ground systems in various countries.

## *[Editor’s Note: the following sections are taken from the update to the Report ITU-R M.2282, and further material from the annexes may be beneficial to be added in this report]*

## *[From ATG Systems Report Annex 1 Report* [*M.2282*](https://www.itu.int/pub/R-REP-M.2282)*]*

## 4.1 System architecture

This broadband DA2GC system is a UMTS TDD system based on commercial off the shelf equipment that complies with the 3GPP Release 7 standards. A separate frequency converter is used to support operation in the 5 855-5 875 MHz band although operation in other bands has been demonstrated.

## 4.2 Spectrum aspects

The system can use switch-selectable bandwidths of 5 or 10 MHz. Although single channel operation is possible, the use of additional channels reduces potential inter-cell interference and also any interference to other systems.

The required spectrum is 20 MHz thereby enabling 2 × 10 MHz or 4 × 5 MHz channels. The system does not require contiguous spectrum. ETSI TR 103 108 proposes that this system operates in the band 5 855-5 875 MHz. However, the system may operate within the extended band of 790 MHz to 6 GHz, e.g. in the bands 1 900-1 920 MHz and 2 010-2 025 MHz which were designated for terrestrial mobile systems based on UMTS-TDD technology.

*[From ATG Systems Report Annex 2 Report ITU-R M.2282]*

# 1 System for public communications with aircraft in Canada and United States of America

In Canada[[1]](#footnote-1) and the United States of America[[2]](#footnote-2), the band pair 849-851 MHz and 894-896 MHz is allocated to the aeronautical mobile service for public correspondence with aircraft. These bands are designated for paired nationwide exclusive assignment to the licensee or licensees of systems providing radio telecommunication services, including voice telephony, broadband Internet and data transmission service, to persons on-board aircraft.

[System for public communications with aircraft in Canada and United States of America

In Canada and the United States of America, the band plan, described below in Fig. 5, is based on two block pairs: 849-850.5/894-895.5 MHz and 850.5-851/895.5-896 MHz. The band 849‑851 MHz is limited to transmissions from ground stations and the use of the band 894‑896 MHz is limited to transmissions from airborne stations.

FIGURE 5

The band plan for aeronautical mobile service in Canada and the United States



The technical rules for certification and systems deployment in the band in the United States and Canada are technology neutral.]

# [4 System for general aviation air-to-ground radiotelephone within the United States of America

## 4.1 General aviation air-to-ground radiotelephone service

This service operates in the 454-459 MHz band and can provide a variety of telecommunication services to private aircraft such as small single engine planes and corporate jets. CFR47[[3]](#footnote-3) § 22.805 contains the channel allocations for the general aviation air-to-ground service. These channels have a bandwidth of 20 kHz and are designated by their centre frequencies in megahertz.

TABLE 1

Signalling channel pair for general aviation air-ground systems

|  |  |
| --- | --- |
| **Ground** | **Airborne mobile** |
| 454.675 | 459.675 |
| a) Channel 454.675 MHz is assigned to each and every ground station, to be used only for automatically alerting airborne mobile stations of incoming calls.  b) All airborne mobile channels are assigned for use by each and every airborne mobile station. | |

Communication channel pairs

|  |  |
| --- | --- |
| **Ground** | **Airborne mobile** |
| 454.700 | 459.700 |
| 454.725 | 459.725 |
| 454.750 | 459.750 |
| 454.775 | 459.775 |
| 454.800 | 459.800 |
| 454.825 | 459.825 |
| 454.850 | 459.850 |
| 454.875 | 459.875 |
| 454.900 | 459.900 |
| 454.925 | 459.925 |
| 454.950 | 459.950 |
| 454.975 | 459.975 |

The transmitting power of ground and airborne mobile transmitters operating in the general aviation air-ground radiotelephone service on the channels listed in CFR 47 § 22.805 must not exceed:

a) Ground station transmitters:the effective radiated power of ground stations must not exceed 100 Watts and must not be less than 50 Watts, except as provided in CFR 47 § 2.811.

b) Airborne mobile transmitters:the transmitter power output of airborne mobile transmitters must not exceed 25 Watts and must not be less than 4 Watts.

1. Refer to <http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09134.html>. [↑](#footnote-ref-1)
2. Refer to: <http://www.gpo.gov/fdsys/pkg/CFR-2010-title47-vol2/pdf/CFR-2010-title47-vol2-part22-subpartG-subjectgroup-id140.pdf>. [↑](#footnote-ref-2)
3. Refer to: <http://www.gpo.gov/fdsys/pkg/CFR-2010-title47-vol2/pdf/CFR-2010-title47-vol2-part22-subpartG-subjectgroup-id140.pdf>. [↑](#footnote-ref-3)