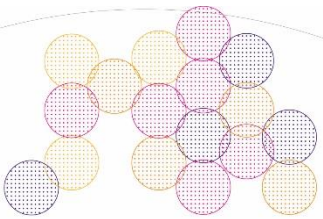
Regulation of Aeronautical Radio System Spectrum Access

Selcuk Kirtay (Plum Consulting) and Andy Knill (Extensity Consulting)



Without access to radio spectrum it would be impossible to undertake national and international flights safely. Aeronautical radiocommunications systems are used to support communications, navigation and surveillance applications which range from two-way communications between air traffic control and pilots to on-board weather and location radars. These applications make use of various frequency bands allocated to a number of aeronautical radio services in the International Telecommunications Union Radio Regulations (ITU RR). Although aeronautical radio spectrum falls within the ITU regulatory framework for allocation and use, it is also regulated by the International Civil Aviation Organisation (ICAO) to ensure the necessary global interoperability which supports the required safety assurance for air operations. It requires the cooperative interworking of a complex set of multi layered organisations – global, regional and national, across the two different domains – telecommunications and aviation. Due to the characteristics of the spectrum allocated for use in aeronautical radio systems there is high demand for the frequencies requiring rigorous sharing approaches. This paper provides an overview of key national and international organisations and regulatory instruments involved in the management of aeronautical radio spectrum access and explains how regulatory responsibilities are undertaken by the telecommunications and civil aviation authorities.

Introduction

Aeronautical radio applications can be categorised into communications, navigation and surveillance systems.

Communications applications include :

- air traffic control (ATC) (i.e. communications (voice and datalink) between the air traffic control and aircraft to ensure safe air traffic, for example aircraft requests for clearances to land or take-off and ATC issue of clearances and instructions to aircraft); and
- aeronautical operational control and administrative communications (i.e. communication of an aircraft with its airline or service partners on the ground to enhance the efficiency of overall flight operation, for example upload to the aircraft of final load sheets; download from the aircraft of status, position and any flight diversion; and upload of weather or Notice to Airmen (NOTAM) information).

In addition to on-board systems, there are a number of navigation applications that help pilots identify the location of aircraft. Examples include:

- Nondirectional Radio Beacon (NDB) – radio beacon transmits nondirectional signals whereby the pilot of an equipped aircraft can determine bearings and home on the station and so aid enroute navigation.
- VHF Omni-directional Range (VOR) – short-range radio navigation system enabling an equipped aircraft to determine its position and stay on course by receiving signals transmitted by a network of fixed ground radio beacons.
- Instrument Landing System (ILS) – a precision runway approach aid employing two radio beams to provide pilots with vertical and horizontal guidance during the landing approach. The localiser (LOC) provides azimuth guidance while the glideslope (GS) defines the correct vertical descent profile.
- Distance Measuring Equipment (DME) – operates on the principle of determining the time required for the round trip of signal exchange between the aircraft and ground station and used for final approaches to airfields in conjunction with ILS.

Ground radars are the main instruments used for surveillance applications. They are used for determining the position of aircraft to support air traffic management. Examples are Primary (non-cooperative surveillance) and Secondary Surveillance Radars (cooperative surveillance requiring interoperable equipment in both aircraft and ground infrastructure). Satellite systems are also increasingly used as part of aeronautical surveillance and navigation systems. These support operations where ground infrastructure is not practical and enable improved approaches to airports.

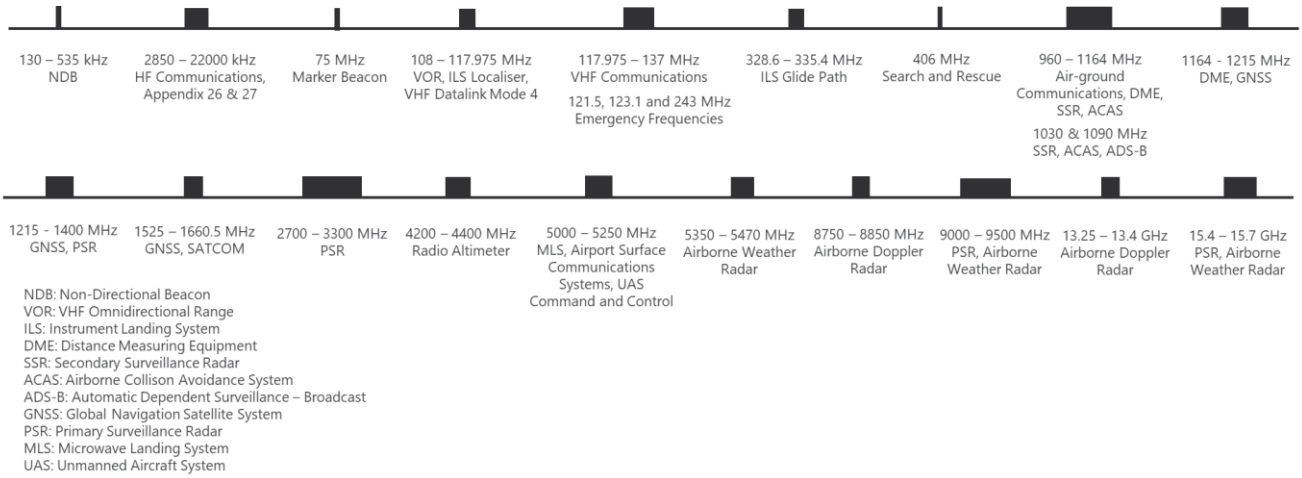
Communications, navigation and surveillance applications primarily operate in aeronautical radio spectrum which is allocated globally. This is essential to ensure that the necessary levels of safety and interoperability are maintained wherever an aircraft is flying.

Good propagation characteristics of aeronautical frequency bands make them attractive to many other sectors seeking spectrum access. Therefore, it is fundamental that sufficiently protected spectrum is available to the aviation sector in order to

enable the necessary applications which rely on both the air and ground elements of aeronautical radio systems wherever they are operating.

Efficient management of aeronautical spectrum requires close cooperation at an international level between ITU (the organisation managing international spectrum allocations) and ICAO (the organisation responsible for the development of aviation standards and recommended practices, i.e., SARPS). Similarly, collaboration is essential between national radio regulators and civil aviation authorities to ensure the orderly management of the aeronautical frequencies in each country

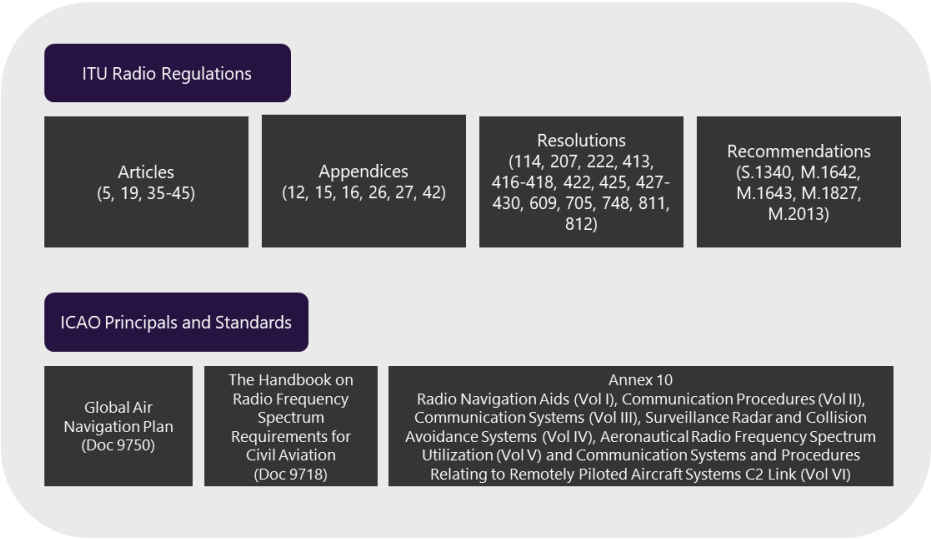
Figure 1: Main aeronautical frequency bands



ITU and ICAO

ITU establishes and updates the international regulations on radio spectrum use through the Radio Regulations which specify what frequencies can be used for different services and how equipment and systems should operate to facilitate coexistence and limit potential for interference. These Regulations are updated through World Radio Conferences. The regulatory provisions and procedures described in the Radio Regulations are implemented typically by national telecommunications regulators through their overarching instruments (such as a Telecommunications Act and its Bylaws), the national frequency plan, and service specific regulations, procedures and licensing processes in each country.

Figure 2: International Management of Aeronautical Spectrum



ICAO establishes the principles and standards required for the safe civilian air transport. The ICAO's Frequency Spectrum Management Panel (FSMP) manages aeronautical frequency spectrum to ensure that sufficient access is maintained to appropriate spectrum for the provision of aeronautical communication, navigation and surveillance services in a safe and efficient manner. Spectrum and frequency management is influenced by a wide range of ICAO documents which establish the requirements in both operational and technical context, e.g., the six volumes of Annex 10 to the convention on International Civil Aviation. It is also important to note the role of regional ICAO organisations where day-to-day management of key aeronautical frequency bands is undertaken to ensure coordination and cooperation within the individual ICAO regions. There are 9 regions with regional offices supported by Planning and Implementation Regional Groups (PIRGs) and Regional Aviation Safety Groups (RASGs) with representatives from the states within a region.

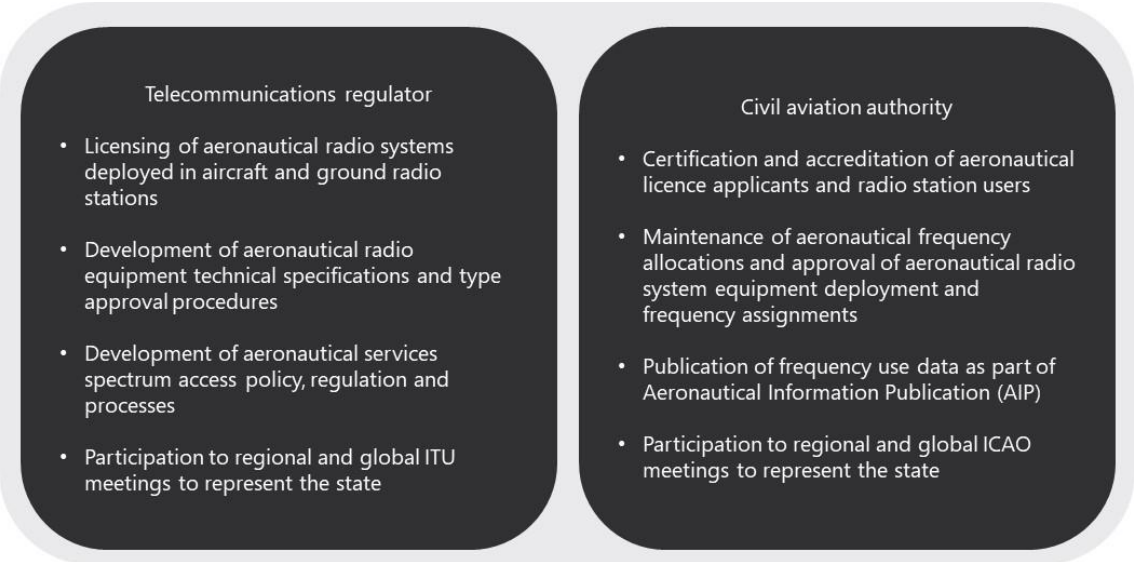
Telecommunications regulator and civil aviation authority

The regulation of aeronautical radiocommunications systems at a national level is typically undertaken by the telecommunications regulator and the civil aviation authority and close cooperation between the two is required..

The telecommunications regulator is responsible for regulating aeronautical spectrum use and represents the state in ITU. In general, licensing of radio spectrum for aircraft and ground radio stations is also undertaken by the telecommunications regulator.

The civil aviation authority is responsible for the certification and accreditation of air navigation service providers, civil aviation operators and service providers. It is also involved in approval of equipment deployment, frequency assignment and licence applications primarily to meet ICAO aeronautical safety obligations. The civil aviation authority publishes the Aeronautical Information Publication (AIP) which is the key reference document providing rules and procedures defined for the operation of aircraft and aerodromes including extensive frequency use information within the national airspace (Flight Information Regions (FIRs).

Figure 3: Responsibilities of the telecommunications regulator and civil aviation authority



Spectrum sharing

ITU Radio Regulations spectrum allocations generally form the basis for identifying the potential for sharing between services although even if services are co-primary it does not mean they can automatically share the frequencies. Over the years, different sharing methodologies and parameters have been developed internationally and there are a significant number of ITU Recommendations and Reports addressing a range of aeronautical frequency bands and applications.

From the aviation community perspective, ICAO is responsible for developing the overall global position and ensures that any spectrum sharing proposals are supported by specialist input. This work is conducted through FSMP which develops the ICAO position and other material to support the update of ITU regulations.

A few examples of sharing issues involving aeronautical systems are provided below.

- **The coexistence of incumbent aeronautical radar services in the 2700 – 2900 MHz with mobile broadband services operating in the adjacent 2500 – 2690 MHz band:** To facilitate adjacent band co-existence, the protection levels at radar receivers necessary to address blocking, intermodulation and unwanted emissions from interfering mobile broadband transmitters were identified; filtering requirements at radar receivers were determined by using the blocking and intermodulation protection levels; and pfd limits were identified to satisfy the radar protection levels identified for mobile transmitter unwanted emissions.
- **Potential interference into radio altimeters operating in the frequency band 4.2 – 4.4 GHz from 5G networks deployed in adjacent bands:** A number of countries have adopted safety and precaution zones around major airport runways to minimise the potential impact of interference into radio altimeters. In the safety zone, 5G base stations are not authorised to transmit. In the protection zone, 5G base station deployments are subject to coordination.
- **Spectrum sharing in the 960 - 1164 MHz band between Programme Making and Special Events (PMSE) and aeronautical systems:** Guard bands and exclusion areas were facilitated to enable sharing between PMSE and incumbent Distance Measuring Equipment (DME), Secondary Surveillance Radar (SSR) and military systems.

Registration of aeronautical frequency assignments

The assignment of aeronautical frequencies is implemented through the national telecommunications regulator's licensing process which also involves the national civil aviation authority. The ground radio stations are assigned individual frequencies while frequency ranges are defined for the equipment on-board aircraft for which compliance checks are implemented as part of air worthiness certification by the civil aviation authority.

The assigned frequencies are registered in databases maintained by both authorities. The Aeronautical Information Publication (AIP) reflects the contents of national frequency assignment databases and is maintained and published by the civil aviation authority.

National frequency assignments are recorded internationally using both ITU and ICAO registers.

The ITU's Master International Frequency Register (MIFR) contains internationally recognised aeronautical assignments which are protected from harmful interference. The registration of frequency assignments in the MIFR takes place at the request of the telecommunications regulatory authority of each ITU member administration.

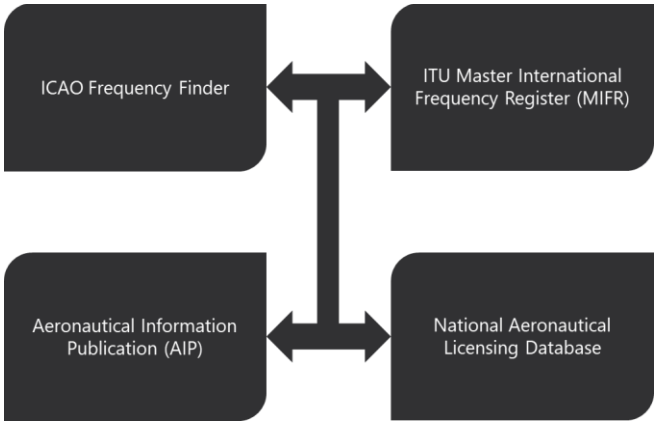
ICAO Regional Offices maintain the registration of aeronautical assignments in the main aeronautical service bands allocated to communications and navigation applications and undertake the actual day-to-day coordination of these frequency assignments. ICAO's Frequency Finder is the tool used for the registration and approval of frequency registrations.

In most cases, assignments recorded in ICAO regional frequency registers are not subsequently filed with ITU and not registered in the MIFR. Therefore, ICAO regional frequency registers are more comprehensive and up-to-date compared to the ITU MIFR. There are on-going initiatives to harmonise the ITU MIFR with the ICAO regional frequency registers.

In the ICAO EUR region, the planning and coordination of frequency assignments is conducted through the Eurocontrol Network Manager in respect of the EU member states and those additional states, including the UK, which are members of Eurocontrol.

It is important that recordings in ITU MIFR and ICAO regional frequency registers are consistent and these are based on an accurate reflection of what is recorded in the national databases and AIP. To ensure the required consistency, an appropriate cross-checking mechanism should be established.

Figure 4: National and international aeronautical frequency registers



Summary

Civil aviation and telecommunications regulatory authorities are the two main national organisations managing the aeronautical radiocommunications system spectrum access. Licensing for radio spectrum access is generally undertaken by the telecommunications regulator while civil aviation authorities are involved in certification and accreditation of licence applicants and approval of equipment, frequency assignment and licence applications. Internationally, civil aviation authorities are represented in ICAO while telecommunications regulatory authorities are represented at ITU.

Aeronautical regulations and procedures; radio interface requirements; and licencing procedures are the main regulatory instruments used for the management of aeronautical radio systems.

Spectrum sharing issues evolve constantly and need to be taken account of as necessary. Coexistence aspects are generally addressed within ITU-R and regional regulatory bodies (e.g. CEPT). ICAO's FSMP develops the position of ICAO member states on radio spectrum issues and pursues the interests of the aviation community in the ITU-R arena.

Registration of aeronautical frequency assignments takes place nationally and internationally. The key national frequency registry is the AIP which is maintained and published by the civil aviation authority. It provides extensive frequency use information at aerodromes and for enroute communications and navigation facilities. The ITU's MIFR and ICAO Frequency Finder are the main international aeronautical frequency registers. In order to ensure the consistency of national and international frequency assignments an appropriate cross-checking mechanism is necessary.