



TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 1: Strategic issues that address the challenge of integration, interoperability and harmonization of systems in support of the concept of “One Sky” for international civil aviation

1.1: Global Air Navigation Plan (GANP) – framework for global planning

AERONAUTICAL RADIO FREQUENCY SPECTRUM NEEDS

(Presented by the Presidency of the European Union on behalf of the European Union and its Member States¹; by the other Member States of the European Civil Aviation Conference²; and by the Member States of EUROCONTROL)

1. PROBLEM/OPPORTUNITY STATEMENT

1.1 For many years, aeronautical radio frequency spectrum has been targeted for use by non-aeronautical services, in particular to satisfy requirements for mobile and mobile satellite communications. This has led to the loss of some spectrum that was allocated exclusively for aeronautical mobile satellite communications but also to decisions at the International Telecommunication Union (ITU) World Radiocommunication Conferences that have authorized non-aeronautical use in bands previously allocated exclusively for aeronautical purposes. This has introduced the potential for interference and the loss of spectrum capacity needed to satisfy current and future aeronautical requirements for communications, navigation, and surveillance (CNS) system, in line with the CNS roadmap which would be included in the Global Air Navigation Plan (GANP). To ensure the long term protection of aeronautical interest in the area of spectrum, the development of strategic objectives, and their active support, are now necessary.

2. BACKGROUND

2.1 The development of new communications, navigation, and surveillance/air traffic management (CNS/ATM) provisions is highly dependent upon the availability of radio frequency spectrum that can support the high integrity and availability requirements associated with aeronautical safety systems, and demands special conditions to avoid harmful interference to these systems.

2.2 The continuous increase in air traffic movements as well as the additional requirement for new and emerging applications, such as unmanned aircraft systems, is placing increased demands on both

¹ Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom. All these 27 States are also Members of ECAC.

² Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Iceland, Moldova, Monaco, Montenegro, Norway, San Marino, Serbia, Switzerland, The former Yugoslav Republic of Macedonia, Turkey and Ukraine.

the aviation regulatory and air traffic management mechanisms. As a result, airspace is becoming more complex and the demand for frequency assignments and hence spectrum allocations are increasing. Whilst some of this demand can be met through the improved spectrum efficiency of new radio systems it is inevitable that existing allocations may need to be broadened or additional aviation spectrum allocations sought to meet this demand.

2.3 ICAO should develop globally harmonized frequency assignment planning criteria and a global frequency assignment plan in support to the ICAO Global Plan in order to improve the efficient use of the frequency bands allocated to relevant aeronautical services.

2.4 Spectrum for aeronautical radio communication and radio navigation (including surveillance) is allocated by the ITU in the framework of the WRC with the recognition of the safety aspects during the studies and the frequency allocation process.

2.5 It has to be noted that an agenda item for the next WRC in 2015 (WRC/15) seeks to identify additional spectrum for use by terrestrial mobile communication systems to facilitate the development of terrestrial broadband applications. This element clearly shows that the pressure on civil aviation spectrum, due in particular to its worldwide harmonization which increases its value and utility, will be very strong. It is therefore essential to ensure that any new allocation to the mobile service does not impact adversely on the operation of these systems. Based on recent experience with the introduction of mobile systems in the frequency band below 2 690 MHz, and interference to adjacent band radars care needs to be taken not only with any proposal for sharing but also with proposals for the introduction of an allocation in an adjacent band.

2.6 In order to ensure the protection of aeronautical frequency bands, it is now necessary to develop a strategic approach to existing and future spectrum use in civil aviation.

3. SPECTRUM ANALYSIS

The following table shows the aeronautical frequency bands analysed in this paper:

Frequency Band	Aviation use
HF	Communication (voice and data), NDB/Locator
VHF	ILS, VOR, GBAS, Communication (voice and data)
960 -1215 MHz	DME, Future Communications System (FCS), SSR, GNSS, ACAS, ADS-B
1215 – 1350 MHz	L-band radar
1545-1555/1646.5-1656.5 MHz	Satellite communications
1 559–1 610 MHz	GNSS
2700 – 3100 MHz	S-band radar
4200 – 4400 MHz	Radar altimeter
5000 – 5250 MHz	MLS, UAS, satellite communication, aeronautical telemetry
5 350–5 470 MHz	Airborne weather and ground mapping radar
9000-9500 MHz	Precision approach radar, airborne weather and ground mapping radar

3.1 HF

NDB/Locator

3.1.1 The use of non-directional radio beacon (NDB)/locator beacons in general is stabilized and may be reduced over time as a result of on-going global navigation satellite system (GNSS) and area

navigation (RNAV) implementation. The NDB/Locator is equipment for which decommissioning can be envisaged.

Communication (voice and data)

3.1.2 On a global basis, high frequency (HF) communications provide the main means for long distance (beyond the radio horizon) air/ground voice and data communications. Despite the introduction of satellite communication systems (to provide long distance communications as an alternative to the use of HF bands in aviation), HF communications are expected to continue to be required in the term. The use of these bands for long distance aeronautical voice and data communications is not however expected to increase significantly, and future requirements are expected to be able to be met in the currently available frequency bands. The continuing availability needs to be secured for use by air/ground communications on a global basis in the foreseeable future to support HF voice and data.

3.2 VHF

ILS, VOR and GBAS

3.2.1 Implementation of ground-based augmentation system (GBAS) is expected to start around 2015 – 2025 and may replace in some areas the instrument landing system (ILS). However the use of ILS is expected to continue in the longer term.

3.2.2 The use of VHF omnidirectional radio range (VOR) systems is expected to decline in the future due to implementation of GNSS and RNAV. However, a number of VOR systems will continue to be in operation to meet specific requirements in the longer term. The vacated spectrum, if any, will be re-used for GBAS and implementation of VHF air/ground communication systems. It will then be necessary to deploy the future communication system (FCS) but due to transition or fallback aspects, the VHF air-ground communication use is expected to continue in the long term.

Communication (voice and data)

3.2.3 The VHF band is extensively used for VHF air/ground voice communications and VHF air/ground and air/air data. Even with a full implementation in Europe of 8.33 kHz channel spacing, saturation of this band is foreseen around 2025. It is therefore necessary to deploy the future communication system (FCS).

3.3 960-1215 MHz

3.3.1 This band is used by several aeronautical systems (DME, SSR (including ADS-B), UAT, GNSS) and its continuing availability, needs to be secured for the long term. Furthermore this band is also planned to be used by the future communication system (air/ground and air/air data link systems).

3.3.2 Two sub-bands around the frequencies 1030 MHz and 1090 MHz are reserved for secondary surveillance radar (SSR). SSR provides, in addition to secondary surveillance radar, major functionality for airborne collision avoidance system (ACAS) and automatic dependent surveillance — broadcast (ADS-B). SSR is expected to continue to be required for surveillance and the use of these frequency bands will be for the long term.

3.3.3 Use of DME systems (deployed in the 977-1215 MHz band), is expected to increase and to continue for the long term.

Note: Link 16 is a tactical data transmission means used by military, in particular for air policy to ensure overall security of air traffic. It is deployed in 969-1008 MHz, 1053-1065 MHz and 1113-1206 MHz.

3.3.4 The band 1164 – 1215 MHz is also used for global navigation satellite system (GNSS) and provides GPS/Galileo/Beidu/Glonass signals. Even though, in accordance with the radio regulations, the use of this band by GNSS systems needs to protect DME from interference and accept interference from DME, no interference from one aeronautical system to another can be envisaged. Moreover under RNAV procedures, DME-DME navigation is planned to be one of the major navigation methods as a back-up of the GNSS. Even if the risk of interference is limited, the likelihood is that this will happen, and so it is inappropriate for a back-up to be deployed in the same frequency band as the primary system. There is therefore a need to redeploy the DME used for the DME-DME navigation in the band 977-1164 MHz.

3.3.5 The band 960 – 1164 MHz is planned to be used for the FCS air/ground and air/air data communications. At this stage two options for the L-band digital aeronautical communication system (L-DACS) are under discussion:

- a) LDACS1 : This option is based on the use of the 977-1164 MHz frequency band with a channel spacing of 1 MHz between the two the DME channels.
- b) LDACS2 : This option is based on the use of the 960-977 MHz frequency band which is free of any civil aviation system.

3.3.6 The choice between these both options will need to be made very shortly, in order to ensure that the future communication system will be ready at around 2025. Due the high density of use by the SSR, the existing DME in the 977-1164 MHz frequency band and the future DME re-deployment, in the 977-1164 MHz frequency band, currently operational in the 1164-1215 MHz frequency band due to GNSS deployment (see paragraph above), LDACS2 appears to be the better choice.

3.3.7 In addition, it has to be noted that during WRC-12 some technical constraints have been placed on the use of aeronautical communication systems in the higher part of the 960-1164 MHz in order to protect the GNSS in the adjacent 1164-1215 MHz frequency band.

3.3.8 This last element strengthens the case for the LDACS2 option, as the most appropriate for the development of the future communication system.

3.4 **1215-1350 MHz – L-Band radar**

3.4.1 This band is extensively used for primary surveillance radar, mainly providing long range independent non-cooperative airspace surveillance. This use is expected to continue to be required in the long term and therefore needs to be protected.

3.4.2 It has to be noted that this band is also foreseen for GNSS signals (GPS, GLONASS, Galileo and Beidu) but not for civil aircraft applications and the protection of the radars from GNSS signal interference is included in the ITU radio regulation.

3.4.3 A new development in radar technology is the multi static primary surveillance radar (MSPSR). MSPSR may provide more spectrum efficient use of this band and better coverage at lower altitudes. However, the implementation of MSPSR is dependent on the cost and improved spectrum efficiency that can be obtained.

3.5 **1545-1555/1646.5-1656.5 MHz – Satellite communications**

3.5.1 During the WRC/12 access to these bands for aeronautical satellite communications has been improved something which will support the requirements for aeronautical satellite communications for the long term. These bands too need therefore to be protected.

3.6 **1 559-1 610 MHz – GNSS**

3.6.1 This band is used by GNSS satellite systems as well as by GNSS satellite augmentation systems and is intensively used for aeronautical radio navigation applications. GNSS already plays a vital role in RNAV operations, ADS-B surveillance and the GLS/GBAS landing system.

3.6.2 This band is however subject to intentional interference (GPS jammers) and unintentional interference (potentially caused by an inadequate regulatory framework and improper implementation of pseudolites and GNSS repeaters). In addition, the proposed use of terrestrial cellular mobile systems in the adjacent band 1545 – 1559 MHz is expected to cause harmful interference to GNSS receivers. Long term protection of GNSS signals is of paramount importance given the variety of GNSS applications for aeronautical navigation and surveillance.

3.7 **2700-3100 MHz – S-Band radar**

3.7.1 This band is used for primary surveillance radar, mainly providing medium range independent non-cooperative surveillance radar. These radars typically provide surveillance in terminal and approach areas around major airports. This use is expected to continue, on a global basis, for the long term.

3.7.2 Radar stations are subject to interference from out-of-band emissions from cellular mobile systems operating in the adjacent band below 2700 MHz. This interference can be mitigated in principle by improving RF selectivity in the radar stations.

3.7.3 The frequency band 2700 – 2900 MHz may also be considered as one of the candidate bands for the future spectrum needs for mobile network during the WRC-15 period.

3.7.4 The strategic objectives is to secure the continuing availability of the frequency band 2700 – 2900 MHz which is allocated to the aeronautical radio navigation service for use by primary surveillance radar on a global basis for the long term.

3.8 **4200-4400 MHz – Radio-altimeter**

3.8.1 The whole of the band 4200 – 4400 MHz is used globally for radio altimeters on board aircraft. Radio altimeters provide an essential safety-of-life function for all phases of flight, including the final stages of landing. The strategic objectives is to secure the continuing availability of the frequency band 4200 – 4400 MHz which is allocated to the aeronautical radio navigation service for use by airborne radio altimeters on a global basis for the long term.

3.9 5000-5250 MHz – MLS, UAS, satellite communication, aeronautical telemetry

3.9.1 This band is used by several aeronautical systems. The strategic objectives for it for the long term are to:

- a) secure the continuing availability of the frequency band 5030 – 5091 MHz which is allocated to the aeronautical radio navigation service for use by the Microwave Landing System (MLS) and to support air/ground communications for unmanned aircraft on a global basis;
- b) secure the continuing availability of the frequency band 5091 – 5150 MHz which is allocated to the aeronautical mobile (R) service for use by airport communications on a global basis; and
- c) secure future implementation of the aeronautical telemetry in the band 5091-5250 MHz.

3.10 5 350-5 470 MHz – Airborne weather and ground mapping radar

3.10.1 This band is used globally for airborne weather radar. These are a safety critical instruments assisting pilots in deviating from potential hazardous weather conditions and detecting wind shear and microbursts.

3.10.2 The strategic objective is to secure for the long term the continuing availability of this frequency band used by airborne weather radar on a global basis.

3.11 9 000-9 500 MHz – Airborne weather and ground mapping radar

3.11.1 The band 9000 – 9200 MHz is used for ground based primary surveillance radar systems including Precision Approach Radar (PAR) and airport surveillance detection equipment (ASDE).

3.11.2 The band 9300 – 9500 MHz is used globally for airborne weather radar and ground based radar. The airborne weather radar is a safety critical instrument assisting pilots in deviating from potential hazardous weather conditions and detecting wind shear and microbursts.

3.11.3 The strategic objective is to secure on a long term basis the continuing availability of these two frequency bands.

4. CONCLUSION

4.1 The availability of adequate radio spectrum is a key factor and need to be ensured for the future development and deployment of CNS technologies and systems.

4.2 Furthermore it is necessary to maintain protection for the spectrum used for aeronautical radio communication and radio navigation systems required for current and future safety-of-life applications.

4.3 The expected increased intensity of the radio frequency utilization will increase pressure on the spectrum, in particular due to its worldwide harmonization; aviation frequency bands will be highly sought.

4.4 In order to ensure that the needs of civil aviation related to spectrum issue can be met, the elaboration and implementation of a spectrum strategy is crucial. The objectives of such strategy will have to:

- a) ensure the protection of existing systems;
- b) allow the development and deployment of future technologies and CNS systems;
- c) facilitate the transition between the existing technology and the next generation technologies; and
- d) ensure that existing aviation frequency bands are not given up without it first having been established that aviation's needs will be covered in the very long term, as it will be difficult to get new global harmonized spectrum if a need arises.

4.5 In addition, to ensure the protection of the different aeronautical systems, there is a need to establish a work programme for the elaboration of the adequate technical recommendations with the appropriate level of protection for all existing and (when known) future equipment on an international level.

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