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**AERONAUTICAL COMMUNICATIONS PANEL (ACP)**

**THIRTIETH MEETING OF WORKING GROUP F**

**Pattaya, Thailand 13 - 19 March 2014**

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| **Agenda Item 7** | Development of material for ITU-R meetings |

**Summary of Analysis Efforts for WRC-15 Agenda Item 1.17**

(Presented by Uwe Schwark)

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| **SUMMARY** |
| This paper is intended to inform the reader about the sharing and compatibility analysis efforts which have been undertaken in the course of WRC-15 agenda item 1.17 on the aeronautical frequency bands below 15.7 GHz. According to the analysis and studies of the frequency bands under consideration, the band 4 200-4 400 MHz is considered suitable for accommodating future WAIC systems without impacting the incumbent use of the band. This is due to the available bandwidth, the low number of incumbent systems, and the ability to design WAIC systems such that their RF emissions do not interfere with these incumbent systems and vice versa.  Furthermore, this paper discusses some considerations on the completion of the ITU-R study work on WRC-15 agenda item 1.17. In particular it is proposed to withdraw the study documents for the bands 2 700-2 900 MHz and 5 350-5 460 MHz and instead incorporate an excerpt of the main results and conclusions of both documents into the ITU-R Report M.[WAIC BANDS]. |



# INTRODUCTION

This document is a summary of the analysis efforts performed to evaluate the aeronautical frequency bands below 15.7 GHz for use by Wireless Avionics Intra-Communications (WAIC) systems. WAIC systems are intended to provide safety-relevant aircraft functions through wireless communications, thereby reducing aircraft weight, increasing aircraft configurability and reducing maintenance of aircraft wiring harnesses. This document is intended to be a quick reference for the Working Document towards a PDNR ITU-R M.[WAIC BANDS] which can be found in Annex 36 to Document 5B/475.

# FRequency bands for evaluation

Resolution **423** **(WRC-12)** invites the ITU-R to first consider existing AMS, AM(R)S and ARNS allocations in frequency bands below 15.7 GHz and then consider bands above 15.7 GHz. In addition to Resolution 423, an allocation for future WAIC systems must be globally harmonized because of the global nature of air traffic. WAIC system components (e.g. a wireless sensor) furthermore have to be designed for the typically confined installation environment in aeronautical applications. Hence, WAIC system components must be of small form-factor to accommodate weight and placement limitations in an aircraft. As such, antenna size and efficiency limit the WAIC systems to use frequencies greater than 1 GHz. Furthermore, low power WAIC transceivers are best suited to frequencies below approximately 6 GHz to minimize path loss and consequently keep their energy consumption within acceptable limits.

# Assessment

In this section, we discuss the consideration of the frequency bands analyzed in the Working Document towards a PDNR ITU-R M.[WAIC BANDS].

## The frequency band 960-1 164 MHz

This frequency band supports a number of critical civil and government aviation navigation systems, including Distance Measuring Equipment (DME), Secondary Surveillance Radar (SSR), Airborne Collision Avoidance System (ACAS), 1090 MHz Extended Squitter, and Universal Access Transceiver (UAT). Although the frequency band already includes an AM(R)S allocation, the planned introduction of additional aviation systems (both on-board aircraft and on the ground) increases the complexity of interference analyses and makes the band too difficult to share with incumbent and planned systems. It therefore is not a viable option for further study.

## The frequency band 1 164-1 215 MHz

This frequency band is allocated to the ARNS for worldwide operation and development of airborne electronic aids to air navigation and directly associated ground-based facilities. Additionally, the Radio Navigation Satellite Service (RNSS) and Global Navigation Satellite Systems (GNSS) use this frequency band. Due to the dependence of civil aviation and commercial users on incumbent systems, this frequency band was deemed unsuitable for WAIC systems and full sharing and compatibility studies were considered unnecessary.

## The frequency band 1 300-1 350 MHz

The frequency band 1 300-1 350 MHz is primarily used for ground-based surveillance radar and long-range detection of aircraft. It is also used to associate airborne transponders for en-route and terminal surveillance. These systems use high RF power and low receiver sensitivity levels. Furthermore, they are located near airports, which places receiver protection and emission limitation requirements on any system attempting to share the band. Therefore, this band is not considered a viable option for further study.

## The frequency band 1 559-1 610 MHz

The frequency band 1 559-1 610 MHz is allocated to ARNS, RNSS, and the Fixed Service (FS); and is utilized by GNSS systems. The RNSS (space-to-Earth) allocation in this frequency band is the main allocation available for GNSS, and plays an essential role in navigation operations. GNSS is foreseen to provide the basis for most civil aviation radionavigation requirements in the future. Received RNSS signal levels are low power and GNSS systems require extreme care and careful design to ensure that they can deliver the required performance on a continuous basis. The stringent technical requirements of GNSS make co-frequency use of this frequency band highly restrictive. Therefore, this band is not considered a viable option for further study.

## The frequency band 1 610-1 626.5 MHz

This frequency band is reserved on a worldwide basis for the use and development of airborne electronic aids to air navigation and any directly associated ground-based or satellite-borne facilities. This frequency band is constrained by sharing with the radio astronomy allocation, which has primary status. Additionally, RR Footnote 5.149 limits airborne use. Due to the requirement for a harmonized worldwide allocation for WAIC systems, this band is prohibitive for WAIC systems due to the fact that there are many Administration-specific footnote allocations and regional differences in this frequency band. . Therefore, this band is not considered a viable option for further study.

## The frequency band 2 700-2 900 MHz

Use of the 2 700-2 900 MHz frequency band by the ARNS is restricted to ground-based radars and associated airborne transponders that transmit only when actuated by radars operating in the same band. Ground-based meteorological radars have primary status (via footnote) in this band. In Canada, the maritime radionavigation service also has primary status. This frequency band is primarily used for surveillance radars and meteorological radars, which are often placed in or near airports. The high RF power and low receiver sensitivity levels associated with these radar systems and their proximity to aircraft at airports places significant receiver protection and emission limitation requirements on any system attempting to share the band. Therefore, this band is not considered a viable option for further study.

## The frequency band 4 200-4 400 MHz

Use of the frequency band 4 200-4 400 MHz by the ARNS is reserved exclusively for radio altimeters installed on-board aircraft and for the associated transponders on the ground. Radio altimeters provide the primary means of altitude detection for all critical phases of flight, especially the final stages of landing. The standard frequency and time signal-satellite service may also be authorized to use the frequency range 4 200-4 204 MHz for space-to-Earth transmissions. Due to the limited number and location of incumbent systems, the globally harmonized allocation, and the fact that any WAIC use on an aircraft will require ICAO and aeronautical standardization groups involvement and ultimately aircraft certification, this frequency band was considered for additional study and is the most obvious candidate band below 15.7 GHz for WAIC systems. WAIC systems were also analyzed to quantify the order of magnitude of interference into the adjacent FSS frequency band (3 600 – 4 200 MHz), with the conclusion that no interference exceeds established protection criteria. CPM text has been drafted and supported by numerous Administrations to add an AM(R)S allocation limited to WAIC systems in this frequency band.

## The frequency range 5 000-5 250 MHz

The frequency bands 5 000-5 010 MHz and 5 010–5 030 MHz are allocated to the AMS(R)S, ARNS, and RNSS. The frequency band 5 030-5 091 MHz is allocated to the AM(R)S. The frequency band 5 091-5 150 MHz is allocated to the AMS and restricted via footnote to systems operating in the aeronautical mobile (R) service and in accordance with international aeronautical standards, limited to surface applications at airports and to aeronautical telemetry transmissions from aircraft stations. Both frequency bands 5 030-5 091 MHz and 5 091-5 150 MHz are also allocated to the ARNS and AMS(R)S. Furthermore, the frequency band 5 091-5 150 MHz is allocated to the FSS via footnote. The frequency band 5 150-5 250 MHz is allocated to the ARNS, FSS, MS (except aeronautical mobile) and the AMS limited to aeronautical telemetry. These provisions for aeronautical telemetry are limited to parts of ITU Region 1 and Brazil. Due to the large number of incumbent systems, the numerous technical protection requirements and compatibility issues, and the potential regulatory changes foreseen in portions of this frequency range, it is unlikely that WAIC systems can make use of these frequency bands without causing interference to incumbent systems or being interfered by them. Therefore, this frequency range is not considered a viable option for further study.

## The frequency band 5 350-5 460 MHz

The frequency band 5 350-5 460 MHz is allocated to the ARNS, Earth Exploration Satellite Service (EESS) (active), Space Research Service (SRS) (active), and Radio Location Service (RLS). The allocation to the ARNS is limited to airborne radars. This allocation is also used for airborne weather and ground mapping observations. The EESS (active), the SRS (active) and the RLS allocations are subject to the condition that systems operating under these allocations shall not cause harmful interference to ARNS systems. This frequency band is used by numerous incumbent systems with protection criteria that complicate coexistence and make sharing impractical. Therefore, this frequency band is not considered a viable option for further study.

## The frequency band 8 750-8 850 MHz

The frequency band 8 750-8 850 MHz is allocated to the ARNS and RLS. In Algeria, Germany, Bahrain, Belgium, China, Egypt, the United Arab Emirates, France, Greece, Indonesia, Iran (Islamic Republic of), Libya, the Netherlands, Qatar, Sudan and South Sudan, the frequency band is also allocated to the maritime radionavigation service on a primary basis for use by shore-based radars only. The use of the band by the ARNS is limited to airborne Doppler navigation aids. According to studies carried out for the band 13.25-13.4 GHz (see below), sharing between airborne Doppler radars and WAIC systems cannot be guaranteed to avoid harmful mutual interference. Therefore, this band is considered impractical and it is not considered a viable option for further study.

## The frequency band 9 000-9 200 MHz

The frequency band 9 000-9 200 MHz is allocated to the ARNS and RLS. The ARNS is restricted to ground-based radars and associated airborne transponders that transmit only when actuated by radars operating in the same band. In Algeria, Germany, Bahrain, Belgium, China, Egypt, the United Arab Emirates, France, Greece, Indonesia, Iran (Islamic Republic of), Libya, the Netherlands, Qatar, Sudan and South Sudan, this frequency band is also used on a primary basis for shore-based radar systems in the maritime radionavigation service. Stations operating in the radiolocation service shall not cause harmful interference to, nor claim protection from aeronautical radionavigation systems utilizing this band or radar systems in the maritime radionavigation service. Systems that use this frequency band include primary surveillance radar, precision approach radar and airport surface detection equipment. The high RF power and low receiver sensitivity levels associated with these radar systems and their proximity to aircraft at airports places significant receiver protection and emission limitation requirements on any system attempting to share the band. Therefore, this frequency band is not considered a viable option for further study.

## The frequency band 13.25-13.4 GHz

The frequency band 13.25-13.4 GHz is allocated to the ARNS, EESS, and SRS (active). Aviation’s use of this band is limited to Doppler navigation aids and ground mapping radars. In Bangladesh, India and Pakistan, this band is also allocated to the FS on a primary basis. The EESS (active) and SRS (active) operating in this band shall not cause harmful interference to, or constrain the use and development of, aeronautical radionavigation service systems. Furthermore, this band is foreseen by some Administrations for the use by airborne Sense and Avoid radars. Studies addressing typical operational scenarios for airborne Doppler navigation and Sense and Avoid radars yielded impractically large minimum required separation distances between these and WAIC systems in order to avoid harmful mutual interference.

## Review of the frequency range 15.4-15.7 GHz

The frequency range 15.4-15.7 GHz contains allocations for the ARNS, RLS, and FSS. The frequency band is used by aviation for ground-based primary surveillance radar systems including precision approach radar and ASDE. The main purpose of these systems is to provide surveillance to support precision approach to aircraft and to detect traffic at airports. This band is also a supplementary band for the main FSS feeder link bands at 19 GHz and 29 GHz. The RLS allocation is to provide remote environmental sensing. The high RF power and low receiver sensitivity levels associated with the radar systems operated in this frequency band and their proximity to aircraft at airports places significant receiver protection and emission limitation requirements on any system attempting to share this band. Therefore, this frequency band is not considered a viable option for further study.

# Conclusion of Studies

As demonstrated above, analysis of the aeronautical frequency bands below 15.7 GHz leads to the conclusion that the band 4 200-4 400 MHz is the best option for WAIC systems due to the low number of incumbent systems and their specific characteristics enabling shared use of the frequency band.

# Considerations for completing ITU-R Study work on WRC-15 AI 1.17

Assessments and sharing studies for WRC-15 agenda item 1.17 have been carried out in accordance with *invites ITU-R* 3i of Resolution 423. *Invites ITU-R* 3i calls for considering frequency bands within existing worldwide aeronautical mobile service, aeronautical mobile (R) service and aeronautical radionavigation service allocations when performing studies under WRC-15 agenda item 1.17. An overview of the results of these assessments is contained in Working Document towards a PDNR ITU-R M.[WAIC BANDS] as contained in Annex 36 to Document 5B/475. It is believed, that this document provides important evidence on the feasibility to accommodate future WAIC systems within existing aeronautical allocations below 15.7 GHz and as such Working Document towards a PDNR ITU-R M.[WAIC BANDS] should be pursued towards final approval by Study Group 5 prior to WRC-15. It is therefore proposed to update the assessments of the bands contained within Working Document towards a PDNR ITU-R M.[WAIC BANDS] according to the material contained in section 3 above.

Furthermore, the following ITU-R documents contain in-depth sharing and compatibility studies for the bands 2 700 – 2 900 MHz, 4 200 – 4 400 MHz and 5 350 – 5 460 MHz:

Annex 42 to Document 5B/304:

Working document towards a preliminary draft new Report ITU-R M.[WAIC\_SHARING\_2 700-2 900 MHz] - Sharing analyses between wireless avionics intra-communications and systems operating under an existing allocation in the frequency band 2 700-2 900 MHz

Annex 28 to Document 5B/475:

Working document towards a preliminary draft new Report ITU-R M.[WAIC\_SHARING\_4 200-4 400MHz] - Compatibility analysis between wireless avionics intra-communications systems and systems in the existing services in the frequency band 4 200-4 400 MHz

Annex 40 to Document 5B/304:

Working document towards a preliminary draft new Report ITU-R M.[WAIC\_SHARING\_5 350-5 460 MHz] - Sharing analyses between wireless avionics intra-communication systems and other systems operating under allocations in the frequency band 5 350-5 460 MHz.

The compatibility analysis of the frequency band 4 200 – 4 400 MHz comes to the conclusion that sharing between WAIC systems and the incumbent users in the band is feasible. Therefore, the Working document towards a preliminary draft new Report ITU-R M.[WAIC\_SHARING\_4 200-4 400MHz] should be further pursued with the aim to finalize the ITU-R Report in time for approval by Study Group 5 prior to WRC-15.

The studies on the frequency bands 2 700 – 2 900 MHz and 5 350 – 5 460 MHz conclude that sharing between WAIC systems and some systems in the existing services in the bands is infeasible for the reasons discussed in sections 3.6 and 3.9 above. In order to keep the number of documents to be treated under WRC-15 agenda item 1.17 as low as possible and due to the fact that it is not necessary to provide comprehensive evidence on the infeasibility of a band, it is proposed to incorporate an excerpt of these studies into the Working Document towards a PDNR ITU-R M.[WAIC BANDS] and withdraw the study documents for the bands 2 700 – 2 900 MHz and 5 350 – 5 460 MHz.