



Report ITU-R M.2168-1
(11/2010)

**Compatibility between a proposed new
aeronautical mobile (R) service (AM(R)S)
system and both radionavigation-satellite
service (RNSS) operating in the
5 000-5 010 MHz band and radio astronomy
in the adjacent band 4 990-5 000 MHz**

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***Note:** This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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operating in the 5 000-5 010 MHz band and radio astronomy
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(2009-2010)

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* This Report should be brought to the attention of Radiocommunication Study Groups 4 and 7.

Objective

This Report addresses the feasibility of an allocation for AM(R)S for surface applications at airports with particular emphasis on technical and operational issues relating to the protection of RNSS in the band 5 000 and 5 010 MHz and of the radio astronomy service in the band 4 990-5 000 MHz from AM(R)S.

1 Introduction

1.1 Studies within ITU-R have identified a number of AM(R)S applications for airport surfaces. These range from uploads of routing and electronic flight bag information, to scheduling de-icing facilities, and surface mapping to preclude runway incursion and aid in obstacle avoidance. In general those applications share the characteristics of short-range (a few kilometres maximum) and high bandwidth per airport. Limitation to ground transmission and the geographic separation of airports will likely facilitate airport-to-airport channel reuse.

1.2 To accommodate future growth in surface applications, the 5 000-5 010 MHz band has been selected for evaluation as potential additional spectrum for the airport surface local area network (LAN) currently being developed for operation in the 5 091-5 150 MHz band. The 5 000-5 010 MHz band currently has aeronautical radionavigation service (ARNS), aeronautical mobile-satellite (R) service (AMS(R)S, reference Radio Regulations No. 5.367), and radionavigation-satellite service (RNSS) Earth-to-space (E-s) allocations. Taking into account that a final determination on compatibility cannot be made until both the AM(R)S and RNSS systems are fully defined, this paper presents the results of initial considerations on compatibility between a proposed new AM(R)S system and RNSS (E-s) systems operating simultaneously in the 5 000-5 010 MHz band. In addition, considerations on compatibility of the proposed new AM(R)S system with the radio astronomy service (RAS) operating in the adjacent 4 990-5 000 MHz band are also examined.

2 System characteristics

2.1 AM(R)S system

2.1.1 In order to address the mix of aviation applications intended for the airport surface, an airport safety service LAN is being developed for operation in the 5 091-5 150 MHz band. Based on projected spectrum requirements for such a system, its operation in the 5 000-5 010 MHz band is also under consideration. One candidate architecture is the airport network and location equipment (ANLE) system. ANLE is visualized as a high-integrity, safety communications, wireless LAN for the airport area, combined with an interconnected grid of multilateration sensors. Simple transmitters would be added to surface-moving vehicles, allowing for the development of a high-fidelity, complete picture of the airport surface environment. In order to speed development and reduce the cost of the ANLE, the system would be based on existing Institute of Electrical and Electronics Engineers (IEEE) “802 series” standards¹. As noted in Report ITU-R M.2118, because of the “mobility” capabilities built into IEEE 802.16e, it is expected that it will prove to be compliant with aviation requirements. As a result, the remainder of this analysis will reference that protocol. Example AM(R)S parameters are shown in Table 1. Due to the signal modulation utilized, it is expected that the AM(R)S signal will look noise-like to RNSS and RAS receivers.

¹ While the system would be based on the IEEE 802 series standards, it is expected that system elements would be tailored for the aviation application. Such tailoring might include bandpass filtering to facilitate sharing with adjacent band MLS, improved receiver sensitivities, and sectorized antennas.

TABLE 1
Example AM(R)S based on IEEE 802.16 e parameters

Parameter	ANLE
Operational bandwidth (MHz)	20 ⁽¹⁾
Receiver sensitivity R_{xs} (dBm)	-83.4 ⁽²⁾
Base station antenna gain G_t (dBi)	8.0
Subscriber unit antenna gain G_r (dBi)	6.0
Assumed link margin (dB)	11
Path loss exponent	2.3
Free-space characteristic distance d_0 (m)	462
Transmitter power required P_t	32.2 dBm ⁽³⁾

- (1) Though this is larger than the band being examined (5 000-5 010 MHz), it results in the worst-case (i.e. highest) transmitter power requirements for the AM(R)S system. Since the maximum sub-carrier power and spacing remains constant (see Appendix A), the total power transmitted in the 5 000-5 010 MHz band would be 3 dB less.
- (2) This sensitivity is for a receiver using all the sub-carriers within a 20 MHz bandwidth. Receiver sensitivity varies versus sub-carrier/channel bandwidth, so a receiver using only all the sub-carriers in the 5 000-5 010 MHz band would be 3 dB more sensitive.
- (3) This is the power required to close the link to users at 3 km assuming worst-case receiver sensitivity. The scalable OFDMA implementation and power control (as described in the IEEE 802.16e standard) will reduce the power based on actual transmitted bandwidth (by a factor of $10 \log (\text{No. used subcarriers}/\text{total subcarriers})$), and based on actual measured signal-to-noise (such that the minimum signal-to-noise is maintained for the selected modulation).

2.1.2 Regarding the time waveform of the AM(R)S signal, for a system based on IEEE 802.16e standards it is envisioned that there really will be no “basic” message duration, rather the parameters are selectable from a “menu” of options. This flexibility of the AM(R)S system is anticipated to exist both in channel bandwidth (i.e. the spectral domain), and message frame duration (i.e. the time domain). In general each frame consists of a forward link (FL; base-to-subscriber) and a reverse link (RL; subscriber-to-base) portion shared on a time division duplex manner where FL and RL transmissions occur on the same frequency channel, but in different (time) portions of the frame. A typical division might be 2/3 FL, and 1/3 RL. It is also envisioned that there will be a brief guard time between all FL and RL frames. Depending on the channel bandwidth during a message frame, a number of message symbols are transmitted. Those symbols are distributed in frequency across the sub-carriers for the selected channel bandwidth. Further details on IEEE 802.16e are contained in Appendix A.

2.2 RNSS systems

Details of the RNSS parameters used for this Report are provided below. The $\Delta T/T$ analysis presented in § 4 provides compatibility analysis results for all RNSS systems in the band 5 000-5 010 MHz. The resulting maximum allowable aggregate interference using the $\Delta T/T$ criterion is calculated.

2.2.1 The 5 000-5 010 MHz band is allocated to RNSS (E-s), and as such would be used for RNSS feeder links. System parameters used for the analysis are shown in Table 2.