Report from the 2007 World Radiocommunication Conference on Items of Interest to Radio Astronomy

December 14th, 2007

Andrew Clegg[1] (NSF), Tomas Gergely[2] (NSF), & Harvey Liszt[3] (NRAO)

Contents[4]

[1] aclegg@nsf.gov
[2] tgergely@nsf.gov
[3] hliszt@nrao.edu

[4] This version of the document is an update of the November 30th, 2007, version, with the following changes: (1) update of agenda item numbers for WRC-11; (2) addition of provisional numerical references to placeholder Resolution/Recommendation references; (3) addition of Study Group/Working Party assignments for WRC-11 agenda items; and (4) typographical corrections.

0. Summary

The 2007 World Radiocommunication Conference (WRC-07) included three agenda items of direct relevance to the Radio Astronomy Service (RAS):

1. Establishing out-of-band emission limits for satellites operating in bands near RAS allocations, above which Administrations operating the satellite networks are requested to consult with Administrations operating radio astronomy observatories;
2. Suppression of allocations for satellite uplink and downlink bands straddling the 1.4 GHz RAS allocation; and
3. Limits on the emissions from handsets and ground terminals for mobile satellite systems operating in the 1668 – 1668.4 MHz band above which Administrations operating the satellite systems would consult with Administrations operating space-based radio astronomy systems.

Seven other items on the WRC-07 agenda were of interest to the RAS, and are summarized in this document. The output of WRC-07 includes a preliminary agenda for the next WRC, which is scheduled for 2011. The preliminary agenda includes 12 items of potential interest to the RAS, with the most significant being the discussion of bands of interest to passive services between 275 and 3000 GHz.

1. Introduction

WRC-07 was held at the International Telecommunication Union (ITU) headquarters in Geneva from October 22nd to November 16th. This document is a summary of the agenda items at WRC-07 most directly relevant to the RAS, and the resolution of those items by the Conference. Most of these items were the subjects of lengthy technical studies and their resolution involved extensive negotiations among the affected parties. This document does not attempt to capture
the complexities, subtleties, and sensitivities involved in each item. Within each agenda item, only the issues of most relevance to the RAS are discussed.

The agenda items of greatest relevance to the RAS were 1.21 (section 12 of this document), 1.17 (section 10), and 1.7 (section 7); however, the resolution of other agenda items may affect radio astronomy observations in spectral regions both inside and outside those allocated to the RAS. Those are also discussed in this document.

The next WRC is currently scheduled for 2011, and the preliminary list of WRC-11 agenda items of interest to the RAS is discussed in section 13. New issues and agenda items will be studied during the period leading up to WRC-11 and much of the work relevant to the RAS will occur in the ITU's Radiocommunication-sector Study Group 7 (Science Services, SG7), and specifically within SG7's Working Party 7D (Radio Astronomy, WP7D).

2. Background

Some notes that may help in understanding this summary:

- The ITU is a specialized agency of the United Nations (see http://www.itu.int).
- The ITU-R is the Radiocommunication sector of the ITU. The ITU-R is charged with studying technical and regulatory issues related to the management of radio frequency spectrum and the equitable use of satellite orbits.
- The previous WRC was held in 2003 (WRC-03).
- The work of a WRC is given by its agenda, which is divided into individual (and usually unrelated) items. Not all agenda items are relevant to the RAS.
- The output of each conference includes a preliminary agenda for the next conference.
- The international rules governing the use of the radio spectrum are contained in the ITU's *Radio Regulations*, an international treaty to which ITU member countries agree to adhere.
- A Resolution approved by a WRC becomes part of the *Radio Regulations*.
- A Recommendation approved by a WRC is published in the *Radio Regulations*. Unlike a Resolution, a Recommendation is not mandatory, but for the most part Recommendations are followed by the member countries.
- Individual countries may adopt their own frequency allocations within their borders and these need not conform to the international allocations, as long as they do not cause interference to countries that are operating in accordance with the international table of allocations.
- The term "active" means transmitting; "passive" means non-transmitting. Radio astronomy is a passive radio service.
- Because commas and decimal points in numeric quantities are used differently around the world, the ITU uses a space as a thousands separator. Therefore, as an example, the number "9,500" becomes "9 500" in ITU documents. This format is retained here only when directly quoting an ITU document.
- Use of the term "mobile-satellite service" refers to a communication link between a mobile station and a satellite. The term "fixed-satellite service" refers to a communication link between a fixed station on the ground and a satellite (it does not, for example, imply a geostationary satellite).
- The Radionavigation Satellite Service (RNSS) includes systems such as GLONASS, GPS, and Galileo (see section 12).
- The term "Administration" with an upper case "A" usually refers to country governments, but may occasionally also refer to an operating agency. In such cases it is always preceded by the name of that operating agency (for example, the GLONASS Administration).
- In this document, the term "co-primary" means the band is allocated on a primary basis to radio astronomy and one or more active services.

3. Additional Spectrum for Active Earth Exploration Satellites

WRC-07 Agenda Item:

1.3 in accordance with Resolution **747 (WRC-03)**, consider upgrading the radiolocation service to primary allocation status in the bands 9 000 – 9 200 MHz and 9 300 – 9 500 MHz and extending by up to 200 MHz the existing primary allocations to the Earth exploration-satellite service (active) and the space research service (active) in the band 9 500 – 9 800 MHz without placing undue constraint on the services to which the bands are allocated

Background: Earth-sensing synthetic aperture radar (SAR) satellite experiments currently use the 300 MHz-wide Earth Exploration-Satellite Service (EESS) allocation in the 9500 – 9800 MHz band. A nadir-pointing satellite experiment in low earth orbit (400 km) has been operating in this band for almost 15 years with an emission bandwidth of about 50 MHz and a transmitter power of about 1 kW. Many more sophisticated experiments are planned.

Relevance to Radio Astronomy: Radio astronomy has no frequency allocations near 9500 MHz and existing telescopes have seldom if ever observed in this range, but newer instruments like EVLA and ATA will have broad frequency coverage and will be capable of observing in this region of the spectrum. Serious gain compression or even damage to a radio astronomy receiver are concerns in the event that strong transmissions from a 9.5 GHz SAR pass through an antenna lobe having substantial gain; the transmissions would still be received very strongly if a high-gain lobe of the SAR passes through a 0 dBi sidelobe of the antenna. However, SARs are normally operated by space agencies, which are usually willing to coordinate their operations with radio astronomy observatories.

Results from WRC-07: Studies concluded that services having existing allocations in the affected bands could share spectrum with SARs. The EESS was allocated an additional 200 MHz on a primary basis in the 9300 – 9500 MHz band, and a new secondary allocation at 9800 – 9900 MHz. The EESS systems can therefore now operate across a total bandwidth of 600 MHz, from 9300 – 9900 MHz. New SAR experiments will have scanning (not purely nadir-pointing) push-broom footprints, making reception by radio telescopes more likely. (SAR Reference: http://www.dlr.de/tsx/start_en.htm)

4. Identification of Bands for IMT-2000

WRC-07 Agenda Item:

1.4 to consider frequency-related matters for the future development of IMT-2000 and systems beyond IMT-2000 taking into account the results of ITU-R studies in accordance with Resolution **228 (Rev WRC-03)**

Background: "International Mobile Telecommunications 2000" (IMT-2000) and systems beyond IMT-2000 ("IMT-Advanced") are dated ITU terms for new generations of cellular-like voice and data services. The combination of both terms was shortened to just IMT. WRC-07 attempted to identify specific bands that could be used for IMT, with an ultimate (but likely unrealistic) goal of achieving global harmonization. Harmonized bands would improve manufacturing and operational efficiency of next-generation devices, and would, for example, reduce the need to carry "quad-band" phones when traveling internationally. This agenda item was of the greatest interest to most Administrations, although its direct importance to the RAS is relatively small. IMT-related activities use spectrum allocated to the mobile or mobile-satellite services. WRC-07 sought to identify such bands that would be appropriate for IMT use, but no new allocations were sought for IMT purposes.

Relevance to Radio Astronomy: The Conference addressed both the terrestrial and satellite components of IMT. The former was of greatest importance to Conference participants, but because any spectrum conflicts with the RAS would occur on a domestic basis, international regulation of the terrestrial component was of somewhat less relevance to the RAS than the satellite component.

The bands under consideration for the satellite component of IMT completely or partially overlapped the 1610.6 – 1613.8 MHz and 1660 – 1670 MHz co-primary radio astronomy allocations. The lower of these bands is already overlapped by mobile-satellite service uplinks of the Globalstar system.

With regard to the terrestrial component of IMT, among the many band segments under consideration was 4800 – 4990 MHz, which is allocated on a secondary basis to the RAS on a worldwide basis, and which neighbors the 4990 – 5000 MHz band which is allocated on a co-primary basis to the RAS worldwide.

Results from WRC-07: With regard to spectrum for the mobile satellite component of IMT, a modification to Resolution 225 was approved which recognized various candidate bands and urged further studies of these bands, including studies on how they can be shared with other allocated services. Within the Resolution, language was inserted that specifically recognized the primary allocations to the RAS in the bands 1610.6 – 1613.8 and 1668 – 1670 MHz, since portions of those bands were identified as candidate IMT satellite component bands.

In addition to the satellite component of IMT, some satellite providers also desire to deploy a complementary ground component (CGC), also referred to as an Ancillary Terrestrial Component (ATC), which would consist of base stations on the ground that would fill in locations where the satellite component cannot cover (urban canyons and inside buildings, for example). WRC-07 approved Recommendation 206 addressing some aspects of CGC/ATC. Because portions of the 1.6 GHz band are under consideration for CGC/ATC, language was inserted in the Recommendation that recognized the need to protect the RAS in the 1610.6 – 1613.8 and 1660 – 1670 MHz bands.

There was no impact of the terrestrial component of IMT on the RAS, as consensus could not be reached on the use of the band 4400 – 4990 MHz for IMT, and it was therefore not identified as a candidate band.

5. Spectrum for Aeronautical Telemetry

WRC-07 Agenda Item:

1.5 to consider spectrum requirements and possible additional spectrum allocations for aeronautical telecommand and high bit-rate aeronautical telemetry, in accordance with Resolution **230 (WRC-03)**

Background: The aviation industry has determined that it needs as much as 650 additional MHz of spectrum to meet its future telemetry requirements in support of flight tests of advanced aircraft. WRC-07 looked at specific bands within the range 3 – 16 GHz from which some or all of the additional spectrum could be derived.

Relevance to Radio Astronomy: Transmissions from airplanes are of concern to the RAS because of the great distance over which airborne operations may be line of sight (potentially hundreds of km). Within the U.S. there is substantial geographic overlap between radio astronomy stations (particularly VLBA) and flight test paths.

Specific bands under consideration in this agenda item included 4400 – 4940 and 5925 – 6700 MHz. The former includes part of the 4800 – 4990 MHz band in which the RAS has a secondary allocation, as well as the band segment 4825 – 4835 MHz, which is a primary RAS allocation in Argentina, Australia, and Canada. A footnote to the International Table of Frequency Allocations requests that Administrations take "all practicable steps" to protect the RAS in the 6650 – 6675.2 MHz band, which covers the emission from a methanol spectral line. There is no allocation to the RAS in this band, however.

Results from WRC-07: Footnote 5.4B01 was added to the International Table of Frequency Allocations, allowing aeronautical-mobile telemetry (for flight testing only) in the band 4400 – 4940 MHz in much of ITU Region 2 (roughly, the Americas) and in Australia. Footnote 5.442 was modified to allow such use at 4825 – 4835 MHz even in those countries where the band is allocated on a primary basis to the RAS. Within Region 2, the following countries specifically excluded this allowance: Brazil, Cuba, the French Overseas Departments and Communities, Guatemala, Paraguay, Uruguay and Venezuela. In a similar fashion, and with the same geographic coverage excepting Australia, Footnote 5.4B02 was added covering the use of the band 5925 – 6700 MHz for flight test telemetry.

Footnotes 5.4B01 and 5.4B02 require that use of the bands for telemetry be in accordance with the Resolution 416, adopted by WRC-07. That Resolution recognizes the use of the bands 4800 – 4990 MHz by the RAS, and the primary RAS

allocation at 4825 – 4835 MHz in Argentina, Australia, and Canada. The Resolution placed the following RAS-relevant restrictions on the use of these bands for flight test telemetry: emissions from aircraft stations only; peak EIRP spectral density of –2.2 dB(W/MHz); use limited to designated flight test areas only; and required consultation if operated within 500 km of the border of a country in which the RAS is primary in 4825 – 4835 MHz.

Briefly summarizing this very complicated result: RAS observations in the bands discussed, including 4825 – 4835 MHz (even where the RAS use is primary) may require schedule coordination with flight testing.

6. Additional Spectrum for Aeronautical Mobile (Route) Service

WRC-07 Agenda Item:

> 1.6 to consider additional allocations for the aeronautical mobile (R) service in parts of the bands between 108 MHz and 6 GHz, in accordance with Resolution **414 (WRC-03)** and, to study current satellite frequency allocations, that will support the modernization of civil aviation telecommunications systems, taking into account Resolution **415 (WRC-03)**

Background: The Aeronautical Mobile (Route) Service [AM(R)S] supports bi-directional communications with aircraft flying on established air routes. The increased demand for voice and data traffic driven by increasing air traffic is leading to congestion of existing AM(R)S bands. Also, new technologies that support aeronautical navigation may not fit the traditional definition of the aeronautical radionavigation service (ARNS), and therefore might not be in conformance with existing ARNS allocations and instead require operations under the AM(R)S.

Relevance to Radio Astronomy: Among the bands under consideration for new AM(R)S allocations was 5000 – 5010 MHz, which borders the 4990 – 5000 MHz band in which Radio Astronomy is allocated on a co-primary basis worldwide (this band is passive use only in the U.S.). The use of this band for AM(R)S was proposed to be limited to surface use at airports for IEEE 802.16-based broadband networks. Only radio astronomy observatories located near airports would likely have been impacted by a new allocation in this band, but local coordination was expected to be able to solve any potential interference problems.

Results from WRC-07: The band 5000 – 5010 MHz was not allocated to the AM(R)S at WRC-07. The band 5091 – 5150 MHz was identified instead, which is already allocated to the aeronautical mobile-satellite (route) service. However, WRC-07 approved Resolution 420 that resolves to study whether the new allocation is sufficient to meet the expected demands for surface-use-only wireless networks, and opens the possibility of the allocation at 5000 – 5010 MHz being made at WRC-11. The Resolution resolves to study the compatibility of such applications with the RAS allocation at 4990 – 5000 MHz

Additional considerations: the following new primary allocations for the AM(R)S were made at WRC-07: 108 – 112 MHz (ground-based systems only); 112 – 117.975 MHz; and 960 – 1164 MHz. These bands are already allocated to the aeronautical radionavigation service. An increased level of signals from airborne stations is therefore anticipated in 112 – 117.975 and 960 – 1164 MHz for radio telescopes observing in these bands, due to the new additional use of the bands by the AM(R)S.

7. Protection of the Space Research Service (Passive) from the Mobile Satellite Service in the 1668 – 1668.4 MHz Band

WRC-07 Agenda Item:

1.7 to consider the results of ITU-R studies regarding sharing between the mobile-satellite service and the space research service (passive) in the band 1 668 – 1 668.4 MHz, and between the mobile-satellite service and the mobile service in the band 1 668.4 – 1 675 MHz in accordance with Resolution **744 (WRC-03)**

Background: The band 1668 – 1668.4 MHz is allocated on a primary basis to both the Space Research (passive) service and the Mobile-Satellite Service (in the Earth-to-space direction). The first part of this agenda item was predominantly aimed at providing some protection for SRS from MSS transmissions.

Relevance to Radio Astronomy: The first part of this agenda item is generally aimed at providing protection for space-based radio telescopes operating under the Space Research Service (SRS) allocation in this band. At present, the only such system planned is the RADIOASTRON orbiting space VLBI system, which needs to be protected from interference caused by the aggregate of emissions from handsets and other terminals transmitting to a geostationary mobile-satellite system planned for this band.

Results from WRC-07: A set of threshold emission levels was worked out which, if exceeded by the planned handsets or other ground user components of the MSS system, would trigger coordination between the Administration operating the MSS system and the Administration operating the SRS system (i.e., Russia, as operator of the RADIOASTRON system). The threshold levels are based upon calculations of the total interference that would be received by RADIOASTRON given its orbital characteristics and the expected characteristics of the deployment of the MSS system's user terminals on the ground. The regulatory mechanism chosen to provide this protection is a new resolution (Resolution 904) referred to in a modified footnote (5.379B) to the allocation table in this band segment.

8. High Altitude Platform Stations (HAPS)

WRC-07 Agenda Item:

1.8 to consider the results of ITU-R studies on technical sharing and regulatory provisions for the application of high altitude platform stations operating in the bands 27.5 – 28.35 GHz and 31 – 31.3 GHz in response to Resolution **145 (WRC-03)**, and for high altitude platform stations operating in the band 47.2 – 47.5 GHz and 47.9 – 48.2 GHz in response to Resolution **122 (Rev. WRC-03)**

Background: High Altitude Platform Systems (HAPS) are balloon-type craft at stratospheric altitudes that could be used for telecommunications. According to their proponents, they would enable, for example, the rapid deployment of a cellular telephone system to cover a large geographic area, faster than the build-out of a traditional ground-based tower system. No HAPS systems currently operate.

Relevance to Radio Astronomy: The band 31.5 – 31.8 GHz is allocated exclusively to the passive services, and the RAS has a primary allocation in the 31.3 – 31.5 GHz band. The RAS has primary status in the 48.94 – 49.04 GHz band. Footnote 5.543A places a hard limit on unwanted emissions that HAPS stations, authorized to operate uplinks in the 31 – 31.3 GHz band, may produce in the 31.5 – 31.8 GHz passive band. ITU-R studies have been conducted to determine the constraints necessary on HAPS emissions from a HAPS station to preclude detrimental interference into the other primary RAS bands. In addition to footnote 5.543A, Resolutions 122 and 125 note the necessary protections of the RAS from HAPS stations.

Results from WRC-07: Footnote 5.543A remains unchanged. Resolutions 122 and 125 were revised. The revisions continue to recognize the existing sharing studies with the RAS, and maintain considerations for the protection of the RAS from HAPS stations.

9. Broadcast Satellite Service (BSS) in the Band 620 – 790 MHz

WRC-07 Agenda Item:

1.11 to review sharing criteria and regulatory provisions for protection of terrestrial services, in particular the terrestrial television broadcasting service, in the band 620 – 790 MHz from broadcasting-satellite service networks and systems, in accordance with Resolution **545 (WRC-03)**

Background: This agenda item completes a review of a satellite broadcast allocation which is no longer readily compatible with evolving terrestrial use of the relevant band, i.e. digital television.

Relevance to Radio Astronomy: Radio astronomers have long been concerned about unwanted emissions from broadcasting satellites operating in the 620 – 790 MHz band

exceeding the Recommendation ITU-R RA.769 detrimental level in the widely-used 608 – 614 MHz RAS band. This band pair was one of those listed in the table of Resolution 740 for possible inclusion in Resolution 739, an issue that was addressed under agenda item 1.21 (see section 12).

Results from WRC-07: Two existing broadcast satellite systems that operate in the 620 – 790 MHz bands (STATSIONAR-T and STATSIONAR-T2) will be allowed to continue to operate but the footnote allocation to the BSS was suppressed. Consequently, no new BSS systems can be brought into use in this band. Footnote 5.311 was replaced by footnote 5.311A and by Resolution 549 detailing this change.

10. Feeder Links for Non-Geostationary Satellite Systems at 1.4 GHz

WRC-07 Agenda Item:

1.17 to consider the results of ITU-R studies on compatibility between the fixed-satellite service and other services around 1.4 GHz, in accordance with Resolution **745 (WRC-03)**

Background: WRC-03 adopted a provisional secondary allocation for feeder links at 1390 – 1392 (Earth-to-space) and 1430 – 1432 MHz (space-to-Earth), for Non-GeoStationary Orbit (NGSO) systems in the Fixed-Satellite Service below 1 GHz (that is, the frequency at which the satellite systems provide service to its users is below 1 GHz). Use of the feeder links was conditioned on compatibility studies that were to be reviewed at WRC-07. However, the sole proponent of this system, a company called Final Analysis, went out of business before WRC-07 and some of the needed compatibility analyses were not performed. Moreover, there appeared to be no other requirement for the use of these allocations.

Relevance to Radio Astronomy: While theoretical analyses showed no unwanted emissions into the 1420 – 1427 MHz band from the proposed system, serious concerns remained about a practical demonstration of compatibility (which was never performed) and about how the space-based component would behave once it aged. Concern was also expressed by radio astronomers that if the system went into operation it could limit observations of Doppler-shifted HI. Finally, if the allocation had been made permanent, other, less benign systems might also have been able to use it. The EESS using 1400 – 1427 MHz, and other services using neighboring bands, expressed additional concerns about this prospective allocation.

Results from WRC-07: The conditional allocations to the FSS were suppressed.

11. Global Broadband Satellite Systems

WRC-07 Agenda Item:

1.19 to consider the results of the ITU-R studies regarding spectrum requirement for global broadband satellite systems in order to identify possible global harmonized fixed-satellite service frequency bands for the use of Internet applications, and consider the appropriate regulatory/technical provisions, taking also into account No. **5.516B**

Background: Footnote 5.516B contains long lists of possible bands for space-to-Earth (17 – 50 GHz) and Earth-to-space (27 – 50 GHz) links for global broadband satellite systems.

Relevance to Radio Astronomy: Radio astronomers may wish to observe in the spectral regions identified for these purposes.

Results from WRC-07: No change to existing regulations under this item.

12. Compatibility between Radio Astronomy and Active Space Services

WRC-07 Agenda Item:

1.21 to consider the results of studies regarding the compatibility between the radio astronomy service and the active space services in accordance with Resolution **740 (Rev. WRC-03)**, in order to review and update, if appropriate, the tables of threshold levels used for consultation that appear in the Annex to Resolution **739 (WRC-03)**

Background: Resolution 739, adopted at WRC-03, sets out a consultation procedure to be followed by Administrations operating satellite systems and those operating radio astronomy stations, in cases when unwanted emissions from a satellite downlink are determined (during the design, launch, or operation of the satellite system) to exceed the detrimental interference level in an adjacent or nearby radio astronomy band. The annex to Resolution 739 contains tables listing threshold levels for unwanted emissions by geostationary (GSO, Table 1) and non-geostationary (NGSO, Table 2) systems into the corresponding radio astronomy band, above which the voluntary consultation process is triggered. Resolution 740, also adopted at WRC-03, contains a list of additional satellite downlink/RAS band pairs for which studies were to be conducted in time for their possible inclusion in the tables of Resolution 739 at WRC-07, to determine what the consultation trigger level should be for these particular band pairs.

Relevance to Radio Astronomy: This agenda item was directly related to protection of the RAS, as explained in the background section.

Results from WRC-07: The band pairs listed in Resolution 740 for which studies have been completed, and the corresponding trigger levels for consultation, were incorporated into the tables of Resolution 739. Resolution 740 listing the band pairs for further study was suppressed (removed from the *Radio Regulations*).

Trigger levels for NGSO systems are given in the form of "Equivalent Power Flux Density" (epfd), which takes into account the aggregate interference from satellites in a given system. The present GLONASS system, as well as its potential successors, were exempted from compliance with the epfd trigger level. GLONASS operates in the upper portion of the 1559 – 1610 MHz radionavigation-satellite service (RNSS) band, and unwanted emissions impact the 1610.6 – 1613.8 MHz RAS band. Exemption of the GLONASS system from the epfd trigger level was achieved through a note to Table 2, which refers to protection of the RAS under an existing agreement between GLONASS and IUCAF (the Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science).

13. Future WRC Agendas

WRC-07 Agenda Item:

7.2 to recommend to the Council items for inclusion in the agenda for the next WRC, and to give its views on the preliminary agenda for the subsequent conference and on possible agenda items for future conferences, taking into account Resolution **803 (WRC-03)**

*Background:*WRC-07 established a preliminary agenda for WRC-11, and suggested topics for possible inclusion in the agenda of WRC-15 (2015). Preliminary topics for future WRC agendas may be modified during the period leading up to those Conferences.

Relevance to Radio Astronomy: Future agenda items may impact the RAS. Those items will drive much of the work that is conducted by Working Party 7D leading up to WRC-11.

Results from WRC-07: Several agenda items currently proposed for WRC-11 are relevant to the RAS. These are summarized in the following sections. The responsible group for each item is noted, as are the groups concerned with each item. Concerned groups may be either contributing groups (not in parentheses) or interested groups that will follow the work and act as appropriate (listed in parentheses).

WP7D (or SG7 generally) is listed as a contributing group for the following items: 1.4, 1.6, 1.8, 1.19, 1.22, and 1.25. WP7D/SG7 is listed as an interested group in the following items: 1.3, [1.5], 1.7, [1.10], [1.13], 1.14, 1.15, {1.20}, 1.21. Square brackets are agenda items not discussed in this document because their relevance to the RAS is slight. Curly brackets refer to an agenda item which does not list WP7D or SG7 as concerned groups, but the item is in fact relevant to the RAS.

a. Spectrum for Unmanned Aircraft Systems

WRC-11 Preliminary Agenda Item:

1.3 to consider spectrum requirements and possible regulatory actions, including allocations, in order to support the safe operation of unmanned aircraft systems (UAS), based on the results of ITU-R studies, in accordance with Resolution **421 [COM6/8] (WRC-07)**

Background: Additional aeronautical spectrum is sought to meet demands of transmission systems that support Unmanned Aircraft Systems (UAS). Resolution 421 [COM6/8] resolves to study spectrum requirements and possible additional allocations for UAS at WRC-11.

Relevance to Radio Astronomy: Aeronautical emissions can be particularly troublesome to the RAS. Representatives of the RAS should monitor the bands being considered for UAS during the WRC-11 cycle, as no specific range for this potential allocation has been proposed.

Responsible Group: WP5B

Concerned Group(s): WP4A, WP4C, (WP7B), (WP7C), (WP7D)

b. Additional Spectrum for Aeronautical Mobile (Route) Service

WRC-11 Preliminary Agenda Item:

1.4 to consider, based on the results of ITU-R studies, any further regulatory measures to facilitate introduction of new aeronautical mobile (R) service (AM(R)S) systems in the bands 112 – 117.975 MHz, 960 – 1 164 MHz and 5 000 – 5 030 MHz in accordance with Resolutions **413 (Rev.WRC-07)**, **417 [COM4/5] (WRC-07)** and **420 [COM4/9] (WRC-07)**

Background: This is a continuation of work left unfinished at WRC-07. See section 6.

Relevance to Radio Astronomy: The band 5000 – 5030 MHz that is under consideration is adjacent to the band 4990 – 5000 MHz, which is allocated on a co-primary basis to the RAS worldwide. See section 6 for additional information.

Responsible Group: Specific to Resolution 420 [COM4/9] on the use of 5000 – 5030 MHz: WP5B

Concerned Group(s): Specific to Resolution 420 [COM4/9] on the use of 5000 – 5030 MHz: WP4C, WP7D, (WP3M)

c. Spectrum above 275 GHz

WRC-11 Preliminary Agenda Item:

1.6 to review No. **5.565** of the Radio Regulations in order to update the spectrum use by the passive services between 275 GHz and 3 000 GHz, in accordance with Resolution **950 (Rev.WRC-07)**, and to consider possible procedures for free-space optical-links, taking into account the result of ITU-R studies, in accordance with Resolution **955 [COM6/9] (WRC-07)**

Background: Footnote 5.565 to the Table of Frequency Allocations presently lists bands between 275 and 1000 GHz in which the passive services, including the RAS, are interested. The list of bands in 5.565 is generally just a summary of the atmospheric windows between 275 and 1000 GHz.

Relevance to Radio Astronomy: This is the preliminary WRC-11 agenda item of most relevance to the RAS. Radio astronomers should develop a revised list up to 3000 GHz (in accordance with the scope of the agenda item) that includes specific bands of interest. The revised footnote should take into account both ground-based (RAS) and space-based (SRS passive) astronomy interests and include sub-mm spectral line and continuum observations. Note that the international table of allocations presently extends only to 275 GHz, and that no new allocations will be made at the next WRC.

The second part of the agenda item dealing with free-space optical links was inserted by an Administration with intense interest in this subject. That subject is believed to have no specific relevance to the RAS, but developments should be followed by astronomers.

Responsible Group: On passive use of 275 – 3000 GHz: WP1A (based on requirements developed by SG7)

Concerned Group(s): On passive use of 275 – 3000 GHz: WP7C, WP7D, (WP3M)

d. Additional Spectrum for Aeronautical Mobile-Satellite (Route) Service

WRC-11 Preliminary Agenda Item:

1.7 to consider results of ITU-R studies in accordance with Resolution **222 (Rev. WRC-07)** in order to ensure long-term spectrum availability and access to spectrum necessary to meet requirements for the aeronautical mobile-satellite (R) service, and to take appropriate action on this subject, while retaining unchanged the generic allocation to the mobile-satellite services in the bands 1 525 – 1 559 MHz and 1 626.5 – 1 660.5 MHz

Background: At WRC-97, the Aeronautical Mobile-Satellite (Route) Service [AMS(R)S] lost exclusive allocations in portions of the 1525 – 1559 MHz (space-to-

Earth) and 1626.5 – 1660.5 MHz (Earth-to-space) bands, to generic Mobile-Satellite Service (MSS) allocations, to accommodate the perceived spectrum demands of various anticipated commercial MSS providers. The AMS(R)S uses portions of those bands for the provision of the Global Maritime Distress and Safety System (GMDSS), providing emergency communications for aircraft. Among the issues under this agenda item is to study whether the shared spectrum arrangement in these bands can provide sufficient capacity for future AMS(R)S requirements, especially for the GMDSS; and if not, whether AMS(R)S should be identified for use in other generic MSS bands and/or if new AMS(R)S allocations may be necessary. Current MSS users of the 1525 – 1559 and 1626.5 – 1660.5 MHz bands are not supposed to lose access to any portion of those bands.

Relevance to Radio Astronomy: Because AMS(R)S involves transmissions from aircraft and ground stations up to satellites, and from satellites back down to aircraft and ground stations, numerous interference possibilities exist with the RAS. The RAS community should watch closely the possible identification of new bands for AMS(R)S, and especially new allocations, for potential conflicts.

Responsible Group: WP4C

Concerned Group(s): WP5C, (WP4B), (WP7B), (WP7C), (WP7D)

e. Fixed Service in the Range 71 – 238 GHz

WRC-11 Preliminary Agenda Item:

1.8 to consider the progress of ITU-R studies concerning the technical and regulatory issues relative to the fixed service in the bands between 71 GHz and 238 GHz, taking into account Resolutions **731 (WRC-2000)** and **732 (WRC-2000)**

Background: Passive services gained primary allocations in a considerable amount of spectrum above 71 GHz at WRC-2000. Resolution 731 acknowledges that at the time these passive allocations were made, future demands for use of these higher bands by the active services were not as well established as the physics-based requirements of the passive services, and that studies are needed to understand how the higher frequencies may be shared among active and passive services. Resolution 732 in turn resolved that appropriate future measures should be taken to address the spectrum requirements of the active services above 71 GHz, and that the sharing criteria between active services should form the basis of a future review of active service allocations above 71 GHz. Some of these "future" reviews appear to be coming to fruition at WRC-11.

Relevance to Radio Astronomy: Because the vast majority of RAS spectrum (by bandwidth) falls in the millimeter wave range, any review of active service

allocations in this region must consider protections for the RAS and other passive services.

Responsible Group: In regard to Resolution 731: WP5C

Concerned Group(s): In regard to Resolution 731: WP7C, WP7D, (WP1A), (WP4A)

f. Review of the Radiolocation Service in the 30 – 300 MHz Range

WRC-11 Preliminary Agenda Item:

1.14 to consider requirements for new applications in the radiolocation service and review allocations or regulatory provisions for implementation of the radiolocation service in the range 30 – 300 MHz in accordance with Resolution **611 [COM6/14] (WRC-07)**

Background: The radiolocation service is looking for a 2+ MHz bandwidth globally-harmonized primary spectrum allocation in the 30 – 300 MHz range. Applications of this service include the monitoring, detection, tracking, and surveillance of satellites and satellite debris in space; remote space sensing; and asteroid detection.

Relevance to Radio Astronomy: The RAS has allocations in this range, including 37.5 – 38.25 MHz (worldwide secondary; partially primary in the U.S.); 73 – 74.6 MHz (primary in Region 2); and 150.05 – 153 MHz (primary in Region 1).

Responsible Group: WP5B

Concerned Group(s): (WP3L), (WP5A), (WP5C), (WP7B), (WP7D)

g. Oceanographic Radar in the Range 3 – 50 MHz

WRC-11 Preliminary Agenda Item:

1.15 to consider possible allocations in the range 3 – 50 MHz to the radiolocation service for oceanographic radar applications, taking into account the results of ITU-R studies, in accordance with Resolution **612 [COM6/15] (WRC-07)**

Background: Oceanographic radars with peak powers of typically 50 W have used groundwave propagation techniques in this frequency range on an experimental basis for approximately 30 years to sense coastal sea state conditions. Such radars may also have value as surveillance tools for security and port operations. Resolution 612 calls for studies of the spectrum requirements for these radars; sharing studies between the radars and existing services in this frequency range; and possible new allocations for the radars at WRC-11.

Relevance to Radio Astronomy: The RAS has allocations at 13360 – 13410 kHz (worldwide co-primary; primary in the U.S.), 25550 – 25670 kHz (exclusive primary worldwide), and 37.5 – 38.25 MHz (worldwide secondary; partially primary in the U.S.) that should be considered in compatibility studies between the oceanographic radars and existing services in the 3 – 50 MHz range.

Responsible Group: WP5B

Concerned Group(s): WP5C, WP6D, (WP5A), (WP7B), (WP7D)

h. Software Defined Radio and Cognitive Radio Systems

WRC-11 Preliminary Agenda Item:

1.19 to consider regulatory measures and their relevance, in order to enable the introduction of software-defined radio and cognitive radio systems, based on the results of ITU-R studies, in accordance with Resolution **956 [COM6/18] (WRC-07)**

Background: Resolution 956 invites the ITU-R to study whether there is a need for regulatory measures related to the application of cognitive and/or software-defined radio systems and technologies.

Relevance to Radio Astronomy: An important consideration in cognitive radio techniques is the method by which such systems would recognize the use of spectrum by passive services and avoid interference to them. In addition, the RAS community may be able to contribute to the regulatory study of cognitive radio by virtue of techniques used to provide for RA observations in bands outside of those allocated to the RAS.

Responsible Group: WP1B

Concerned Group(s): SG3, SG4, SG5, SG6, SG7

i. High Altitude Platform Station Gateway Links in the Range 5850 – 7500 MHz

WRC-11 Preliminary Agenda Item:

1.20 to consider the results of ITU-R studies and spectrum identification for gateway links for high altitude platform stations (HAPS) in the range 5 850 – 7 075 MHz in order to support operations in the fixed and mobile services, in accordance with Resolution **734 (Rev.WRC-07)**

Background: Resolution 734 calls for sharing studies to identify two 80-MHz channels within an existing Fixed Service allocation within the range 5850 – 7075 MHz to facilitate gateway links to and from HAPS stations.

Relevance to Radio Astronomy: Footnote 5.148A and 5.149 to the Table of Frequency Allocations call attention to the use of the band segment 6650 – 6675.2 MHz by the RAS (for observations of a methanol spectral line). The footnotes urge Administrations to take all practicable steps to protect the RAS from harmful interference, particularly from spaceborne or airborne transmissions. This band segment falls with the 5925 – 6700 MHz primary Fixed Service allocation (worldwide), and therefore could be considered for HAPS gateway links under this agenda item.

Responsible Group: WP5C

Concerned Group(s): WP4A, (WP3M), (WP5A), (WP5B), (WP7B), (WP7C). Note: WP7D is not included.

j. Primary Radiolocation Service Allocation in the Band 15.4 – 15.7 GHz

WRC-11 Preliminary Agenda Item:

1.21 to consider a primary allocation to the radiolocation service in the band 15.4 – 15.7 GHz, taking into account the results of ITU-R studies, in accordance with Resolution **614 [COM6/19] (WRC-07)**

Background: This band is currently allocated to the aeronautical radionavigation service (ARNS), although none of the systems operating in the band are based upon International Civil Aviation Organization (ICAO) standards. Many of the systems operating in the band have characteristics more like the radiolocation service (RLS) than the ARNS. Resolution 614 invites the ITU-R to consider adding a primary RLS allocation to reflect current and future systems using this band.

Relevance to Radio Astronomy: The RAS has a worldwide exclusive passive allocation in the adjacent band 15.35 – 15.4 GHz. Resolution 614 resolves to study the compatibility of the RLS and the adjacent RAS as part of the process leading up to a possible new primary RLS allocation.

Responsible Group: WP5B

Concerned Group(s): WP4A, (WP3M), (WP7D)

k. Short-Range Devices

WRC-11 Preliminary Agenda Item:

1.22 to examine the effect of emissions from short-range devices on radiocommunication services, in accordance with Resolution **953 [COM6/4] (WRC-07)**

Background: This agenda item addresses the proliferation of short-range RF devices such as UWB and RFID tags, and the effect on existing radiocommunication services of these devices operating inside and outside of Industrial, Scientific, and Medical (ISM) bands.

Relevance to Radio Astronomy: While not defined as a radiocommunication service, the impact of short-range devices on services that utilize very low signal strengths is addressed in Resolution 953. The scope of the agenda item may require broadening to address possible impacts on the RAS.

Responsible Group: WP1A

Concerned Group(s): SG3, SG4, SG5, SG6, SG7

l. Additional Spectrum for the Mobile-Satellite Service

WRC-11 Preliminary Agenda Item:

1.25 to consider possible additional allocations to the mobile-satellite service, in accordance with Resolution **231 [COM6/21] (WRC-07)**

Background: Report ITU-R M.2077 suggests a shortfall of MSS spectrum bandwidth of 19 – 90 MHz (Earth-to-space) and 144 – 257 MHz (space-to-Earth) for the provision of the satellite component of IMT. Resolution 231 invites the ITU to study the possibility of new MSS allocations, particularly in the range of 4 – 16 GHz, to rectify the predicted shortfall.

Relevance to Radio Astronomy: The RAS has numerous allocations and footnote protections within the 4 – 16 GHz range that should be taken into account during compatibility studies involving new MSS spectrum.

Responsible Group: WP4C

Concerned Group(s): SG1, SG3, SG5, SG6, SG7