CRAF
Committee on Radio Astronomy Frequencies

Position on WRC-12 Agenda Items

1 - The Committee on Radio Astronomy Frequencies (CRAF)*

Radio astronomy plays a key role in increasing our understanding of the universe in which we live; it is a passive service, so does not cause interference to other users of the radio spectrum. Protection of radio astronomy operations from radio interference is becoming more difficult as use of the spectrum increases for terrestrial, air- and space-borne communications. The Committee on Radio Astronomy Frequencies (CRAF) of the European Science Foundation[1] (ESF) represents European radio astronomers and observatories; it is a sector member of the ITU and active in the study and promotion of the protection of the frequency bands used by the Radio Astronomy Service (RAS). CRAF's mission is:

- to work towards the goal of keeping the frequency bands used for radio astronomy observations free from man-made interference;
- to argue the scientific needs of the European radio astronomy research community for continued access to and availability of the radio spectrum for radio astronomy, including the promotion of new allocations if necessary;
- to support related science communities in their needs concerning interference-free radio frequency bands for passive use.

2 - Why protect Radio Astronomy?

Aside from its ultimate goal of answering many fundamental questions posed by mankind, radio astronomy has acted and continues to act as an engine for technological development and has nurtured some of the technologies indispensable to modern life. It needs adequate protection and support in the future to enable it to continue to do these things.

The need for interference free RAS bands

Large radio telescopes routinely detect minute signals that cannot be resolved by normal receivers. For example, a 1 W transmitter broadcasting on 2.7 GHz from a geostationary orbit 36000 km above the site of a radio telescope will be detected at a level similar to a weak cosmic radio source even when the telescope antenna is not pointing at the transmitter. It is also important to appreciate that there is not a free choice of frequencies or frequency bands in which to observe many of the celestial objects; spectrum requirements for the successful operation of radio astronomy observatories are dictated by nature. Consequently, the RAS needs sufficient bandwidth at particular frequencies free from man-made interference.

Protecting an investment

In Europe there are more than fifty radio astronomy observatories; each constitutes a significant investment into scientific infrastructure for fundamental research. Not all European countries have their own observatories, but since radio observatories usually have a policy of sharing their facilities for free

[1] The European Science Foundation (ESF) is an association of 75 Member Organizations from 30 countries. The ESF brings European scientists together to work on topics of common concern, to co-ordinate the use of expensive facilities, and to discover and define new endeavours that will benefit from a co-operative approach.

with any bona-fide scientist from any country, many have very active radio astronomy research communities.

The radio astronomy community has recently begun to construct and operate the next generation of observational facilities on scales that are beyond the reach of individual countries:

- The Square Kilometre Array - 'SKA', will be built either in South Africa or Australia/New Zealand. It will have an inner core with a diameter of several kilometres with large number of remote stations up to 5500 km away. The total collecting area will be one square kilometre, resulting in an instrument a hundred times more sensitive than the largest telescopes today. An important criterion that will drive the decision on the final location of the site is the likely future radio frequency interference level.

- The Atacama Large Millimetre Array (ALMA) will be composed of at least 50 high-precision antennas located on the Chajnantor plain of the Chilean Andes; a site that offers the exceptionally dry and clear sky required to operate at millimetre and sub-millimetre wavelengths.

- LOFAR is a new European low frequency interferometer operating at metre wavelengths in two VHF bands. Its core is located in The Netherlands, with a number of additional stations either operational, being built or planned in several other European countries.

The SKA and ALMA projects are important global scientific initiatives with strong European involvement. The protection of radio astronomy is an issue that transcends national borders.

3 – CRAF comments and position on the main WRC-12 Agenda Items of interest to the Radio Astronomy Service

AI 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 (WRC 07);*
Comments CRAF's concerns relate to unwanted emissions falling into designated RAS bands from terrestrial and satellite components used for the control of UAS. Compatibility studies currently in progress look at the possibility of use of spectrum already allocated to similar services but there are also proposals that allocations might be made in bands adjacent or near to radio astronomy allocations at 4990 – 5000 MHz and 15.35 – 15.40 GHz. The studies indicate that an allocation immediately adjacent to the 4990 – 5000 MHz RAS band is probably not feasible (guard band required) and suggest incompatibility of allocations adjacent to the RAS band at 15.35 – 15.40 GHz. CRAF will continue to contribute to and support the completion of CEPT and ITU-R studies as appropriate.	
CRAF position CRAF does not support new allocations to UAS systems adjacent to RAS bands. However, if allocations are made they must be appropriately regulated to ensure compatibility with RAS operation. This should be supported in advance by necessary compatibility studies. CRAF supports the 'no change' option Method A1 of the current CPM text.	

AI 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 (WRC 07) and 420 (WRC 07);*
Comments [Res 420] The 5000 - 5030 MHz band under consideration is adjacent to the RAS band at 4990 – 5000 MHz. ITU-R studies indicate that compatibility with the RAS operating in this band would require restriction of the AM(R)S use to only surface applications at airports, with a separation	

distance of the order of 150 km from RAS observatories. For observatories within this distance, site-specific compatibility analysis should be performed in order to ensure that RAS is protected. AM(R)S operation in this band could potentially have a significant effect on the RAS as many observatories are located well within 150 km of an airport. It would be up to each national administration to make sure that the relevant compatibility studies are carried out for observatories on their territory and the results acted upon. There may also be cross-border issues. CRAF observes that the ITU-R studies conducted to date do not provide an unequivocal case that the additional spectrum is needed; alternative techniques requiring smaller amounts of spectrum may adequately cover requirements.

CRAF position

CRAF does not support allocations at 5000-5030 MHz. CRAF supports the Method 'C1' no change option in the current CPM text.

AI 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 results of ITU R studies, in accordance with Resolution 955 (WRC 07);*

Comments

[Res 950] There are as yet no allocations at these frequencies and provision needs to be made for the protection of passive services until such time as the Table of Frequency Allocations is extended. The remote geographical location of the few RAS stations making observations at these frequencies does not necessarily mean interference free co-existence with new active services applications and this should be recognized. The spectrum above 275 GHz is of increasing importance to the RAS; this frequency range is used for observations of important spectral lines and continuum bands which assist in the study and understanding of the universe. Significant infrastructure investments are currently being made via international collaboration for the use of this frequency range; for example, the ALMA telescope in Chile, which is a global collaboration.

[Res 955] No evidence has been provided that interference between free-space optical systems is a concern; CRAF believes that existing ITU-R Recommendations and Reports sufficiently address free-space optical links.

CRAF position

[Res 950] CRAF supports the proposed revision of RR footnote 5.565 including modified lists of frequency bands for the RAS, EESS and SRS as developed in the current CPM text.

[Res 955] CRAF supports the suppression of this resolution.

AI 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);*

Comments

Technological development now brings the requirement for consideration of active services use of these bands that have up to date been mainly used by the passive scientific communities. CRAF believes that an appropriate international regulatory environment should be put in place, taking into account the requirements of all the passive services in the bands above 71 GHz. Some technical studies have been conducted to assess sharing possibilities between the RAS and EESS with fixed services allocated to adjacent bands; some concerns have been expressed over the content of these studies. However, it is clear that protection of the RAS will require coordination zones around observatories that are operating at these frequencies. In Europe there are already incidents of interference at some of the frequencies in this range at the Onsala (Sweden) & Pico Veleta (Spain) observatories from automotive SRR applications. It is possible that issues will also emerge in relation to the fixed service as these systems come into use. FS links at 71-76 and 81-86 GHz that were specifically designed to take into account the protection requirements of the ALMA radio telescope were recently implemented in Chile.

CRAF position

CRAF supports efforts to develop regulatory protection for passive frequency bands in the 71-238 GHz range and urges that appropriate mandatory in-band or adjacent-band limits are developed,

together with necessary co-ordination zones to ensure adequate protection of the RAS and other passive services. Further studies on compatibility may be required and CRAF will contribute to these as they arise.

AI 1.16	*to consider the needs of passive systems for lightning detection in the meteorological aids service, including the possibility of an allocation in the frequency range below 20 kHz, and to take appropriate action, in accordance with Resolution 671 (WRC 07*);
Comments ITU-R studies show that the use of systems under the Metaids (passive) service in the 8.3-11.3 kHz range is possible whilst being protected from emissions of other services under specific coordination conditions. An allocation to the meteorological aids service (passive) in this 8.3-11.3 kHz frequency band would provide necessary recognition and long-term protection to this application.	
CRAF position CRAF supports an allocation to the meteorological aids service (passive) between 8.3 and 11.3 kHz.	

AI 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 (WRC 07);*
Comments CRAF supports the conclusion that software-defined radio (SDR) should be considered to be a 'technique' and that there is no need for any specific regulations for SDR. Cognitive Radio Systems (CRS) are a potentially significant threat to the RAS and passive services if not appropriately regulated. It is assumed within the ITU that use of the RAS & science services passive RR 5.340 bands by active radio systems using cognitive radio techniques will be completely excluded, since these bands would always appear to be unused due to the intentional lack of emitters. This implied protection must be enshrined in regulatory text. The principle RAS concerns on this issue relate to active CRS operating in shared bands or within a defined radio quiet zone. Protection of the RAS implies that the CRS system knows its geographical location and has some means of determining what the regulatory implications of its location are. There is however a suggestion that some administrations might license systems that do not have geo-location capabilities; these are likely to cause problems for the RAS and are in contradiction to the suggested ITU-R definition of a CRS system published in Report ITU-R SM.2152	
CRAF position [SDR] SDR should be controlled via regulations applicable to the generic system type for which it is configured. CRAF supports the 'no change' current CPM text option on SDR [CRS] CRAF believes that active CRS applications are incompatible with the RAS and other passive services in shared bands without strong and appropriate regulation. Emissions from active CRS systems must be prohibited in bands listed in RR Nos. 5.340 and 5.149 and in internationally recognized radio quiet zones.	

AI 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);*
Comments The HAPS community have identified two 80 MHz bands near the 6.650 – 6.6752 GHz RAS band for gateway links. However, there is already spectrum designated for these operations for HAPS. Within the RAS this band is used for studies of the methanol line which was only discovered in 1991 and has become of increasing importance to radio astronomy; it is widely observed in Europe. Under RR No. 5.149, in making assignments to stations of other services to which the band 6 650-6 675.2 MHz is allocated, administrations are urged to take all practicable steps to protect the RAS from harmful interference. CRAF believes that studies have shown that there are clear compatibility issues with HAPS allocations in or near this band.	
CRAF position	

CRAF does not support additional allocations to HAPS gateway links proposed near the 6 650 - 6 675.2 MHz RAS band. CRAF supports Method A of the CPM text for 'no change'' to the RR.

AI 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 (WRC 07);*

Comments

Via this proposed allocation, powerful airborne radar units with unwanted emissions at a significant level would be operating adjacent to a RAS band which is covered by RR footnote 5.340. The requested allocation is in effect an extension to lower frequencies of an already existing allocation to give the radar more bandwidth and thus a slightly increased resolution. Strong interference to ~30 RAS sites is acknowledged in the current CPM text unless stringent interference limitation procedures are met. Results of some studies show that unwanted signals potentially received from the radar could be as high as 55 dB above the ITU-R Recommendation RA769 protection threshold. Four methods are proposed in the CPM text: A, B & C are similar, gradually reducing the actual allocation and thus moving it further away from the RAS band allowing some sort of minimal guard band. All suggest an additional possible WRC-12 resolution to protect the RAS. Only method 'D' proposes no change and maintains the status quo. It is interesting to note that one of the stated disadvantages of Method A in the current CPM text is that the need for the full 300 MHz of added spectrum "*may not have been fully justified"*.

CRAF position

CRAF does not support the allocation. However, if allocations are made the protection of the footnote 5.340 covered RAS band at 15.35 – 15.40 GHz should be ensured via appropriate regulation. CRAF supports method D in the current CPM text for 'No Change'

AI 1.22	*to examine the effect of emissions from short-range devices on radio communication services, in accordance with Resolution 953 (WRC 07);*

Comments

CRAF believes that presently there appears to be some lack of clarity about the definition of SRD; in what bands they may or may not be permitted an allocation and how global or regional harmonization may be achieved. In Europe there is a significant threat developing to radio astronomy use of the 6 650 - 6 675.2 MHz RAS band from mobile short range/ultra wideband devices. Operation of these devices would be allowed on a non-interference basis; however, emission limits currently proposed have the potential to generate interference to stations of the RAS in even medium density deployment situations. This is in contrast to the intention expressed in RR footnote 5.149, in which administrations are urged to take all practicable steps to protect the RAS from harmful interference. It is difficult to assess the potential risk to RAS operations arising from the results of implementation of any of the various Methods described in the CPM text. Method 'A' is a no change option. Method 'B' proposes a WRC resolution to study regional & global harmonization generating recommendations & reports. Method 'C' proposes the recognition of a limited number of harmonized frequency bands & emission levels. CRAF is concerned that with this method SRD's present 'non-interference, non-protected' status may become open to review and that a formal definition of "short-range" communications would be required in the RR. Arriving at this definition would be difficult given the wide range of SRD characteristics. Method 'D' proposes to take Method 'C' further and is of equal concern.

CRAF position

Should any provision relating to SRDs be included in the Radio Regulations, compatibility with and protection of the RAS should be ensured via appropriate regulation. CRAF will continue to contribute to and support the completion of CEPT and ITU-R studies as appropriate.

AI 1.25	*to consider possible additional allocations to the mobile-satellite service, in accordance with Resolution 231 (WRC 07);*

Comments

MSS operators estimate a need for another approximately 300 MHz bandwidth for both uplinks and downlinks for their systems. Ten candidate bands between 4 - 16 GHz have been identified for

possible allocations and six merit further consideration at this stage. One of these is directly adjacent to the 10.6 GHz RAS band and another is close to the 15.4 GHz RAS band (the former is considered for downlinks and the latter uplinks). Compatibility studies have shown that there would need to be exclusion zones around observatories for the handset uplinks to protect radio astronomy stations using the 15.4 GHz RAS band and that MSS operators would need to place additional filtering of 29dB in their systems to protect radio astronomy stations from the satellite downlinks in the 10.6 GHz band. CRAF also notes that the estimated spectrum requirements and studies do not necessarily imply a situation which needs to be met by new allocations. CRAF believes that there is a clearly demonstrable difficulty with compatibility between the RAS and MSS at these frequencies and will continue to contribute to and support the completion of CEPT and ITU-R studies as appropriate.

CRAF position

CRAF does not support the allocations. However, if any new MSS allocations are made these should not subject the RAS to restrictive conditions or compromise operations; CRAF urges administrations to support the generation of adequate regulatory provision to protect the RAS. CRAF supports 'no change' methods in the CPM text for the bands mentioned; specifically, D1 & F1.

AI 8.1.1	AI 8.1.1 Issue A - WRC Resolution 63: *To examine the impact of ISM equipment on digital radiocommunication systems in terms of the CISPR method; it is believed that Resolution 63 (Rev.WRC-07) should be revised to improve collaboration with CISPR.*

Comments

AI 8.1.1 In SM-1081, the following is excerpted from the RR: **15.13** § 9: *"Administrations shall take all practicable and necessary steps to ensure that radiation from equipment used for industrial, scientific and medical applications is minimal and that, outside the bands designated for use by this equipment, radiation from such equipment is at a level that does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service operating in accordance with the provisions of these Regulations."* Although ITU-Rep. SM-1081 mentions that protection requirements for the RAS are outlined in ITU-R RA. 769, the report also describes limits for industrial equipment as given by CISPR-11. Industrial equipment emissions at the level of these limits would require free-space separation distances of several kilometres from radio observatories in order to fulfil the ITU-R RA. 769 protection requirements.

CRAF position

CRAF supports WRC Res. 63 and believes that particular consideration should be given to the requirements of radio astronomy and other passive services so that the standards set for ISM equipment in the bands listed in footnotes 5.340 and 5.149 of the RR are made consistent with those of the RR for those bands.

AI 8.2	*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 **806 (WRC-07)**;* 1.6 to consider an allocation in the band 77.5 – 78 GHz to the Radiolocation service on a primary basis in accordance with Resolution [SRR_RLS] (WRC-12) 1.8 to consider an extension of the current worldwide allocation to the Earth Exploration Satellite Service (EESS) (active) in the frequency band 9 300 – 9 900 MHz by at least 600 MHz within the frequency range 8 700 – 10 500 MHz ;

Comments

8.2.1.6: radio astronomy observations in the band 77.5 – 78.0 GHz are covered by the RR footnote 5.149. The mm-wave regime is already strongly affected by quantum noise in the receivers and radio astronomy utilises wide bandwidths in order to achieve sufficient sensitivities. Any interference will practically isolate the 76-77.5 GHz primary band from the other primary band at 79-94 GHz, reducing sensitivity. Atmospheric absorption and local topography can, under some circumstances serve to shield radio observatories from emissions by the radio location service.

8.2.1.8: the proposed new generation of very powerful ground imaging radars can illuminate the site of a radio observatory with pulses having a peak power flux density of 0.02 – 0.06 mW/m^2. A 100m radio dish may collect up to 0.5 W per pulse which can destroy RAS receiver front-ends. Severe

interference in the form of blocking or even damage can be expected even when EESS and RA antennas are not aligned and the receiving band does not coincide with the EESS band. Unless strongly suppressed, the unwanted emissions of the EESS systems can be a far ranging source of radio interference for radio astronomy on the adjacent 10.6 - 10.7 GHz band and on the 8.4 - 8.5 GHz space research band used for geodetic VLBI measurements by radio observatories.
CRAF position **8.2.1.6** New allocations for radio location should not compromise the operation of radio observatories in the band 77.5-78 GHz and in adjacent bands. Coexistence studies are recommended to provide guidelines for the protection of radio observatories operating on mm-wavelengths. **8.2.1.8** CRAF urges administrations to ensure effective protection of radio observatories and space research stations operating in adjacent bands. Coexistence studies are recommended to suggest suitable hard limits for out of band emissions by EESS; any direct illumination of radio astronomy observatories and space research ground stations by the new generation of EESS should be prohibited.

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