

1 - The Committee on Radio Astronomy Frequencies (CRAF)^{†*}

The Committee on Radio Astronomy Frequencies (CRAF) of the European Science Foundation¹ (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; and to support related science communities in their needs concerning interference-free radio frequency bands for passive use.

2 - Why protect Radio Astronomy?

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. 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. 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.

Radio astronomy research is concerned with naturally occurring phenomena, so the operational frequencies it uses cannot be moved within the spectrum; the RAS needs sufficient bandwidth at particular frequencies, free from man-made interference. Additionally, radio astronomy cannot operate effectively with levels of interference that would be tolerable in commercial systems. Developments over the last 20 years mean that radio astronomical observations are now often made on a coordinated basis worldwide. When European telescopes are combined with those in the rest of the world using interferometric techniques, almost the present maximum possible collecting area can be obtained as well the maximum angular resolution currently achievable.

3 – CRAF comments and position on the main WRC-15 Agenda Items of interest to the Radio Astronomy Service

In this section the WRC-15 Agenda Items in which CRAF has an interest are discussed and CRAF's position on each is stated (based on the status of Conference preparation at January 2013). As preparations for WRC-15 evolve, new versions of this document will be released in which this information is updated.

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.

AI 1.1 *to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution 233 [COM6/8] (WRC-12);*

Comments

This AI is likely to be one of the most important issues not only for the RAS but the whole telecommunications sector. Mobile systems do not usually provide viable co-existence environments for the RAS in shared or even some adjacent bands. Therefore an IMT allocation within a shared or nearby RAS band may imply that an observatory’s operational capability is affected. This Agenda Item targets as yet undecided frequency ranges from ~470 MHz up to ~6 GHz. Background and receiver noise is at its minimum in this frequency range, as a consequence the sensitivity and range of radio astronomical measurements is at its maximum. This frequency range is therefore extremely important for the RAS, which is reflected in the numerous primary and secondary allocations. Based on the output of the recent ITU-R JTG 4-5-6-7 meeting, RAS bands that may be affected are:

[The table below assumes that proposals from various sector members are accepted that studies need not be done (hence the band excluded from consideration) due to earlier ITU-R studies having taken place showing that sharing is not feasible in the following bands: 1626.5-1660.5 MHz, 1668-1675 MHz, 3400-3600[†] MHz & 4500–4800 MHz. This may change in July 2013; if so other RAS bands may become subject to threat.]

Frequency Band	RAS Status*	RR FN	Potential IMT Proposal	RAS Use
608 - 614 MHz	Sec	5.149	In band sharing or adjacent	Continuum observations, VLBI
1300 - 1350 MHz	☆	5.149	In band sharing	Continuum and spectral line observations (e.g. Neutral Hydrogen line), VLBI
1350 - 1400 MHz	☆	5.149	In band sharing	Continuum and spectral line observations (e.g. Neutral Hydrogen line), VLBI
1400 - 1427 MHz	PRI	5.340	Adjacent (both sides)	Continuum and spectral line observations (e.g. Neutral Hydrogen line), VLBI
1710 -1785 MHz	☆	5.149	Nearby (below 1700 MHz)	Spectral line observations (e.g. Hydroxyl line), VLBI
2655 - 2690 MHz	Sec	5.149	Nearby (above 2700MHz)	Coninuum observations, VLBI
2690 - 2700 MHz	PRI	5.340	Adjacent (above)	Continuum observations, VLBI (Iso, RAS techniques used by SRS)

* (RR Region 1 or European Common Allocation)

☆ - RAS use is supported by the inclusion of footnote RR 5.149

† - Above 3600 MHz there are counter proposals that the frequency range up to 4200 MHz *should* be studied for potential allocation.

Canada has recently proposed the following in the context of UHF bands for IMT:
“It is proposed that when considering suitable frequency ranges within the range 470 - 698 MHz WP5D defines two ranges, one below 608 MHz and the other one above 614 MHz, with a fixed separation, and a centre gap that includes the band 608 – 614 MHz to provide for coexistence with the radio astronomy service in the areas where it is being used.”

To ensure adequate protection, all RAS bands that may be affected should not be subjected to interference levels from wanted or unwanted emissions of IMT systems that exceed those specified in Recommendation ITU-R RA.769-2.

CRAF Position

CRAF strongly urges administrations to support the Canadian statements in relation to the 608-614 MHz RAS band. No new allocations of spectrum to mobile broadband systems should be made unless acceptable compatibility criteria for the RAS (for both in-band sharing and adjacent bands) are developed via appropriate studies and included in subsequent regulation. CRAF will contribute to compatibility studies as they take place.

AI 1.2

to examine the results of ITU-R studies, in accordance with Resolution 232 [COM5/10] (WRC-12), on the use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, service in Region 1 and take the appropriate measures;

Comments

A specific band proposed for mobile (including IMT) use in its own right. It is sufficiently far away from RAS allocations that assuming no degradation of OOB limits in the equipment standards applicable to mobile systems is allowed, then it is anticipated that the interference environment for the nearest RAS band (608-614 MHz) will not be significantly altered. However, some administrations suggested the downward extension to 470 MHz, which would make coordination of the 608-614 MHz band impossible.

CRAF Position

No new allocations of spectrum to IMT systems should be made unless acceptable compatibility criteria for the RAS are developed via appropriate studies and included in subsequent regulation. CRAF will contribute to studies as they take place. The frequency range considered here should not be significantly extended downwards as that would endanger protection efforts for the localised RAS use of the 608-614 MHz band.

AI 1.5 *to consider the use of frequency bands allocated to the fixed-satellite service not subject to Appendices 30, 30A and 30B for the control and non-payload communications of unmanned aircraft systems (UAS) in non-segregated airspaces, in accordance with Resolution 153 [COM6/13] (WRC-12);*

Comments

This AI potentially includes allocations near the following RAS/SRS bands:

Frequency Band		RAS Status*	RAS Utilization
4990-5000	MHz	PRI	Continuum observations, VLBI
5000-5010	MHz	Sec	Continuum observations, VLBI
5010-5030	MHz	Sec	Continuum observations, VLBI
8215-8400	MHz	1	RAS techniques used by SRS
8400-8500	MHz	PRI	RAS techniques used by SRS
14.47-14.5	GHz	Sec	Spectral line observations, VLBI
14.5 - 14.8	GHz	Sec	VLBI (when compatible with primary use)
14.8 - 15.35	GHz	Sec	VLBI (when compatible with primary use)

¹ RAS use is supported by the inclusion of footnote RR 5.149

To ensure adequate protection, all RAS bands that may be affected should not be subjected to interference levels from wanted or unwanted emissions of UAS that exceed those specified in Recommendation ITU-R RA.769-2.

CRAF Position

CRAF supports the protection of existing RAS & SRS allocations. No changes should be made to the RR unless acceptable sharing criteria are developed with the RAS and SRS.

AI 1.6 *to consider possible additional primary allocations:*
1.6.1 *to the fixed-satellite service (Earth-to-space and space-to-Earth) of 250 MHz in the range between 10 GHz and 17 GHz in Region 1;*
1.6.2 *to the fixed-satellite service (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 within the range 13-17 GHz;*

and review the regulatory provisions on the current allocations to the fixed-satellite service within each range, taking into account the results of ITU-R studies, in accordance with Resolutions 151 [COM6/4] (WRC-12) and 152 [COM6/5] (WRC-12), respectively;

Comments
 [Region 1 allocations, i.e. AI 1.6.1 only considered here] RAS bands that may potentially be affected (i.e. by sharing or adjacency) are:

Frequency Band		RAS Status*	FN	RAS Utilization
10.6-10.65	GHz	PRI	5.149	Continuum observations, VLBI
10.65-10.68	GHz	PRI	5.149	Continuum observations, VLBI
10.68-10.7	GHz	PRI	5.340	Continuum observations, VLBI
14.47-14.5	GHz	sec	5.149	Spectral line observations, VLBI
14.5 - 14.8	GHz	sec		VLBI (when compatible with primary use)
14.8 - 15.35	GHz	sec		VLBI (when compatible with primary use)
15.35-15.4	GHz	PRI	5.340	Continuum observations, VLBI

To ensure adequate protection, all RAS bands that might be affected should not be subjected to interference levels from the emissions of FSS systems that exceed those specified in Recommendation ITU-R RA.769-2.

CRAF Position
 CRAF supports the protection of existing RAS allocations. No additional allocation of spectrum to support additional FSS use should be made in or near RAS allocated bands unless acceptable compatibility criteria are developed via appropriate studies and included in subsequent regulation.

AI 1.9	<p><i>to consider, in accordance with Resolution 758 [COM6/15] (WRC-12):</i></p> <p><i>1.9.1 possible new allocations to the fixed-satellite service in the frequency bands 7 150-7 250 MHz (space-to-Earth) and 8 400-8 500 MHz (Earth-to-space), subject to appropriate sharing conditions;</i></p> <p><i>1.9.2 the possibility of allocating the bands 7 375-7 750 MHz and 8 025-8 400 MHz to the maritime-mobile satellite and additional regulatory measures, depending on the results of appropriate studies;</i></p>
<p>Comments</p> <p>A recent US contribution to ITU-R WP4A on the proposed possible new allocations to the FSS in the frequency bands 8400-8500 MHz (uplink), concluded that exclusion zones for FSS of >700 km were needed for all SRS (deep space) stations considered. The exclusion zones were computed based on the Recommendation ITU-R SA.1157 protection criteria for the SRS deep-space earth stations (broadly similar figures to those for the RAS stations in Recommendation ITU-R RA.769-2), and using the Recommendation ITU-R P. 452 propagation loss model. New FSS allocations as proposed will potentially provide a source of interference for the 8.4-8.5 GHz space research band used for geodetic VLBI measurements by radio observatories together with ground stations of the space research service.</p>	
<p>CRAF Position</p> <p>CRAF supports the protection of the SRS allocation at 8400-8500 MHz. No new allocations to the FSS should be made in this frequency band unless acceptable sharing criteria with SRS in 8400-8500 MHz are developed and included in appropriate regulations.</p>	

AI1.10 *to consider spectrum requirements and possible additional spectrum allocations for the mobile-satellite service in the Earth-to-space and space-to-Earth directions, including the satellite component for broadband applications, including International Mobile Telecommunications (IMT), within the frequency range from 22 GHz to 26 GHz, in accordance with Resolution 234 [COM6/16] (WRC-12);*

CRAF comments

The 23.6 - 24 GHz RR 5.340 protected passive band used by the RAS could potentially be affected by unwanted emissions of the proposed use in adjacent bands. Shared RAS bands around 22 GHz may also be affected.

Frequency Band		RAS Status*	FN	RAS Utilization
22 - 22.21	GHz	PRI	5.149	Continuum and spectral line observations (e.g. Water line), VLBI
22.21 - 22.5	GHz	PRI	5.149	Continuum and spectral line observations (e.g. Water line), VLBI
22.5 - 22.55	GHz	PRI		Continuum and spectral line observations (e.g. Water line), VLBI
22.55 - 22.6	GHz	PRI		Continuum and spectral line observations (e.g. Water line), VLBI
22.6-23	GHz	PRI	5.149	Spectral line observations (e.g. Ammonia line), VLBI
23 - 23.55	GHz	1	5.149	Spectral line observations (e.g. Ammonia line), VLBI
23.6-24.0	GHz	PRI	5.340	Continuum and spectral line observations (e.g. Ammonia line), VLBI

¹ RAS use is supported by the inclusion of footnote RR 5.149

To ensure adequate protection, all RAS bands that might be affected should not be subjected to interference levels from the emissions of MSS systems that exceed those specified in Recommendation ITU-R RA.769-2.

CRAF Position

CRAF supports the protection of all of the RAS bands in the range 22-26 GHz considered under this AI. No new allocations to the MSS should be made unless acceptable compatibility criteria with the RAS are developed and included in appropriate regulation.

AI 1.11	<i>to consider a primary allocation for the Earth exploration-satellite service (Earth to- space) in the 7-8 GHz range, in accordance with Resolution 650 [COM6/17] (WRC-12);</i>
Comments Uplink stations for EESS can usually be coordinated with RAS and SRS.	
CRAF Position CRAF supports the protection of the SRS (passive). The lower frequency range 7190 – 7235 MHz is favoured for new allocations.	

AI 1.12	<i>to consider an extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz, in accordance with Resolution 651 [COM6/18] (WRC-12);</i>
Comments Unless strongly suppressed, the out of band emissions of these 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 (together with ground stations of the space research service). CRAF has recently co-authored with the national administrations of Germany and France a working document towards a PDNR describing the influence of out-of-band emissions produced by typical space-based synthetic aperture radars (SAR) operating in the current and potentially future allocation to the EESS (active) in the 9.6 GHz frequency range on Earth stations operating in the RAS around 10.65 GHz, concluding: <i>“Data loss conditions were revisited for cases when a SAR system illuminates a RAS observatory whenever a satellite is in optical (i.e. not radio) visibility of the RAS station. Although the percentage of data loss, under technically feasible attenuation conditions of unwanted emissions in the order of 30 to 40 dB, may exceed the 2% criterion in the first worst case situation, it was concluded that this would never exceed 3%. Reducing this data loss level to 2% as specified in Recommendation ITU-R RA.1513 would require an attenuation of unwanted emissions of 63 dB with regard to the peak envelope power of the SAR pulse. If it would be difficult or impossible to meet such attenuation in practice, particularly if the band would be extended above the current allocation, potential mitigation techniques would become necessary.”</i> It was also pointed out that accidental damage to RAS receivers could be avoided, if an area of 92 km (vertical) by 28.8 km (horizontal) centred on the RAS station is excluded from illumination, or the RAS station avoids pointing towards the satellite.	
CRAF Position The addition of 600 MHz to the existing allocation can only be supported if the Radio Astronomy Service and the Space Research Service (passive) using radio astronomy techniques in nearby bands are adequately protected from unwanted emissions via appropriate regulation. CRAF considers that the burden of any required co-ordination actions should rest with the satellite operator and not individual RAS observatories.	

AI 1.14	<i>to consider the feasibility of achieving a continuous reference time-scale, whether by the modification of coordinated universal time (UTC) or some other method, and take appropriate action, in accordance with Resolution 653 [COM6/20] (WRC-12);</i>
Comment CRAF has no fundamental objections to a changeover to a continuous reference time-scale. However, this may cause operational difficulties for particular research sectors of the RAS and the matter is still under discussion amongst astronomers.	
Position CRAF has decided to adopt the position of the International Astronomical Union (IAU) which has not yet been finalized.	

AI 1.17	<i>to consider possible spectrum requirements and regulatory actions, including appropriate aeronautical allocations, to support wireless avionics intra-communications (WAIC), in accordance with Resolution 423 [COM6/22] (WRC-12);</i>																														
Comments The RAS bands that may potentially be affected are given in the following table.																															
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Unwanted emissions from WAIC systems may significantly affect RAS use in these bands owing to the acknowledged susceptibility of the RAS to airborne sources of interference. To ensure adequate protection, all RAS bands that might be affected should not be subjected to interference levels from the emissions of WAIC systems that exceed those specified in Recommendation ITU-R RA.769-2.																															
CRAF Position CRAF supports the protection of existing radio astronomy allocations. No new allocations for WAIC systems should be made unless acceptable compatibility criteria are established and included in subsequent regulations.																															

AI 1.18	<i>to consider a primary allocation to the radiolocation service for automotive applications in the 77.5-78.0 GHz frequency band in accordance with Resolution 654 [COM6/23] (WRC-12);</i>
Comments Radio astronomical observations in the band 77.5 – 78.0 GHz are covered by the footnote 5.149 and have a secondary allocation. 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. Increased interference from the proposed allocation will practically isolate the 76-77.5 GHz primary band from the other primary band at 79-94 GHz, reducing achievable sensitivity. In ITU-R WP7D contributions have recently been made detailing studies showing that exclusion zones of ~30 km or more would be needed around observatories to ensure protection of the RAS and that the erection of shielding fences around observatories (a proposed mitigation technique) is unlikely to be practical.	
CRAF Position CRAF supports the protection of existing RAS allocations. No allocations to the radiolocation service should be made unless acceptable sharing criteria with the RAS are established and included in future regulations.	

AI 2	<i>to examine the revised ITU-R Recommendations incorporated by reference in the Radio Regulations communicated by the Radiocommunication Assembly, in accordance with Resolution 28 (Rev.WRC-03), and to decide whether or not to update the corresponding references in the Radio Regulations, in accordance with the principles contained in Annex 1 to Resolution 27 (Rev.WRC-12)</i>
Comments Recommendation ITU-R RA. 769 has been in use for some time. It contains interference limits for the RAS and their dependence on frequency, bandwidth and duration. Recommendation ITU R RA. 769-1 had until recently been referenced in previous versions of the RR, but the revised version, Recommendation ITU-R RA.769-2, has dropped out of the list. It would benefit the spectrum management process if Recommendation ITU-R RA.769-2 would be included in the list of referenced recommendations to facilitate the efficient drafting of resolutions and specific regulations for the protection of the RAS.	
CRAF Position CRAF urges that Recommendation ITU-R RA.769-2 is included in the list of referenced Recommendations.	

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