World Radiocommunication Conferences

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1. Introduction

World Radiocommunication Conferences (WRCs), called World Administrative Radio Conferences (WARCs) until 1993, are important to most countries. They are convened regularly by the International Telecommunication Union (ITU), a specialized agency of the United Nations, to update the regulations governing the use of the radio spectrum according to changes in technology and to allow the introduction of new services. They accomplish this by reallocating spectrum to the various radio services, and by updating other articles of the regulations.

WRCs are large events. The last one, WRC-00, was attended by more than 2000 delegates, over 80 companies and some 300 observers, from more than 150 countries. An excellent account of a WRC as experienced by an astronomer can be found at:

http://dsnra.jpl.nasa.gov/freq_man/wrc97.html

2. A brief history of radio astronomy participation in World Radio Conferences

The history of WRCs is closely related to that of the International Telecommunication Union (ITU). The origins of the ITU go back to 1865, when 20 founding member states established the *International Telegraph Union (ITU),* by signing the First International Telegraph Convention. The First International Radiotelegraph Conference, held in Berlin in 1906, established the first International Radiotelegraph Convention. The Annex to this Convention contained the first regulations governing wireless telegraphy. Expanded and revised by numerous radio conferences since, they are known today as the *Radio Regulations (RR).* The 1927 Radiotelegraph Conference, held in Washington, D.C., established the International Radio Consultative Committee (CCIR) to assist with recommendations for technical standards for the various radio services. Finally, the 1932 Madrid Conference, combined the *International Telegraph Convention* of 1865 and the *International Radiotelegraph Convention* of 1906, to form the *International Telecommunication Convention, and* changed the name of the Union to *International Telecommunication Union*, by which it is still known today.

The history of the modern ITU begun with the Atlantic City Conference, held in 1947, convened with the aim of developing and modernizing the organization. At this meeting the ITU became a UN specialized agency and the International Frequency Registration Board (IFRB) was established. These institutions were tasked with coordinating the increasingly complicated task of managing the radio-frequency spectrum and the Table of Frequency Allocations that was introduced in 1912 in the wake of the *Titanic*

disaster. An Extraordinary Administrative Conference for space communications was held in Geneva in 1963 to allocate frequencies to the various space services for the first time. General WARCs or G-WARC that allowed reallocation of the spectrum across the board were held in 1959 and 1979 in Geneva. In addition, limited conferences that dealt with requirements of specific services were held between these G-WARCs (e.g. the 1983 and 1987 Mobile-WARCs that dealt with requirements of the mobile services). Until 1993, WARCs were held on an "as needed" basis. Since 1993 to date they have been held regularly, at 2-3 year intervals, with a variety of unrelated topics on their Agenda.

The need for exclusive bands allocated to radio astronomy was discussed first at the 1950 Zurich URSI General Assembly. Radio astronomy was recognized as a "radio service" at the 1959 G-WARC, when the 1400-1427 MHz band was allocated to radio astronomy for observations of the recently discovered HI line. Charles Seeger represented the radio astronomy community at this meeting, which lasted for four months! The international radio astronomy community recognized that to sustain and enlarge the gains of the 1959 WARC, it would have to get organized, and the Inter-Union Committee for the Allocation of Frequencies (IUCAF) was formed shortly after WARC-59, to prepare the radio astronomy positions for the 1963 Space WARC. IUCAF surfaced for the first time at the 1963 Space WARC, and managed to obtain secondary allocations for the 1.6 GHz OH lines that were discovered while the Conference was meeting. The next WARC, at which allocations up to 275 GHz were made to the various services for the first time was held in 1971, in Geneva. Radio astronomers managed to get table allocations for the 1665 and 1667 MHz OH lines, for ammonia at 23.7 GHz and for HCN at 86.3 and 88.6 GHz at this meeting. They also obtained footnote allocations for observations of another 7 spectral lines, and the conference adopted a Recommendation on the Shielded Area of the Moon that reserved it for radio astronomy purposes.

By the 1979 G-WARC the radio astronomy community realized that it had a large stake in World Administrative Radio Conferences, and 14 radio astronomers spent some or all of the 6 week long conference in Geneva. This massive participation had good results:16 bands were allocated to radio astronomy in the table, the highest one at 116 GHz. Another 18 radio astronomy allocations by footnote were added above 140 GHz. The conference also approved Recommendation 66, that gave expression to the preoccupation of astronomers about unwanted emissions, particularly from space-borne platforms, that still survives, albeit in a heavily modified form. After the G-WARC, the participation of astronomers in the WARCs diminished temporarily. Only 1 astronomy representative attended the 1987 Mobile WARC and the 1988 Orbital WARC. Complacency couldn't last long, however. The 1992 WARC, held in Spain at Malaga-Torremolinos, had a very full agenda, and considered allocations to satellite services that were close to or overlapped bands of interest to radio astronomers. The 1452-1492 MHz band was allocated to satellite broadcasting and the 1613.8- 1626.5 MHz band was allocated to the mobile satellite service on a secondary basis at this WARC. While the 1610.6-1613.8 MHz radio astronomy allocation was upgraded simultaneously to primary status, and a footnote was adopted to protect the radio astronomy service from harmful interference, the IRIDIUM satellite system that utilizes this allocation for its downlink, became the most difficult problem for radio astronomers for many years.

WRC-95 and WRC-97 were attended by 9 and 14 members of the radio astronomy community, respectively. Central to the agendas of these WRCs was the increasing demand for satellite spectrum, and because of this, they posed large challenges for radio astronomers. For example, WRC-97 allocated the 40.5-42.5 GHz band to the Fixed Satellite Service, adjacent to the 42.5-43.5 GHz primary radio astronomy band. To defend radio astronomy bands from spillover emissions, astronomers demanded

protection of the bands through specific pfd limits that would protect their observations. The first footnote limiting unwanted emissions spilling over into a radio astronomy band was adopted at WRC-97. Astronomers also succeeded in attaching resolutions to the more controversial satellite allocations, requiring that the impact on radio astronomy and possible mitigation methods be studied. The most recent WRC (WRC-00), attended by 17 astronomers, approved the rearrangement of the 71-275 GHz spectrum range for the benefit of astronomers and other passive scientists.

3. The ITU framework

Why should radio astronomers pay attention to the ITU and to WRCs? The International Telecommunication Union (ITU), an independent organization of the United Nations, regulates uses of the radio spectrum internationally, through the Radio Regulations (RR). The RR, that deals with all aspects of radiocommunications and cover the use of the radio frequency spectrum by all radiocommunication services, constitute an international treaty. The international Table of Allocations is one part (Article 5) of the RR. As defined by the ITU, radiocommunication involves the use of the spectrum up to 3 000 GHz. At present allocations cover only up to 275 GHz, but this limit is likely to increase in the near future. Countries are sovereign with regard to the use of the radio spectrum within their own borders and are under no obligation to adopt or follow the international table.

WRCs may have a large impact on radio astronomy in a variety of ways:

- Directly, through the allocation process by:
  - Mandating In-Band Sharing
  - Adopting Adjacent Band Allocations (Satellite Downlinks)
  - Adding Footnotes to the Table of Allocations
- Establishing (or not establishing) Standards (e.g. Spurious Emissions, Frequency Tolerances, etc.)

The impact may also be indirect, for example:

- Through studies that may affect the status of radio astronomy in various bands or regions of the spectrum,
- Imposition of other regulations (e.g. coordination zones around radio observatories, earth stations, etc.),
- Placing issues of interest to radio astronomy (or related issues) on the agenda of future WRCs

4. How do WRCs work?

The scope of a WRC is limited by its agenda. Each WRC develops and formally adopts a draft agenda for the next conference, and a provisional agenda for the one after. Both draft Agendas are contained in WRC Resolutions that must be formally approved by the ITU Council, which meets annually and that can, and often does revise the agenda. For example, it has on occasions dropped agenda items, to reduce the conference workload and attendant costs, or added items considered urgent by the members. Since 1993, WRC

agendas have, as a rule, contained numerous unrelated issues, that are considered urgent by the members, sometimes leading to quite a fight about what issues should be on the Agenda of a forthcoming Conference.

The preparatory process for a WRC starts immediately upon the conclusion of the previous one, based upon the provisional agenda just established and usually also under pressure from unresolved issues. Preparatory efforts are channeled towards the Conference Preparatory Meeting (CPM) that is charged with preparing a report containing the "technical" basis for the various agenda items. The first CPM meeting, held immediately after the WRC, determines the contents and organization of the Report, based on the agenda just established. The studies mandated in WRC resolutions are carried out (or not!) in the various study groups in the year(s) between WRCs.

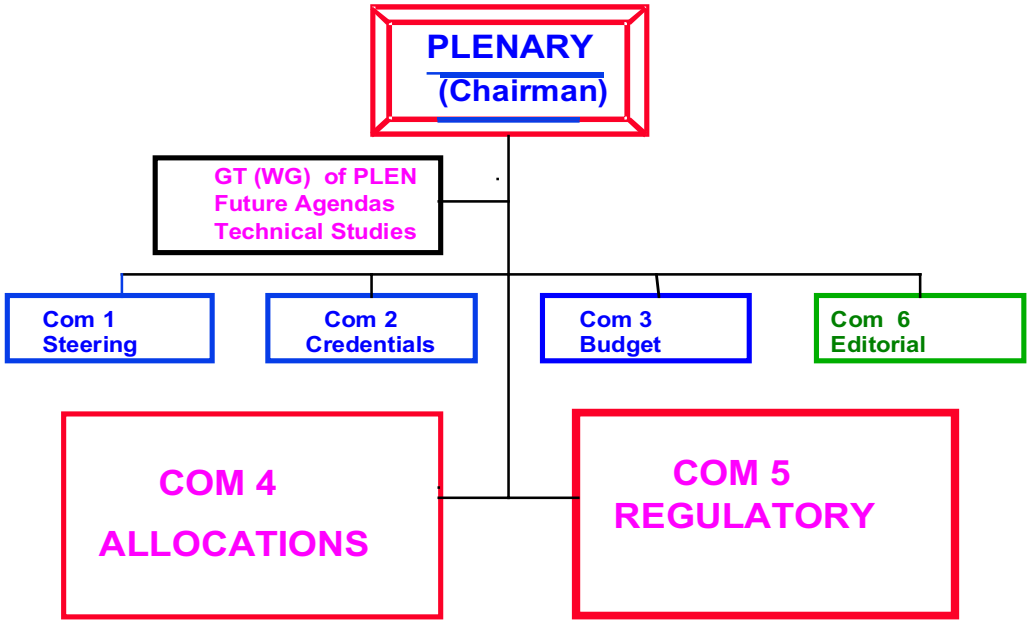
Member administrations in good standing are entitled to submit proposals to the WRC, usually up to a certain deadline a few months before the beginning of the Conference, to allow time to translate them into the languages required by the ITU Convention (English, French, and Spanish) and distribute them to member administrations. Notwithstanding enormous pressures to submit proposals in a timely fashion, they are often received up to the beginning of the Conference and even later.

As noted already, a few thousand delegates may attend a WRC and it is clearly impractical to discuss or debate any issue in such a large group. As a rule, a Conference structure is agreed upon among the major participants, to carry forward the work. The usual committee structure is shown in Fig. 1.

Committees 1 through 3 deal with formal matters, such as scheduling the daily work of the Conference, accreditation of the delegations and the budget. The main task of the committee is to make sure that the meaning of the English, French and Spanish text is identical. The substantive work is done in the two main committees, dealing with allocations and regulatory issues. These committees are further split in various sub-committees, dealing with the various agenda items. The breakdown of the allocation committee during WRC-00 is shown in Figure 2, which also indicates the issues of interest to radio astronomers by order of importance ranging from essential to marginal or mild interest.

After being introduced, proposals are assigned to the various subcommittees and agreement on details is then worked out in sub-subcommittees or drafting groups. The process of breaking a proposal down into its various elements continues until a manageable size, in terms of issues and of delegations willing to dedicate resources to it, is reached. The fact that subgroups are often nested 5-6 levels deep, and that many discussions take place in parallel, explains the necessity for large delegations as well as a large astronomy participation. As a rule issues are resolved by consensus, which often requires many meetings to work out even a minimal agreement, which is sometimes characterized as the "state of equal unhappiness of all parties". Once agreement is reached, the consensus is elevated to the parent group for further discussion (hopefully minimal) and approval. The process of elevating approved documents to higher and higher-level groups continues until a given proposal/issue reaches the Plenary for final approval. When consensus cannot be reached, the issue is returned to the parent group, where further attempts may be made for resolution at a higher level. Votes, while certainly a possibility, are usually avoided. They tend to polarize a Conference, making progress on all issues more difficult. They are taken only as a last recourse, in cases where attempts to reach a consensus solution failed, and the issue cannot be deferred. Otherwise, the Conference may settle for a partial solution or the issue may be passed on to the next Conference, possibly along with a Resolution (or Resolutions) requiring further studies within the ITU-R.

Fig. 1 Typical WRC Committee Structure



Much depends on a Chairperson's ability to conduct meetings, and nudge or if necessary, force the group towards some common ground.

A good example of an issue of great interest to radio astronomy where consensus was reached relatively early and easily was the realignment of allocations in the 71-250 GHz spectral range, adopted by WRC-00. There were good reasons for a successful outcome:

- Astronomers coordinated the proposals very closely and carefully worldwide, during the process leading up to the WRC. This resulted in nearly identical proposals by the three large regional groups within the ITU (CITEL, CEPT and APT) and minimized potential opposition.

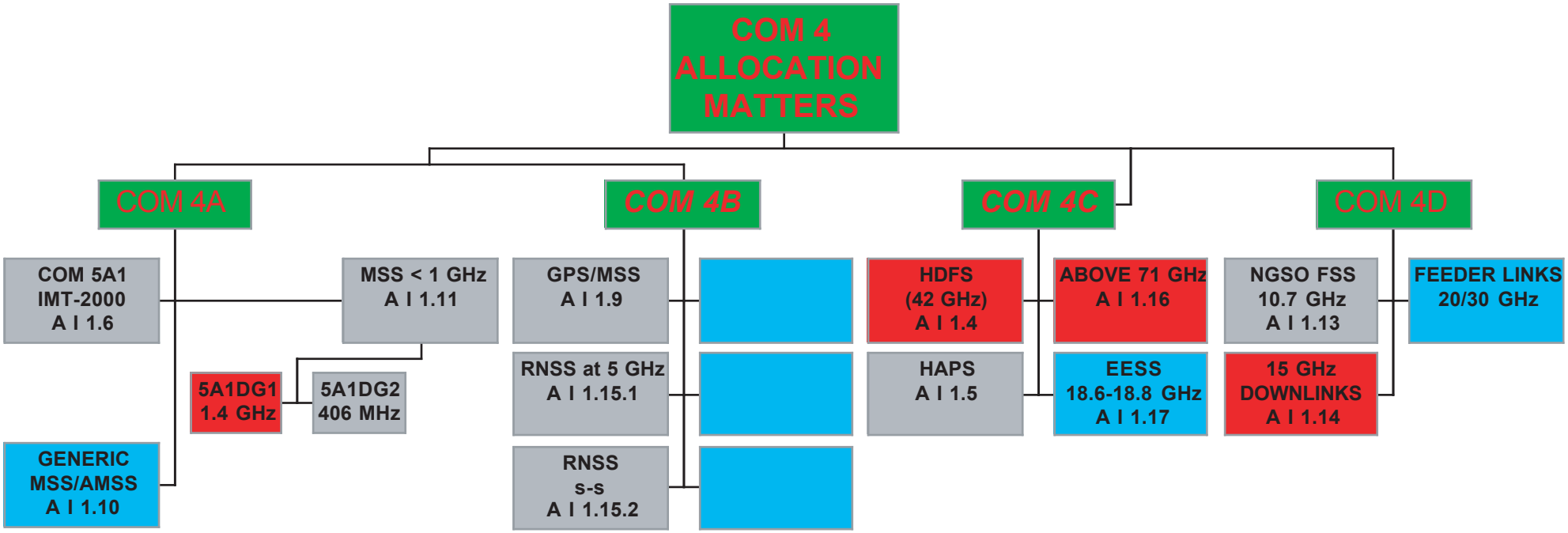
- The astronomy proposals were also carefully coordinated with the remote sensing community, the other major interest group involved, as well the Amateur community, that was also very interested in the process.

- Very few systems above 71 GHz are operational, so no costly equipment needed to be relocated in spectrum

- There were as yet few active commercial requirements in this spectral region, even though that situation is rapidly changing!

- Flexibility was shown by the astronomy community in developing the proposals, including willingness to give up access to some spectral lines in return for others.

An issue involving radio astronomy, where consensus could not be reached is that of protection of radio astronomy allocations at 42.5-43.5 GHz (7-mm continuum) and the 42.821 GHz, 43.122 GHz and 43.423 GHz SiO lines (listed in RR 5.149 and in Rec. ITU-R RA.314) and the 42.159 GHz SiO line (not listed in either of the above). The band and the spectral lines it contains need to be protected from unwanted emissions of



Main Committees

Essential To Radio Astronomy

Interest To Radio Astronomy

No Radio Astronomy Interest

Fig. 2 : Breakdown of an Allocation Committee.

potential satellite downlinks that intend to operate in the adjacent lower band. This issue illustrates the difficulties encountered when satellite downlinks and radio astronomy are allocated in close proximity. It has been the subject of various Resolutions and studies since WRC-97, that first allocated the 40.5-42.5 GHz band to the Fixed Satellite Service, was on the agenda of WRC-00 and is once again on the Agenda of the upcoming WRC-03.

The achievements of a WRC are contained in its "Final Acts", a document that updates the Radio Regulations. Administrations may and frequently do except themselves from complying with some of the provisions of the Final Acts, reserving their position on those that they find objectionable. The Final Acts are eventually be ratified by Administrations (in the U.S they are subject to approval by the Senate, a process that may take a long time).

5. References

Findlay, J.W. "IUCAF and Frequencies for Radio Astronomy", in IAU Colloquium No. 112 (D. L.Crawford, ed.), Light Pollution, Radio Interference and Space Debris, 1991, Astr. Soc. Pacific Conf. Ser., Vol. 17

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Kuiper, T. B. H.,"WRC-97, Geneva, Nov. 2-7", at:
http://dsnra.jpl.nasa.gov/freq_man/wrc97.html

The website of the ITU:
http://www.itu.int/

is a particularly useful source of reference for WRC related issues.