Spectrum Management Activities of the U.S. National Academy of Sciences' Committee on Radio Frequencies

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Abstract

The role of the U.S. National Academy of Sciences' Committee on Radio Frequencies (CORF) in protecting the passive, scientific use of radio and microwave spectrum for radio astronomy and Earth remote sensing research will be described, particularly those involving L-band. Involving the broad radio science and engineering community is critical to the committee's work, which bears directly upon radio astronomy and Earth science. As technology continues to progress and devices utilize wireless transmitters, it is essential for the active and passive users of the spectrum to communicate directly with one another in order to avoid potential conflicts in the future.

1. Policy Background

The Committee on Radio Frequencies (CORF, see Appendix) brings the prestige of the U.S. National Academy of Sciences (NAS) to the protection of the frequency interests of radio astronomers, remote-sensing researchers, and other scientific users of the radio spectrum. CORF's chief task is to coordinate the needs for radio-frequency allocations and protection from radio-frequency interference for U.S. scientific research. CORF brings together representatives from such fields as space science, radio astronomy, atmospheric science, oceanography, life science, remote sensing, and electrical engineering. CORF monitors these fields and identifies areas in need of deeper study by report-writing committees of the NAS. As an activity of the NAS, CORF provides independent, external advice to the U.S. government.

Access to spectrum in the United States is assigned by the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA). Spectrum is typically assigned to services (classes of users) on a primary basis or a secondary basis, and allocations include details on permitted transmission power levels and operation times. The difference between a primary allocation and a secondary allocation is essentially that the users of a secondary allocation must accept interference from the users of a

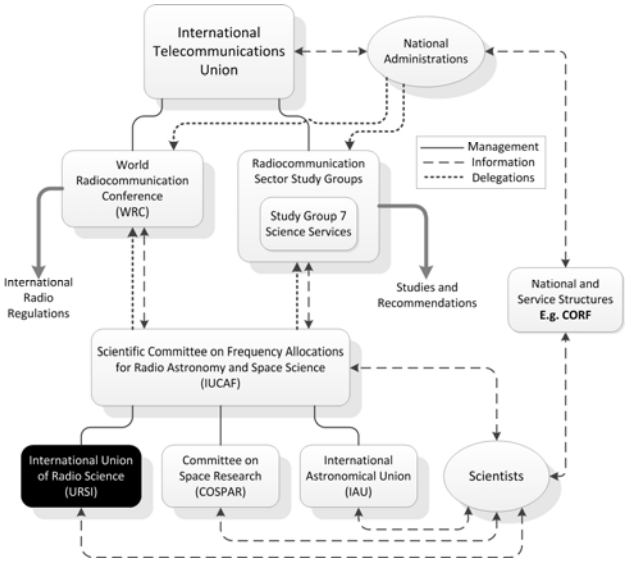

Fig. 1. Diagram showing the structure of the international frequency allocation process with respect to the requirements and protection of scientific services [1].

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primary allocation and conversely must not interfere with the users of the primary service. The International Telecommunication Union (ITU), an agency of the United Nations, periodically updates its allocation table to coordinate international spectrum usage and prevent problems due to interference (Figure 1). The ITU Radio Regulations (ITU-RR) are not binding on the United States *in toto*—the real treaty obligation of the U.S. government is that it will not assign transmitter licenses in such a way that will cause interference to stations licensed by other governments that are in accordance with the ITU-RR. Within this framework, national governments create and enforce additional regulations, typically to include additional details and to elaborate on permitted uses of the spectrum. In the United States, federal use of spectrum is managed by the NTIA, whereas nonfederal (i.e., commercial, amateur, and passive scientific) use of spectrum is managed by the FCC. The authority of the FCC and NTIA are parallel in this respect. From a regulatory perspective, the RAS and EESS are comparable to all other services, despite the fact that that they do not transmit [2].

2. Scientific Background

Radio astronomy is a vitally important tool used by scientists to study our universe. It was through the use of radio astronomy that scientists discovered the first planets outside the solar system, circling a distant pulsar. Among other achievements, radio astronomy measurements have discovered ripples in the cosmic microwave background, generated in the early universe, which later formed the stars and galaxies we know today.

Earth remote sensing is a critical and unique resource for monitoring weather and climate on both a research and an operational basis. Satellite-based microwave remote sensing represents the only practical method of obtaining a global perspective and uniform-quality atmospheric and surface data encompassing the most remote oceans as well as densely populated areas of Earth.

3. The Radio Environment

Demand for spectrum from commercial and other users has grown substantially over the past 20 years. The current generation of wireless electronics and communications applications has placed pressure on spectrum managers to open new areas of the spectrum for commercial use. Other technologies such as ultrawide-band (UWB) devices used by vehicular radars are also threatening access to bands which are needed to conduct scientific research. Similarly, the frequency needs of the scientific and related engineering communities have become greater as radio research techniques and instruments have become more sophisticated and sensitive. For many researchers, CORF serves as a means for presenting their needs to federal regulatory agencies and for defending their frequency allocations from commercial competition. CORF represents the interests of nongovernment activities and scientists as well as those of federally supported scientists.

4. Activities of the Committee on Radio Frequencies

4.1 Public Pleadings Before the U.S. Federal Communications Commission

To protect these two especially important, and sensitive, passive science services, CORF monitors and responds to radio frequency interference and allocation issues as they arise and works closely with spectrum managers at the NSF, the frequency management office at NASA, and the office of radio frequency management at NOAA. A major CORF activity is participation in public pleadings before the FCC and NTIA regarding allocation and assignment of radio frequencies and other regulatory matters. CORF also provides information on radio science frequency allocation matters to commercial radio users, who usually become aware of the committee through its FCC filings. CORF also participates in preparations for the WRCs. Over the past several years, CORF has provided input on threats to observations in many different bands, from the UHF through W-band.

4.2 Views of the NAE and NAS on Agenda Items at Issue at the World Radiocommunication Conference 2015

To ensure their ability to use the radio spectrum for scientific purposes, scientists must be party to the discussion in the lead-up to the WRC, which will next be held in 2015 in Geneva, Switzerland. By request of the NSF and NASA,

a committee of the NRC, chaired by David DeBoer (University of California at Berkeley), under CORF's auspices, was convened to provide guidance to U.S. spectrum managers and policymakers as they prepare for the WRC in order to protect the scientific exploration of the Earth and Universe using the radio spectrum. The report [3] identifies and discusses those Agenda Items with relevance and potential impact to radio astronomers and Earth remote sensing researchers.

4.3 Spectrum Management for Science in the 21st Century

Both the active and the passive services are increasing their use of the spectrum, and so the potential for interference, already strong, is also increasing. An NRC committee was convened, chaired by Albin Gasiewski (University of Colorado) and Marshall Cohen (Caltech), with support from NASA, NSF, and NOAA, to explore the tension between the active services' demand for greater spectrum use and the passive users' need for quiet spectrum. The resulting report, "Spectrum Management for Science in the 21st Century" [2], which was commissioned under CORF's auspices, make recommendations which provide a pathway for putting in place the regulatory mechanisms and associated supporting research activities necessary to meet the demands of both active and passive users.

This report found that better utilization of the spectrum and reduced RFI for scientific as well as commercial applications would be possible with better knowledge of actual spectrum usage. It therefore called for the U.S. Government to develop a national spectrum assessment system that measures the radio frequency environment.

The way in which radio astronomers and Earth remote sensing scientists conduct their research is changing. A number of exciting, contemporary problems in astrophysics require radio astronomers to observe across broad swaths of the spectrum for which legal protection from interference do not exist. Similarly, the ability of passive microwave Earth remote sensing platforms to study water in various phases, at both continuum and spectral line frequencies, means that these instruments will be increasingly used to provide key information, but increasingly subject to interference. As science and technical capability continue to advance, the way we use and manage the spectrum needs to be revisited.

Generally, the report stressed the importance of increased cooperation between the active and passive services through new regulatory and technical approaches to accommodate the increased demand for spectrum by all users. In particular, it recommended the development for cooperative RFI mitigation techniques and the associated forums and outreach necessary to enable the development of standards for greater spectral utilization and interference avoidance.

4.4 A Survey of the Active Scientific Use of the Radio Spectrum

To support the presidential initiative for spectrum management in the 21st Century, a presentation of current and future needs of scientific users of the spectrum is in order. In recent years, the explosion of new wireless technologies has significantly increased the demand for access to the radio spectrum. The increased demand has led to discussions in both government and industry about new ways of thinking about spectrum allocation and use. Scientific users of the radio spectrum (such as radio astronomers and earth scientists using remotely sensed data) have an important stake in the policies which will result from this activity. A survey of the scientific uses of the spectrum (up to 3 THz) by passive (receive-only) means was conducted by the NRC [2]. Identifying the potentially dire interference situation posed to NASA's in-orbit and planned passive remote sensing observatories and to NSF's ground-based radio astronomy observatories, the report had a significant amount of impact in the Administration and Congress, and in 2012 NASA requested that the NRC embark on a similar study to explore the current and planned scientific use of the spectrum by active means and the current and potential vulnerabilities and problem areas. This new study, led by Fawwaz Ulaby (University of Michigan), will assist spectrum management decision makers in balancing the requirements of the scientific users of the spectrum with other interests.

4.5 Handbook on Frequency Allocations and Spectrum Protection for Scientific Uses

CORF was heavily involved in the finalization and publication of the "Handbook on Frequency Allocations and Spectrum Protection for Scientific Uses [4]," a document which provides radio astronomers, remote sensing scientists, agency spectrum managers, and relevant commercial interest with a compact, comprehensive guidebook of radio spectrum allocations and needs for the Radio Astronomy and Earth Exploration Satellite Services. The "Handbook," published in 2007, also provides nontechnical descriptions of the exciting scientific astronomical and Earth science

research enabled by access to the spectrum. An updated version of the Handbook is currently being considered by CORF.

4.6 Handbook on Frequency Allocations and Spectrum Protection for Scientific Uses

In 2013 the collective membership of CORF independently authored and published a paper in IEEE Transaction on Geoscience and Remote sensing which provided a summary of the complex national, regional, and global regulatory frameworks used to manage the spectrum [1].

5. References

1. David R. DeBoer, et al., "Radio Frequencies: Policy and Management," IEEE Trans. Geosci. Remote Sens., Vol. 51, Iss. 10, October 2013, pp. 4918-4927.

2. National Research Council, *Spectrum Management for Science in the 21st Century*, The National Academies Press, Washington, D.C., 2010.

3. National Research Council, *Views of the U.S. NAS and NAE on Agenda Items at the World Radiocommunication Conference 2015,* The National Academies Press, Washington, D.C., 2013.

4. National Research Council, *Handbook on Frequency Allocations and Spectrum Protection for Scientific Uses,* The National Academies Press, Washington, D.C., 2007.

6. Appendix

The current membership of the Committee on Radio Frequencies of the U.S. National Academy of Sciences is given below.

Members
Dr. David R. DeBoer, University of California at Berkeley, *Chair*
Dr. Jasmeet Judge, University of Florida, *Vice-Chair*
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