National Science Foundation

CORF Meeting

April 10, 2006

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NSF Spectrum Management

Responsible for ensuring the access of the scientific community to portions of the radio spectrum that are needed for research purposes

Staffing:

T. Gergely
Spectrum Mgr
Full Time
IRAC, RCS , WRC, WP 7D, etc.

A. Clegg
Deputy Spectrum Mgr
~50%
FAS, SPS, WP 7D, other as available

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National Issues

- **FCC changes:**
  - **Chairmanship: Powell replaced by K. Martin in March, 2005**
  - **At present only 4 FCC Commissioners in office**
- **NTIA changes:**
  - **Administrator: M. Gallagher left in January, replaced by J. Knauer, acting**
  - **Since 2003, issues must be coordinated between NTIA and FCC within 15 business days**
  - **Objective:**
    - ✓ **Promote Efficient Use of Spectrum**
    - ✓ **More Responsive, Cooperative, and Effective Spectrum Management**
    - ✓ **Conduct Joint Spectrum Planning**

  In practice, FCC provides a draft document to NTIA (NPRM, R&O, etc) and IRAC agencies must react to draft within the 15 day limit. For many complex issues, this length of time is highly insufficient, but is enforced!

- **MoU currently under revision**

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Strategic Spectrum Planning

- **Presidential Initiative (May 2003): Mandates comprehensive review to develop recommendations for improving spectrum management**
- **Recommendations released in November 2004**
  - > **standardize methods required for evaluating spectrum efficiency and effectiveness (NTIA, FCC and other Federal Agencies)**
  - > **NTIA should work cooperatively with other federal agencies and with input from the FCC to develop a best-practices handbook of analytical engineering spectrum tools and procedures, *including unwanted emissions limits!* (NTIA, FCC and other Federal Agencies)**
  - > **Institute Career Development Program (NTIA, FCC)**
  - > **The FCC and NTIA in coordination with the federal agencies should develop a plan to increase sharing of spectrum between federal and non-federal users, including: (1) the identification of bands appropriate for sharing and bands where sharing would not be feasible or contrary to the public interest.... and (4) the reduction of barriers to shared allocations**
  - > **To formalize the coordination process and to ensure that national security, homeland security, public safety, federal transportation infrastructure, scientific research, and economic opportunity are fully taken into consideration, the Assistant Secretary for Communications and Information should establish a Policy and Plans Steering Group (PPSG)**
  - > **As needed, Policy Coordinating Committee (PCC) of the White House should be used to address spectrum-based radiocommunication issues that have not been resolved by the PPSG..... Such issues would include only those having a potentially significant impact on national security, homeland security, public safety, federal transportation infrastructure, scientific research, or economic opportunity.**
  - > **NTIA and the FCC should coordinate the development of a National Strategic Spectrum Plan**

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Strategic Spectrum Planning

- NSF Long Range Spectrum Plan compiled by T. Gergely and A. Clegg, released in November, 2005
- Covers all/most spectrum related NSF activities:
  - ✓ Radio and radar astronomy
  - ✓ Upper and lower atmospheric research
  - ✓ Polar Programs
- Radio Astronomy trends noted:
  - > Coverage of broad spectral range, outside allocated radio astronomy bands, required by the science
  - > Observations at higher and higher frequencies, covering up to the THz region
  - > Does not anticipate requests for additional spectrum allocations to radio astronomy below 275 GHz
  - > Anticipates need for spectrum allocations for radio astronomy in the 275-1000 GHz range, within the next decade
- Based on input from NSF staff, it is intended to be a living document (expected to be reissued in a few years)
- Please let us know comments, errors, revisions needed, etc

They will be incorporated in the next reissue

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14.0-14.5 GHz Satellite Coordination ViaSat

- ViaSat, like Boeing and ARINC uses 14-14.5 GHz secondary allocation (WRC-03), to uplink to satellites from aircraft, provides broad-band, in-flight Internet connection
  - FCC O&A released April 6, 2005
  - NSF-ViaSat coordination agreement similar to NSF-Boeing Connexion and NSF-ARINC agreement
  - Provides protection during periods of notified observations in the 14.47-14.5 GHz RA band to:
    - Arecibo, Green Bank and Socorro at -221 dB(W/m^2/Hz) level
    - VLBA sites at -189 dB(W/m^2/Hz) level, by:
      - ✓ ceasing transmissions in the 14.47 – 14.5 GHz band within line-of sight
      - ✓ attenuating unwanted emissions in the 14.47-14.5 GHz band to 769 levels
  - Future sites may be added on a 2-month notice

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14.0-14.5 GHz Satellite Coordination (Issues)

- NRAO is supposed to coordinate provision of observing schedules to all three systems, a week in advance
  - Are schedules being provided?
- Agreements to be reviewed annually for effectiveness, changes needed, etc.
  - Do these agreements serve a(ny) purpose?
  - If so, are they useful in their present form?
  - If not, should they be replaced by something else?
- Has interference been reported instances in the 14.47-14.5 GHz band? If so, has the source been investigated?

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Satellite Coordination
New Iridium

Aeronautical uplinks

- **Iridium wants to conclude an agreement on aeronautical uplinks operating in the 1616- 1626.5 MHz band, on the same terms as the existing NSF-Globalstar agreement**

  Globalstar:

  When an airborne mobile Earth station is within 4.1(√ h) km (where h is the aircraft altitude in meters) of a radio astronomy site that is making observations, the average unwanted emission levels at the input port to the transmit antenna for any 1 MHz segment in the band 1610.6 - 1613.8 MHz from the airborne mobile Earth station shall not exceed -65 dBW/MHz, with a corresponding aircraft underside antenna gain of nominally -10 dBi or lower gain.

  When an airborne mobile Earth station is within 4.1(√ h) km of a radio astronomy site that is not making observations, any licensed Globalstar frequency may be used.

  Radio astronomers:

  Provide an observation schedule for the band 1610.6 - 1613.8 MHz for the sites included in MoU, with two weeks advance notice

- **Iridium analysis shows no more interference than Globalstar terminals, under the same conditions (verified by astronomers)**
- **Agreement in signing phase**

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Satellite Coordination
New Iridium

Eagle Broadband Repeaters

- Iridium recently amended its license application, to include broadband repeaters that would be installed at fixed locations (mostly inside buildings), in the 1616-1626.5 MHz band, operating at higher power than MES.
- NSF requests coordination of these stations with Arecibo, the VLA and VLBA, prior to operations.
- Iridium lowers input power to the MES level
- NTIA: rules protecting radio astronomy stations in 47CFR25.213 should apply, and be sufficient for protection
- Issue still being argued

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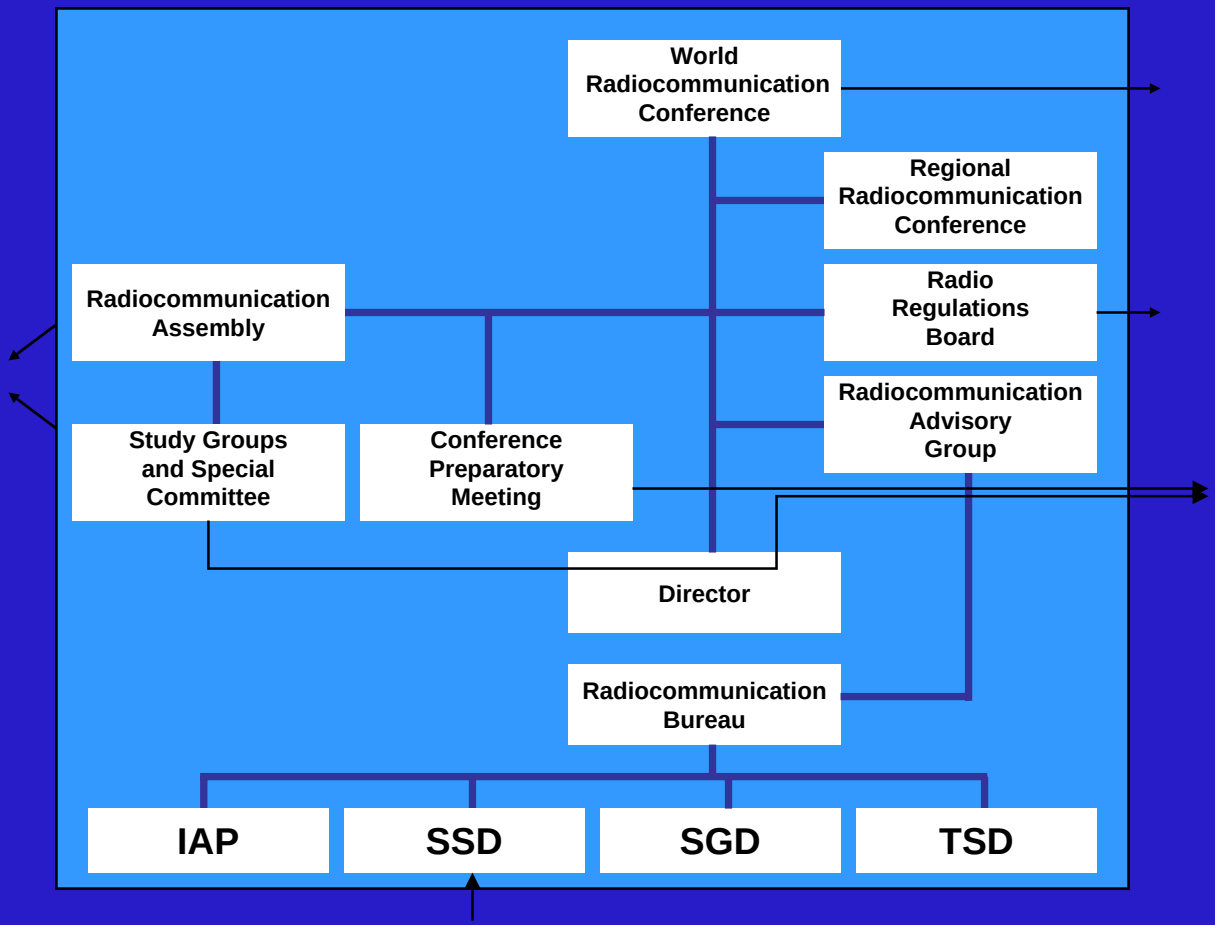
Radio Astronomers' Interaction With the ITU-R



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WRC-07 Preparations

- WRC-07 Agenda in Resolution 802(WRC-03) (see handout)
- Conference Preparatory Meeting (CPM-07) February 19 – March 2 ?, 2006 in Geneva
- WRC-07 Currently Scheduled to Be Held October 15-November 9, in Dubai/Geneva (?)

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WRC Preparations: The US Process

- **Three Track Process:**
  - > NTIA Develops Govt. Proposals through the Radio Conference Subcommittee (RCS) of the IRAC ⇦Science community input through NSF/NASA/NOAA Reps
  - > FCC Develops Private Sector Proposals,
    - * FCC Convenes WRC (Industry) Advisory Committee to Provide Private Sector Input
    - * WAC Develops Industry Proposals ⇦Some science participation
    - * FCC Publishes Notice of Inquiry (NoI) Regarding Proposals ⇦CORF through filings
  - > U.S. Radiocommunication Sector SGs, WPs and TGs Develop Technical Input to ITU-R SGs and CPM Report ⇦CORF through individual member participation
- NTIA and FCC reconcile proposals, when necessary
- **Final Set of U.S. Proposals Developed Jointly by NTIA, FCC and DoS**

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The ITU Process

- International uses of the radio spectrum are regulated by the International Telecommunication Union (ITU), an organ of the United Nations, through the Radio Regulations (RR)
- Changes to the RR, an international treaty, are adopted at World Radiocommunication Conferences (WRCs), held every 3-4 Yrs
- The international Table of Allocations is part of the RR (Article 5).
- At present spectrum allocations cover the range 9 kHz to 275 GHz
- ITU-R Recommendations (non-mandatory) are worked out and adopted within the Radiocommunication Study Groups
- Study Groups also elaborate technical bases for WRC action (CPM Report)
  - Study Group 7 (Science Services)
    - Working Party 7C (Remote Sensing and Meteorology)
    - Working Party 7D (Radio Astronomy)

  Other Important Groups for Radio Astronomy:
  - SG 1 Spectrum Management (Unwanted emissions)
  - SG 4 Fixed Satellites
  - SG 8 Mobile (cell-phones, mobile satellites)
- Countries Sovereign With Regard to the Use of the Radio Spectrum Within National Borders. No Obligation to Follow the International Table of Allocations

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WRC-07 Agenda Items of Interest to Radio Astronomy

- **Being on the Agenda is a Condition for an Issue to be Treated**
- **WRC-07 Radio Astronomy issues**
  - **Allocations near 1.4 GHz for satellite up and downlinks (AI 1.17)**
  - **Continuation of unwanted emissions study (AI 1.21)**
  - **Continuation of regulatory studies of HAPS (AI 1.8)**
  - **Sharing with MES in the 1668-1670 MHz range (AI 1.7)**
  - **IMT- 2000 related issues (AI 1.4 and 1.1.9)**
  - **Protection of terrestrial services from BSS networks at 620-790 MHz (AI 1.11)**
  - **Future Agenda Items (AI 2.2)**
- **WRC-10**
  - **Allocations between 275-1000 GHz (AI 2.2)**
  - **Sharing with the Fixed Service at 81-86 and 92-100 GHz (AI 2.7)**

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AI 1.17 - 1.4 GHz Allocations for Satellite Up and Downlinks

- WRC-03 allocated the 1390-1392 MHz and 1430-1432 MHz bands to feeder links (up and down, respectively) for non-GEO systems in the mobile-satellite service
  - On a secondary basis
  - Subject to ITU-R studies on compatibility between the fixed-satellite service and other services (including passive services) around 1.4 GHz, in accordance with Resolution 745 (WRC-03)
  - Not be used, until ITU-R studies reviewed at WRC-07!
- Studies carried out were mostly positive but
- Sole proponent satellite company out of business
- CPM text lists only one method to satisfy the AI: suppress allocation
- US, Canada, Europe, Asia-Pacific Proposal: Suppress allocation

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AI 1.21 - Continuation of Unwanted Emissions Study

- WRC-03 adopted Resolution 739, that calls for
  - Administrations to take all reasonable steps to ensure that space stations, operating in some bands, do not exceed unwanted emission threshold levels in certain radio astronomy bands, at the site of observatories (see Tables 739-1 and 739-2)
  - the administration operating the satellite system, and the one operating the radio astronomy station to enter into consultations if the threshold levels are exceeded,
  - with the aim of reaching a mutually acceptable solution,
  - Using as guidance Rec. ITU-R SM.1633
- WRC-03 also adopted Resolution 740, that calls for reviewing and updating
  - Recommendation 1633 and others, if appropriate
  - the Res. 739 Tables, based on ITU-R studies, limited only to the band pairs in Table 740

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Band-pairs to be considered for further studies (Table-Res. 740)

Space service band MHz/GHz	Space service	Radio astronomy service band MHz/GHz
137-138	MSS (space-to-Earth)	150.05-153.0
387-390	MSS (space-to-Earth)	322-328.6
400.15-401	MSS (space-to-Earth)	406.1-410
620-790(No. 5.311) see Resolution 545 (WRC-03)	BSS (space-to-Earth)	608-614
1 452-1 492	BSS (space-to-Earth) (non-GSO systems only)	1 400-1 427
1 525-1 559	MSS (space-to-Earth) (non-GSO systems only)	1 400-1 427
1 525-1 559	MSS (space-to-Earth) (non-GSO systems only)	1 610.6-1 613.8
1 559-1 610	RNSS (space-to-Earth)	1 610.6-1 613.8
2 655-2 670	BSS (space-to-Earth)	2 690-2 700
2 655-2 670	FSS (space-to-Earth) (Region 2)	2 690-2 700
2 670-2 690	FSS (space-to-Earth) (Region 2)	2 690-2 700
10.7-10.95	FSS (space-to-Earth)	10.6-10.7
21.4-22.0	BSS (space-to-Earth)	22.21-22.5

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Table Res. 739-1
Band pairs where Rec. 769 threshold levels are recommended and consultations may be triggered if the levels are not met by GEO satellite systems .

Space service	Space service Band (MHz)	Radio astronomy Band (MHz)
BSS (s-to-E) MSS (s-to-E)	1 452-1 492 1 525-1 559	1 400-1 427
MSS (s-to-E) MSS (s-to-E)	1 525-1 559 1 613.8-1 626.5	1 610.6-1 613.8
BSS (s-to-E) FSS (s-to-E)	2 655-2 670	2 690-2 700
FSS (s-to-E)	2 670-2 690	2 690-2 700 (in Regions 1 and 3)
	GHz	GHz
BSS (s-to-E)	21.4-22.0	22.21-22.5

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Table Res. 739-2
Band pairs where Rec. 769 threshold levels are recommended and consultations may be triggered if the levels are not met by non-GEO satellite systems

Space service	Space service band	Radio astronomy band
	MHz	MHz
MSS (s-to-E)	1 613.8-1 626.5	1 610.6-1 613.8

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AI 1.7 - Sharing with MES in the 1668-1670 MHz Range

- **AI: Consider the results of sharing in the 1668-1668.4 MHz band between space research service (passive) and the mss (Earth to space)**
- **WRC-03 added MSS (Earth-to-space) allocations to the 1668-1675 MHz band(s)**
- **Also added footnote 5. XXX**

  In order to protect the radio astronomy service in the band 1 668-1 670 MHz, the aggregate power flux-density (pfd) values produced by mobile earth stations in a network of the mobile-satellite service operating in this band shall not exceed –181 dB(W/m^2) in 10 MHz and –194 dB(W/m^2) in any 20 kHz at any radio astronomy station recorded in the Master International Frequency Register, for more than 2% of integration periods of 2 000 s. (WRC-03)

- **Allocation not implemented in U.S.**
- **U.S view Support completion of studies-Preliminary studies show need for coordination radii ~ 300 kms.**

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WRC-10 AI 2.2 - Allocations Between 275-3000 GHz

- WRC-03 adopted Resolution 950 that calls for:
  - Consideration of frequency allocations between 275 and 3000 GHz taking into account ITU-R studies
  - Voluntary registration of systems operating at the above frequencies in the MIFR
- U.S and others: Preliminary studies submitted to WP 7D. These studies are in a fluid state. (see, e.g Annex 2 to Doc 7D/106 (WP 7D Chairman's Report of the Nov, 2005 meeting)
- Characteristics for active services that would make use of this spectrum are unavailable at present (except for the Amateur Service)
- Except for astronomers, consensus in U.S. is to postpone this AI
  - Active services not ready
  - VERY time consuming
- U.S. Proposal: Modify RR 565, as needed

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RR 565

– The frequency band 275-1 000 GHz may be used by administrations for experimentation with, and development of, various active and passive services. In this band a need has been identified for the following spectral line measurements for passive services:

– - Radio astronomy service: 275-323 GHz, 327-371 GHz, 388-424 GHz, 426-442 GHz,
453-510 GHz, 623-711 GHz, 795-909 GHz and 926-945 GHz.

– - Earth exploration-satellite service (passive) and space research service (passive):
275-277 GHz, 294-306 GHz, 316-334 GHz, 342-349 GHz, 363-365 GHz, 371-389 GHz, 416-434 GHz, 442-444 GHz, 496-506 GHz, 546-568 GHz, 624-629 GHz, 634-654 GHz, 659-661 GHz, 684-692 GHz, 730-732 GHz, 851-853 GHz and 951-956 GHz.

– - Future research in this largely unexplored spectral region may yield additional spectral lines and continuum bands of interest to the passive services. Administrations are urged to take all practicable steps to protect these passive services from harmful interference until the date when the allocation Table is established in the above-mentioned frequency band. (WRC-2000)

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What can/should be done

- Contribute to studies in WP 7D, documenting the uses of bands above 275 GHz by radio astronomy
- Contact person: Andy Clegg

  aclegg@nsf.gov
- Rec. ITU-R RA.314 lists the astrophysically important lines, based on those recommended by the IAU.
- WG (Div. X) on astrophysically important spectral lines of the IAU to meet during the Prague GA (Aug 18, 11:00-12:30) Please attend and contribute to revise the list (Rec. ITU-R RA.314 available as handout) !

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AI 2.7 - Sharing with the Fixed Service at 81-86 and 92-100 GHz

- Consider the progress of studies concerning regulatory and technical issues relative to the fixed service in the bands 81-86 GHz and 92-100 GHz
- In accordance with Resolutions 731 and 732 (adopted at WRC-00 along with the reallocation of spectrum above 71 GHz)
- While there is now some use of these bands by the fixed service, there are no studies, except for a preliminary one in US WP 7D (H. Liszt – US 7D/34R1)
- U.S.: this is an ITU-R issue, not appropriate for WRC, delete AI

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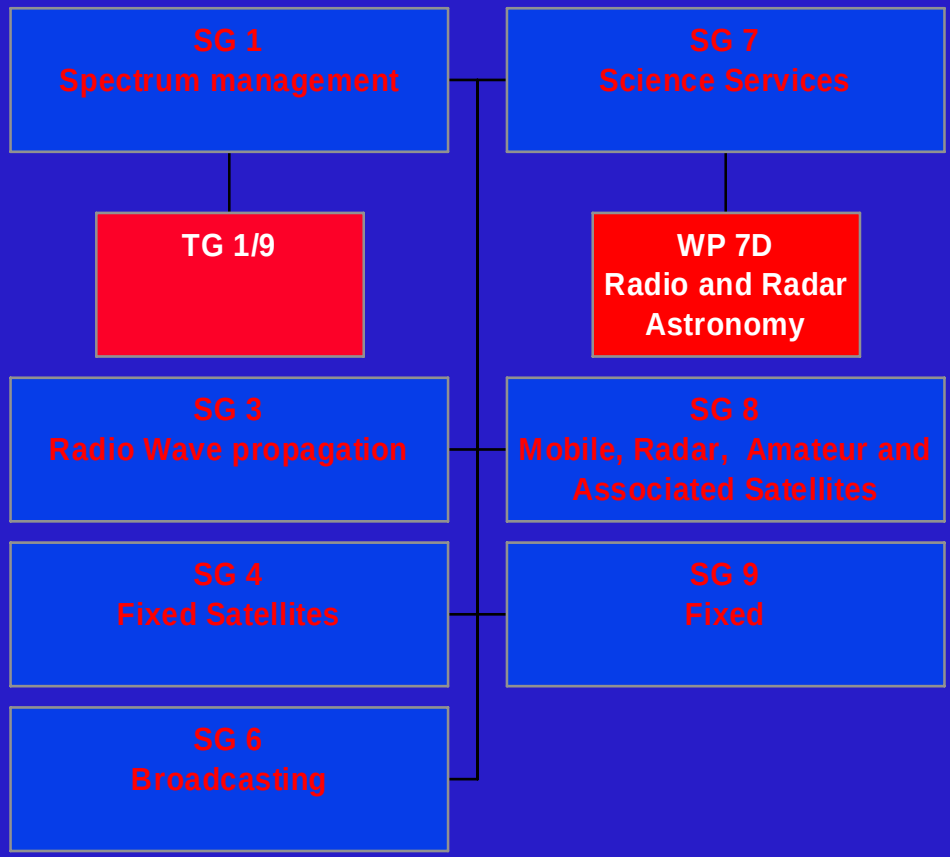
ITU-R Study Groups Relevant to Radio Astronomy



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WP 7D

- WP 7D deals with radio and radar astronomy issues within the ITU-R
- 2 International meetings/yr, usually, at ITU Hqrs, Geneva
- Next meeting: August, 2006 (Geneva), a few days after the IAU GA
- Chaired by M. Ohishi (Japan)
- US WP 7 D ~60 members; ~15 active participants, less than half of whom are astronomers
- 10 Meetings last year (at NSF – meetings accessible by phone)
- Please let myself or A. Clegg know if you wish to participate

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WP 7D – Major Issues

- Revision of Recommendations RA 517, 611
  - Update Tables in Recs. 517, 611, Eliminate repetitious text
- Frequency Sharing Between the Radio Astronomy Service and Other Services Above 70 GHz
  - Describe US process
- Recommendation on Mutual Planning Between Radio Astronomy and Remote Sensing (CloudSat) operations in the 94 and 130 GHz Bands
  - Development of Cloud Profiling Radars and Radio Telescopes operating in these bands should take place in close contact between the interested communities
  - Some guidelines for the avoidance of receiver damage, interference and coordination
  - This Recommendation was approved in the SG
- Develop Justification for Allocations to Radio Astronomy in the 275-1 000 GHz Range
- High Precision Timing of Pulsars
- BPL
- Quiet Zones
- Mitigation Techniques Used in Radio Astronomy

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Recommendations in the ITU-R RA Series

Number	Title
Rec. ITU-R RA.314-10 (03)	Preferred Frequency Bands for Radioastronomical Measurements
Rec. ITU-R RA.479-5 (03)	Protection of Frequencies for Radioastronomical Measurements in the Shielded Zone of the Moon.
Rec. ITU-R RA.517-3 (03)	Protection of the Radioastronomy Service from Transmitters in Adjacent Bands
Rec. ITU-R RA.611-3 (03)	Protection of the Radioastronomy Service from Spurious Emissions
Rec. ITU-R RA.769-2 (03)	Protection Criteria Used for Radioastronomical Measurements
Rec. ITU-R RA.1031-1 (95)	Protection of the Radioastronomy Service in Frequency Bands Shared with Other Services
Rec. ITU-R RA.1237-1 (03)	Protection of the Radioastronomy Service from Unwanted Emissions Resulting from Applications of Wideband Digital Modulation
Rec. ITU-R RA.1272-1 (02)	Protection of Radioastronomy Measurements Above 60 GHz from Ground Based Interference
Rec. ITU-R RA.1417 (99)	A Radio-quiet Zone in the Vicinity of the L2 Sun-Earth Lagrange Point
Rec. ITU-R RA.1513-1 (03)	Levels of Data Loss Acceptable to Radio Astronomy Observations and Percentage-of-Time Criteria Resulting from Degradation by Interference for Frequency Bands Allocated to the Radio Astronomy Service on a Primary Basis
Rec. ITU-R RA.1630 (03)	Technical and Operational Characteristics of Ground-based Astronomy Systems for Use in Sharing Studies with Active Services Between 10 THz and 1 000 THz
Rec. ITU-R RA.1631 (03)	Reference Radio Astronomy Pattern to Be Used for Compatibility Analysis Between non-GSO systems and Radio Astronomy Stations Based on the epfd Concept

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Summer School

- SECOND SUMMER SCHOOL IN SPECTRUM MANAGEMENT FOR RADIO ASTRONOMY, held at Castel San Pietro Terme, Italy, 6-10 June 2005

- Most presentations can be found at:

http://www.radionet-eu.org/rnwiki/SpectrumManagementWikiPage

- Students and lecturers divided evenly – 22 each
- Most students from Italy- no U.S. “student” participant
- Next Summer School – 2008 in S. Korea ?

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Improving Spectrum Management through Economic and Other Incentives

- Workshop organized by the NRC's CSTB, Febr. 28-March 1 to explore incentives for more efficient use of radiofrequency spectrum by the private sector and government spectrum users
- Topics:
  - > EFFICIENCY, QUANTIFICATION, AND VALUATION OF SPECTRUM
  - > MECHANISMS, TOOLS, AND APPROACHES
  - > INTERNATIONAL EXPERIENCE
  - > USER PERSPECTIVES