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CORF Meeting

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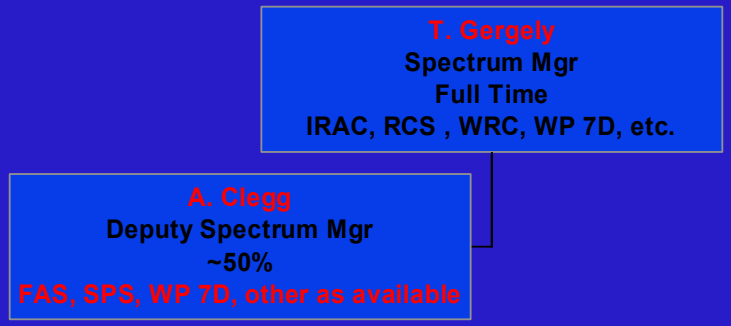
NSF Spectrum Management

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

Staffing and structural changes

NSF ESM prior to XX/2005

NSF ESM after XX/2005



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National Issues

- FCC rulemakings (NOIs and NPRMs):
  - 2nd R&O WRC Implementation
  - 14.5 GHz Issues
  - 2nd R&O on UWB systems
  - BPL – See presentation by Andy Clegg
  - Cell phone use on Aircraft - See presentation by Andy Clegg
- NTIA
  - > 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 insufficient!

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WRC Implementation

- NTIA recommends WRC - 03 implementation actions to the FCC in Jan 04
- FCC releases 2nd R&O in March 05
- Allocates the Band 5010-5030 MHz to RNSS downlinks (Galileo)
  - Adopts protection of 5 GHz radio astronomy band nationally, through international footnote 5.443B (Rec. 769 limit in 4.99-5.0 GHz band, as adopted by WRC-03)
- Downgrades provisional US allocation in the 1390-1392 and 1430-1432 MHz bands to little LEO feeder links to secondary
- Maintains requirement to complete all ITU-R studies prior to making band available for use
- FCC actions identical to WRC-03 actions

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14.5 GHz Issues (ESVs)

- **ESVs**
  - R&O, released on Jan 6, 2005 provides regulatory framework for the operation of ESVs in FSS networks in the 5925-6425 MHz/3700-4200 MHz and 14.0-14.5 GHz/ 11.7-12.2 GHz bands
  - NPRM (released in Nov, 2003) proposes footnote protection for 14.47-14.5 GHz band, asks the right questions
  - Filings by CORF, NRAO, Cornell, NSF input to NTIA essentially ignored by FCC
  - R& O: "Operations of Earth Stations on Vessels (ESVs) in the 14.47-14.5 GHz (Earth-to-space) frequency band within a) 45 km of the radio observatory on St. Croix, Virgin Islands (latitude 17° 46' N, longitude 64° 35' W); b) 125 km of the radio observatory on Mauna Kea, Hawaii (at latitude 19° 48' N, longitude 155° 28' W); and c) 90 km of the Arecibo Observatory on Puerto Rico (latitude 18° 20' 46" W, longitude 66° 45' 11" N) are subject to coordination through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC)."

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14.5 GHz Issues (AMSSR)

- FCC NPRM, Regarding Service Rules to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations released February, 2005
- NPRM Asks Questions Regarding protection of Radio Astronomy in the 14-14.5 GHz band
- Proposes coordination with Radio Observatories through NTIA
- Option: AES does not operate within sight of RAS station
  - FCC: This involves 14.47-14.5 GHz band, should RAS status be changed to secondary in that band?
- Seeks comment regarding sites to be protected (US 203)
  - Footnote issue

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US Footnotes

- Several US footnotes list US radio observatories to be protected (to various degrees) in some bands, e.g.:
- US203 Radio astronomy observations of the formaldehyde line frequencies 4825-4835 MHz and 14.470–14.500 GHz may be made at certain radio astronomy observatories as indicated below:

4 GHz	14 GHz	
X		National Astronomy and Ionosphere Center, Arecibo, Puerto Rico.
X	X	National Radio Astronomy Observatory, Green Bank, W. Va.
X	X	National Radio Astronomy Observatory, Socorro, New Mexico
X	X	Hat Creek Observatory (U of Calif.), Hat Creek, Cal
X	X	Haystack Radio Observatory (MIT-Lincoln Lab), Tyngsboro, Mass
X	X	Owens Valley Radio Observatory (Cal. Tech.), Big Pine, Cal.
	X	Five College Radio Astronomy Observatory, Quabbin Reservoir (near

- Most lists are (or fairly quickly become) obsolete.

How can CORF maintain an up-to-date registry, to be referenced by the footnotes? (Should CORF do it?)

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2nd R&O on UWB systems FCC 04-285

- Relaxes peak emission limits w/respect to Pt 15 devices for wideband systems operating in the 5925-7250 MHz and 16.2-17.7 GHz bands, but maintains the UWB limits for unwanted emissions (-51.3 dBm/MHz and –61.3 dBm/MHz, respectively)
- Allows vehicular radar systems (swept frequency, stepped frequency and frequency hopping radars) in the 23.12-29 MHz band, excluding fundamental emissions from the 23.6-24.0 GHz band. Unwanted emissions limits in the restricted bands is –61.3 dBm/MHz

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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**
- **Recommendations:**
  - > **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**

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Strategic Spectrum Planning

- **Recommendations:**
  - > 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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ALMA

- Chilean Administration Submits ALMA Registration to ITU in All Radio Astronomy Bands in the 31.3 - 275 GHz Range (Dec. 4, 2004)
- Bands Used by ALMA in the 275-950 GHz Range Also Notified
- Chilean Administration Establishes Quiet Zone for the Benefit of ALMA (August 12, 2004)
  - > Quiet Zone (No transmissions in ALMA Bands) within 30 km radius, centered on 23° 01' S; 67° 45' W
  - > Coordination Zone: 120 km radius, centered on 23° 01' S; 67° 45' W
  - > Transmitters Below 31.3 GHz:

    Maximum Power of 2.5 kW at 10 km From Edge of Coordination Radius- In Band Unwanted Emissions Limited to Rec.RA. 769 Levels Above 31.3 GHz
  - > Transmitters Above 31.3 GHz:

    Emissions Limited to Rec. RA.769 in ALMA Bands, at ALMA site

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Satellite Coordination

- 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-ARINC coordination agreement similar to NSF-Boeing Connexion agreement in this band
  - 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 while 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
  - To be reviewed annually for effectiveness, changes needed, etc.

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Satellite Coordination (2)

- **New Iridium**
  - Would like 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 so far supports the case, in showing no more interference than Globalstar terminals, under the same conditions**

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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 (2-3 → 3-4 Yrs)
- The international Table of Allocations is part of the RR (Article 5). At present spectrum allocations cover only up 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, 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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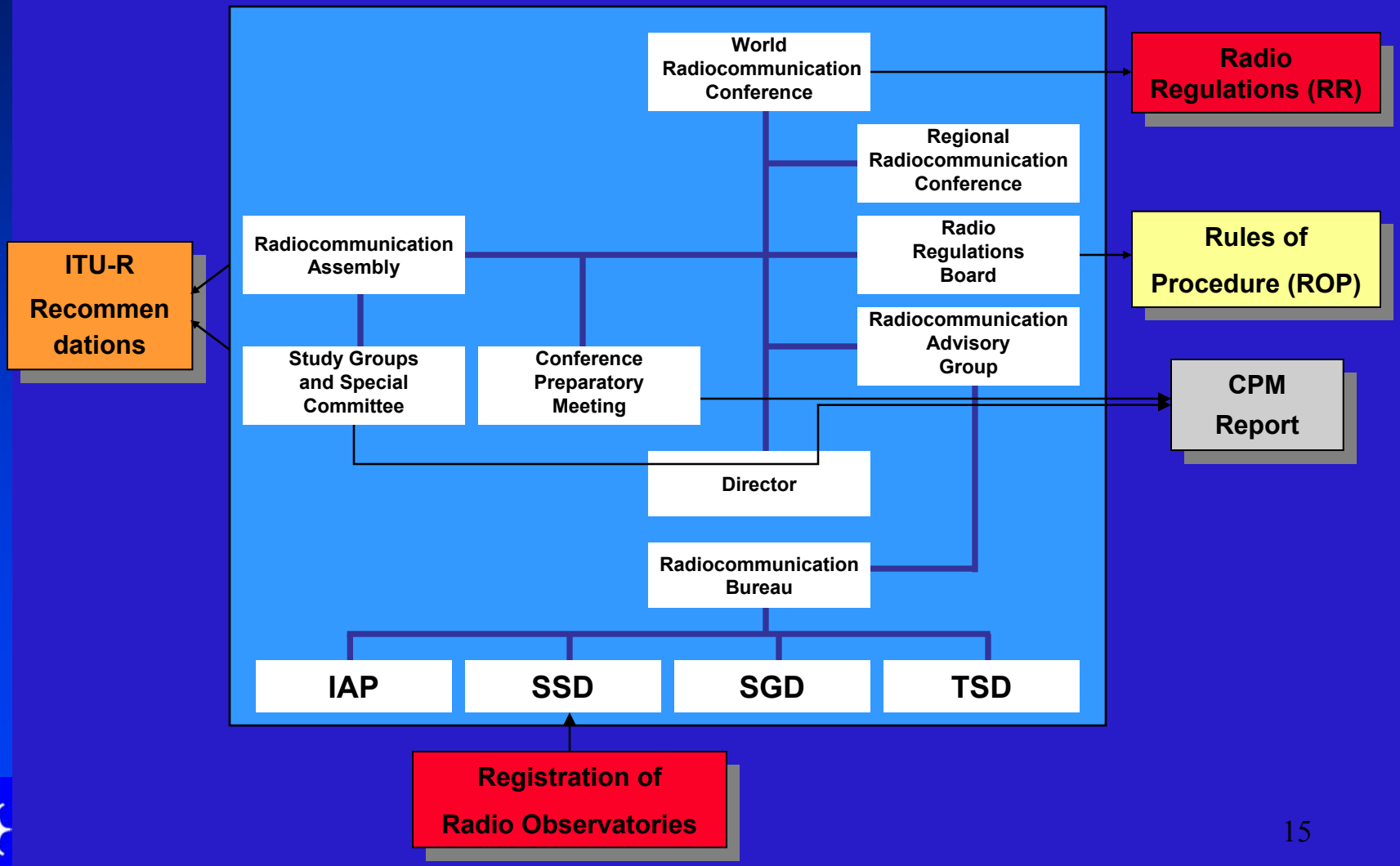
Radio Astronomers' Interaction with the ITU-R



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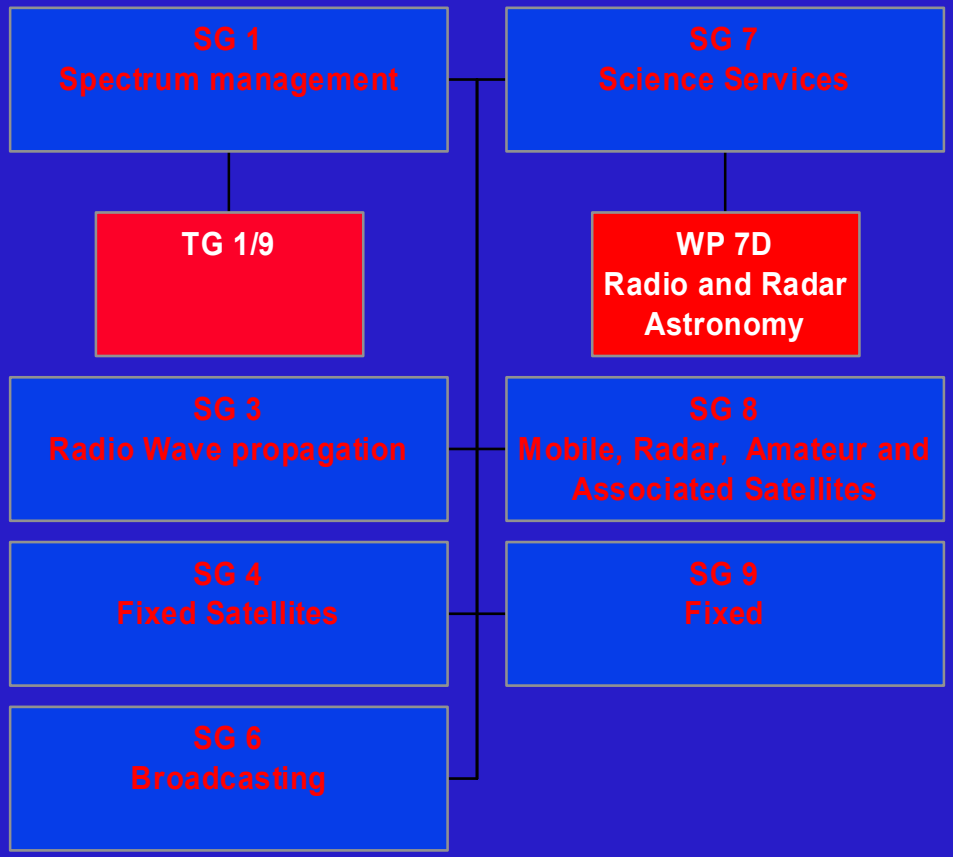
ITU-R Study Groups



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WP 7D

- WP 7D deals with radio and radar issues within the ITU-R
- 2 International meetings/yr, usually at ITU Hqrs, Geneva
- Next meetings: November, 2005 and August, 2006 (Geneva)
- Chaired by M. Ohishi (Japan) US WP 7 D ~60 members; ~15 active participants, less than half of whom are astronomers
- 8 Meetings last year (at NSF – meetings accessible by phone)

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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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WP 7D – Major Issues

- **Revision of Recommendations RA 517, 611 and 1031**
  - Update Tables in Recs. 517, 611
  - Eliminate repetitious text in same Include levels of data loss considerations and epfd concept in Rec. 1031
- **Recommendation on Protection of 1400-1427 MHz Band from Satellite Links (1390-1392 MHz up; 1430-1432 MHz down) that may eventually operate**
  - Satellite links should protect the 1400-1427 MHz band to the Rec. 769 levels (-259 dBW/m^2 in any 20 kHz band and –243 dBW/m^2 in 27 MHz)
  - No more than 2% total data loss due to the uplink and downlink
- **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
- **Develop Justification for Allocations to Radio Astronomy in the 275-1 000 GHz Range**
  - See Presentation by Andy Clegg
- **High Precision Timing of Pulsars**

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Future WRC Agenda Items

- WRC-03 adopted a draft agenda for WRC-07 (now slipping to 2008), and a provisional draft agenda for WRC-10
- Being on the Agenda is a Condition for an Issue to be Treated
- WRC-07/08 RA 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)
  - 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)
  - Sharing with MES in the 1668-1670 MHz range (AI 1.7)
- 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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Human Resource Issues

- A Number of the Most Experienced Radio Astronomers Involved in Spectrum Management Retired During the Last Few Years
- Those Remaining Are Mostly In the 50+ Age Group and Nearing Retirement
- There is Little Incentive for Younger Scientists and Engineers to Get Involved
  - Lack of Recognition at the Observatory Level
  - Lack of Resources (Travel and Educational)
  - Lack of Knowledge of Opportunities

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Radio astronomy involvement in spectrum management activities (U.S.)

		FTEs		
		Act.	1990s	Min Needed
• NSF		1.6	1	2
▪ Sp Mgr	1			
▪ 2 pt time	.6			
• NRAO		1.2	2	3
▪ Tucson				
▪ Socorro	.2			
▪ Cville	1(0.8+0.2)			
▪ ALMA				
• NAIC		.5	1.25	1.25
• Univ. Obs.		.5		2
▪ SETI Inst.	.25			
▪ Haystack	~.1		.1	
▪ Berkeley	~.1			
Total		~ 4	3.35	~ 8

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Radio astronomers present in spectrum management activities (international)
(Gov/Non-Gov)

- **Americas:**
  - US 2/3 (5)
  - Canada 1/1 (2)
  - Brazil 1
- **Europe** 1
  - Netherlands 1?
  - Germany
  - France 1/0
  - U.K. 1/1
  - Russia
- **Asia**
  - Japan 1
  - India
  - Korea 1
- **Australia** 1

Total: ~ 14, worldwide

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Summer School

- **SUMMER SCHOOL IN SPECTRUM MANAGEMENT FOR RADIO ASTRONOMY, Green Bank, June 2002**

  Proceedings at:

  http://www.iucaf.org/sschool/procs/

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

  http://www.astron.nl/craf/ss2005.htm