National Science Foundation

CORF Meeting

May 14, 2003

Tomas E. Gergely

Electromagnetic Spectrum Manager

National Science Foundation

tgergely@nsf.gov

703-292-4896

National Science Foundation

NSF Spectrum Management

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

Last years' perspective

WRC ACTIVITIES **WRC-03 PREPARATIONS** **WRC-00 IMPLEMENTATION**	**NATIONAL REGULATORY (IRAC) ACTIVITIES**
SATELLITE COORDINATION	**MEETINGS NEW INITIATIVES**

National Science Foundation

NSF Spectrum Management

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

This years' perspective

National Science Foundation

NATIONAL REGULATORY (IRAC) ACTIVITIES

SPECTRUM MATTERS !!!

FCC spectrum policy task force

ET Docket No. 02- 135

November 2002

Spectrum Summit

April 4-5, 2002

GAO

Reports to Congressional Requesters

September 2002

January 2003

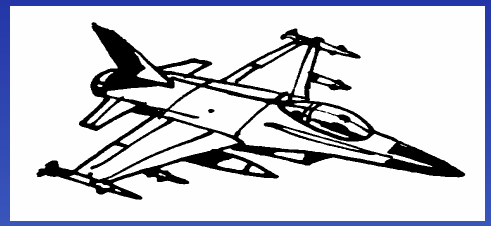
Telecommunications

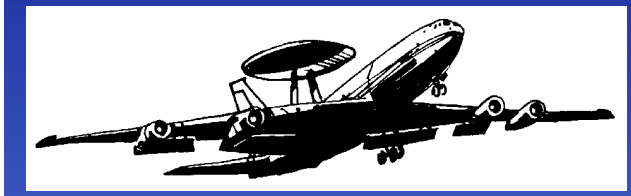
Better Coordination and Enhanced Accountability Needed to Improve Spectrum Management

Comprehensive Review of U.S. Spectrum Management with Broad Stakeholder Involvement Is Needed

National Science Foundation

Increasing Spectrum Congestion





Comm/Sensors

Radar

CEC

Telemetry

Cell Phones

Broadcasting

Civil Transportation

Civil Space

Pt - Multipoint

Microwave Networks

PCS

Law Enforcement

Science

Public Safety

National Science Foundation

Pressures
(US and Worldwide)

- **Increasing demand for spectrum-based services and devices is straining ("*longstanding and outmoded*") spectrum policies**
  - 3G
  - Wi Fi
  - UWB
  - Satellites
- **Propelled by:**
  - **Technological advances that enable changes in spectrum policy**
    - increased use of digital technologies
    - development of software-defined radios
  - ***Most* "prime spectrum" has already been assigned to one or more parties, and it is becoming increasingly difficult to find spectrum that can be made available either for new services or to expand existing ones.**

National Science Foundation

Pressures
(US and Worldwide)

- Leading to flood of FCC rulemakings over last 18 months or so:
  - 4.9 GHz
  - Wireless Services (1.7 GHz)
  - WRC Implementation
  - Task Force Issues
- Acceleration of process: FCC-NTIA MOU (January 31, 2003)
  - Coordination of Spectrum Issues
  - Promote Efficient Use of Spectrum
  - More Responsive, Cooperative, and Effective
  - Conduct Joint Spectrum Planning
- Issues are to be coordinated between NTIA and FCC within 15 business days!
- This length of time is quite often insufficient!

National Science Foundation

70-80-90 GHz NPRM

- Released by the FCC on June 28, 2002
- Promotes New Applications in the 71-76;81-86 and 92-95 GHz bands
- Extensively pre-coordinated with NSF/NTIA

"Uses of the millimeter wave bands include radio astronomy, spaceborne cloud radars, and military applications. Potential use of the spectrum for applications such as passive imaging of airport runways (when obscured by fog or smoke), imaging to display hidden contraband, weapons and nonmetal objects, point-to-point communications, and point-to-multipoint communications"

National Science Foundation

Radio Astronomy Related Issues

70-80-90 GHz NPRM

- Should the U.S. Reallocate the 71-76 GHz, 81-86 GHz and 92-95 GHz bands along the lines adopted by WRC-00 (favorable to RA), as opposed to WRC-79 (unfavorable to RA) ?
  - ✓ NSF/NTIA request adopted by FCC, but "..we request comment on whether the 81-86 GHz, 92-94 GHz, and 94.1-95 GHz bands should also be allocated to the RAS on a primary basis. Is this quantity of spectrum necessary for RAS purposes and would such a large allocation hinder effective use of spectrum needed for other applications? If not all of this spectrum is needed by the RAS, which portions are most essential or, alternatively, should certain portions be on a secondary or unprotected basis?
- How should the use of these bands be apportioned between licensed and unlicensed users?
  - ✓ FCC would authorize low power (9 μW/cm^2 at 3 m) devices in the 92-95 GHz band, wants comments in other bands
  - ✓ Spurious ems not to exceed 90 pW/cm^2 at 3 m
- How to coordinate licensed services with Radio Astronomy?
  - ✓ NSF/NTIA: exclusion radii of 150 km around single dish telescopes, 25 km around VLBI stations desired,
  - ✓ FCC: should licensees verify that pfd at observatory is less than specified value?

National Science Foundation

Satellite Coordination

- NSF-USAF MoU in existence since 1986, revised in 1991, but never signed
- New NSF-USAF MoU on Use of GPS L3/L4 signal signed on Dec. 1, 2002
- Provides for exchange of:
  - Dates of regularly scheduled GPS L3/L4 tests, and as much information as possible regarding unscheduled or extraordinary activity
  - scheduled observations at 1370-1390 MHz to USAF, allowing to avoid overlap, as much as possible
  - MoU covers national facilities but other observatories can join
- Designates operational and organizational contact points between the NSF and the USAF

National Science Foundation

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). Within the Current Practices of the ITU, Radiocommunication Is Considered to Encompass the Spectrum Below 3 000 GHz, but at Present Spectrum Allocations Cover Only up to 275 GHz
- ITU-R Recommendations (non-mandatory) are debated/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

National Science Foundation

WRC Preparations: The International Process

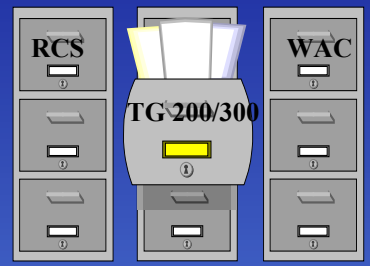
- Preparations for the (Next) WRC Start As Soon As One Ends. They Are Channeled Towards the Conference Preparatory Meeting (CPM), That Prepares a Report Containing the "Technical" Basis for the Various Agenda Items
- First CPM Meeting, Held Immediately After the WRC, Determines the Content and Organization of the CPM Report, Based on the WRC Agenda
- Studies, Mandated in WRC Resolutions Are Carried Out (or not!) in the Various Study Groups
- "Responsible" SGs Draft CPM Text, With Input From Other "Interested" SGs/WPs
- Draft CPM Report Put Together by Chapter Rapporteurs
- Second CPM Meeting, Held ~ 6 Months Before the WRC, to Finalize CPM Report
- These Meetings Have Become Very Political. Often Serve to Stake Out Preliminary Positions for the WRC, Rather Than Attempting to Solve Technical Issues

National Science Foundation

WRC Preparations: The US Process

- **Three Track Process:**
  - NTIA Develops Govt. Proposals through the Radio Conference Subcommittee (RCS) of the IRAC
  - FCC Develops Private Sector Proposals:
    - Convenes WRC (Industry) Advisory Committee to Provide Private Sector Input
    - WAC Develops Proposals
    - FCC Publishes Notice of Inquiry (NoI) Regarding Proposals
  - U.S. Radiocommunication Sector SGs, WPs and TGs

    Develop Technical Input to ITU-R SGs, Input to CPM Report
  - If Govt. and Private Sector Proposals Differ, they go Through a Reconciliation Process (NTIA/FCC/DoS)
- Final Set of U.S. Proposals Developed Jointly by NTIA, FCC and DoS



National Science Foundation

RADIO ASTRONOMY ISSUES ON THE WRC-03 AGENDA

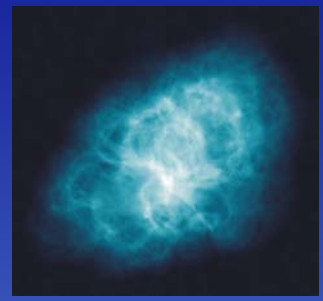
- Most radio astronomy issues at WRC-03 revolve around satellite downlink allocations, particularly to NGSO satellite systems, in bands adjacent to or close to a radio astronomy band, and how to solve it




- AI 1.15c 4990-5000 MHz 5010-5030 MHz
- AI 1.16 1400-1427 MHz 1430-1432 MHz 1390-1392 MHz
- AI 1.32 42.5-43.5 GHz 40.5 – 42.5 GHz
- AI 1.8.2 Unwanted Emissions, Across the Board
- Out of ~ 45 WRC-03 Agenda Items ~ 10 directly relevant to radio astronomy

National Science Foundation

AI 1.15c



- *"to review the results of studies concerning the radionavigation-satellite service in accordance with Resolutions 604 (WRC-2000), …"*
- *The 5010-5030 MHz band was allocated to the Radionavigation Satellite Service at WRC-00 (To be used by the European Galileo system).*
- *Concern about Galileo unwanted emissions spilling over into the nearby 4990 – 5000 MHz Radio Astronomy band, extensively used worldwide Radio astronomy band protected through a footnote with a provisional hard pfd limit, to apply at radio astronomy sites, adopted at WRC- 00*
- *Resolution 604: Appropriate definitive limit to be confirmed at WRC-03 Studies within ITU-R confirm limit, CPM text shows example of regulatory solution through footnote coupled with Resolution.*
- *CITEL, CEPT and APT proposals similar, along lines of CPM*
- *U. S. : No proposal*

National Science Foundation

AI 1.16

- *"to consider allocations on a worldwide basis for feeder links in bands around 1.4 GHz to the non-GSO MSS with service links operating below 1 GHz, taking into account the results of ITU-R studies conducted in response to Resolution 127 (Rev.WRC-2000), provided that due recognition is given to the passive services, taking into account No. 5.340".*
- *1400 – 1427 MHz band, allocated to the passive services (Radio Astronomy and EESS). RR 5.340 "All emissions are prohibited in the bands…1400-1427 MHz…".*
- *Resolution 127 invites additional tests and demonstrations, including test measurements from operational systems to validate theoretical studies on operational and technical means of protecting passive services from unwanted emissions of the little LEOs*
- *Dec. 2001, FCC releases footnote, allocating the 1390-1392 MHz band and 1430-1432 MHz band (down) for feeder links to little LEOs operating below 1 GHz , subject to the conditions in Res. 127, and subject to the adoption of an international allocation at WRC-03.*

National Science Foundation

AI 1.16 (contd.)

US proposal to WRC-03 agreed on recently:

- *Provides allocations to Little LEO up and downlinks*
- *Protection of Radio Astronomy through footnote containing hard limit*

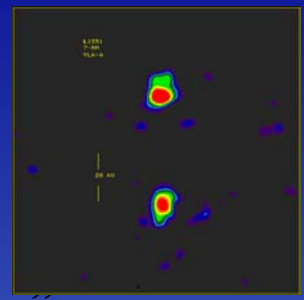
Problems:

- *Studies and practical demonstrations requested in Res. 127 presented last week*
- *Little support for allocation elsewhere*
  - > *At CPM supported by Indonesia and Morocco*
  - > *Opposed by APT, Arab bloc, CEPT, CITEL*

    (NOC and suppress Res. 127)
- *Likely to be controversial*
- *Do or die issue for little LEOs*

National Science Foundation

AI 1.32



- *"To consider technical and regulatory provisions concerning the band 37.5 – 42.5 GHz, in accordance with Resolutions 128 (WRC-2000)..."*
- *Issue: 42.5-43.5 GHz band, used for both continuum and SiO lines, needs to be protected from unwanted emissions of adjacent FSS downlink (and BSS).*
- *FSS Downlink Allocation at 40.5-42.5 GHz, first made at WRC-97, reviewed at WRC-00 . WRC-00 adopts footnote to protect radio astronomy in the adjacent band, containing provisional hard limits on unwanted emissions. (Limit is MORE restrictive than ITU-R RA.769)*
- *Footnote to be reviewed at WRC-03. Res. 128 (WRC-00) invited further studies on the provisional pfd values in the footnote, technical and regulatory measures that may protect radio astronomy, etc…*

National Science Foundation

AI 1.32

- ***Studies carried out within ITU-R show that protection of radio astronomy cannot be achieved without a guardband***

  Issues:

  - ***Hard pfd limits (footnote) vs. coordination***
  - ***Radio astronomy protection to the required spectral line limit (most stringent) up to the edge of the radio astronomy band (42.5 GHz)***

    vs. to the edge of lowest frequency spectral line (42.77 GHz) mentioned in Rec. 314
  - ***Registering VLBI and single dish telescopes sites vs. telescope sites***
  - ***Priority of registration***
- ***Agreement on U.S. proposal reached***
- ***Footnote protection for radio astronomy observations in 42.5-43.5 GHz continuum; 42.77-43.5 GHz spectral line***
- ***Coupled to Resolution below 42.77 GHz***
- **Separate registration for VLBI and single dish telescopes**

National Science Foundation

AI 1.8.2

- *"Consideration of the results of studies, and proposal of any regulatory measures regarding the protection of passive services from unwanted emissions, in particular from space service transmissions, in response to recommends 5 and 6 of Recommendation 66 (WRC-2000)"*
- ***Studies carried out within ITU-R TG 1/7***
  - *Extremely controversial, in U.S and worldwide*
  - *TG 1/7 results summarized in Recommendation ITU-R SM.[BBB]*
  - *Unsatisfactory to passive services, provides no protection*
- ***US proposal:***
  - *No changes to the Radio Regulations (No regulatory measures to protect passive services)*
  - *SUP Rec. 66*

National Science Foundation

Potential Solutions

- **Regulatory, hard: Mandatory limits on unwanted emissions in the Radio Regulations**
  - Favored by most astronomers
  - Favored by CEPT, APT in certain cases (e.g. 5 GHz)
  - Opposed by U.S. (but adopted de facto and with extreme reluctance in a very limited number of cases, e.g. 1.4 GHz)
- **Regulatory, soft(er): Mandatory coordination between Administrations, triggered when pfd level exceeds a certain threshold**
  - Favored by CEPT, APT in certain cases
  - Opposed by U.S.
- **Non or quasi regulatory: Resolution calling for coordination when pfd level exceeds threshold**
- **Non regulatory: Do nothing, adopt mitigation techniques (if and when problems arise)**
  - Favored by USA, Canada in most cases

National Science Foundation

Problems

All approaches present difficulties:

- **Mandatory limits:**
  - **Computation and/or measurement of unwanted emissions of satellite systems is a substantial problem. No accepted method on how to deal with it within the ITU (or elsewhere)**
  - **Requires knowledge of radio astronomy antenna pattern (mostly unknown, particularly of far sidelobes!)**
- **Mitigation**

  Not much can be done after satellite is in orbit!

National Science Foundation

OTHER AIs OF INTEREST TO RADIO ASTRONOMY AT WRC-03

- **AI 1.11 Secondary Aeronautical MSS uplinks at 14.0-14.5 GHz**
  - **Studies completed, sharing possible.**
  - **U.S. opposed to footnote protecting radio astronomy**
  - **U.K., France may propose such a footnote**
- **AI 1.13 (Res. 122) HAPS Allocations at 31 GHz**
  - **Studies within ITU-R show adjacent band operations compatible through technical (filtering, limited guardband) and regulatory solutions**
  - **U.S. opposed to footnote containing hard limits to protect passive services (31.3-31.8 GHz band)**
- **AI 1. 31 (Res. 226 and 227) Additional MSS Allocations at 1-3 GHz**
  - **Issue: MSS Uplink allocation desired by CEPT, Arab bloc in 1670-1675 MHz band (adjacent to 1660-1670 MHz RA band) or 1668-167X MHz band (overlapping RA band)**
  - **U.S. opposed to new allocation**

National Science Foundation

Future Conference Agenda Items

- Each WRC Develops and Formally Adopts a Draft Agenda (Contained in a Resolution) for the Next Conference, and a Provisional Agenda for the Following One. Currently, Agendas Consist of Many Unrelated Items
- Getting on the Agenda Is a Condition for an Issue to Be Treated, and Often There Is Considerable Fight Over Future Agenda Items
- WRC-07
  - Allocations in the 275 – 1000 GHz Range
  - CEPT and Possibly APT in Favor
  - Consider Studies on Protection of Passive Services- CEPT
- WRC-10
  - Consider Regulatory and Technical Measures Needed to Establish IRQZs

National Science Foundation

Initiatives

- 1st ever Summer School in Spectrum Management
  - **Held at Green Bank, June 9-15, 2002**
  - *45 participants from 12 countries, 23 US/22 foreign, 7 female/38 male*
  - *35 formal lectures, hardware demonstrations by Green Bank staff*
  - *available at http://www.iucaf.org/sschool/*
  - *The intention is to repeat the Summer School on a 3-year cycle*
- *CORF Study Getting Under Way*
- *More Needs to Be Done to Attract New People to the Activity!*

National Science Foundation

Issues

- A Number of the Most Experienced Radio Astronomers Involved in Spectrum Management Retired During the Last 5 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

National Science Foundation

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

	FTEs Act.	1990s	Min Needed
• NSF			2
▪ Spectrum Manager	1	1	
▪ 2 others	.3		
> NRAO		2	3 (1+5/6)
▪ Tucson	.1		
▪ Socorro	.2		
▪ Cville (Ret.)	.5		
> NAIC	.2	1.25	1.25 (2)
> SETI Inst.	.2		
> Haystack	>.1		
> Berkeley	.25 (?)		
> Univ. Obs.			2 (4/5)
Total	~ 1.5/(2.0)	3.25	7- 8

National Science Foundation

Radio astronomy involvement in spectrum management activities (international)

- **Americas:**
  - US 4
  - Canada 1
- **Europe** 1
  - Netherlands 1
  - Germany 1
  - France 1/1
  - U.K. 1/1
  - Russia 1
- **Asia**
  - Japan 1
  - India 1
  - Korea 1
  - China
- **Australia** 1

Total: ~ 15, worldwide