Committee on Radio Frequencies

XXVIII IAU General Assembly

RAFCAP Meeting

August 24, 2012

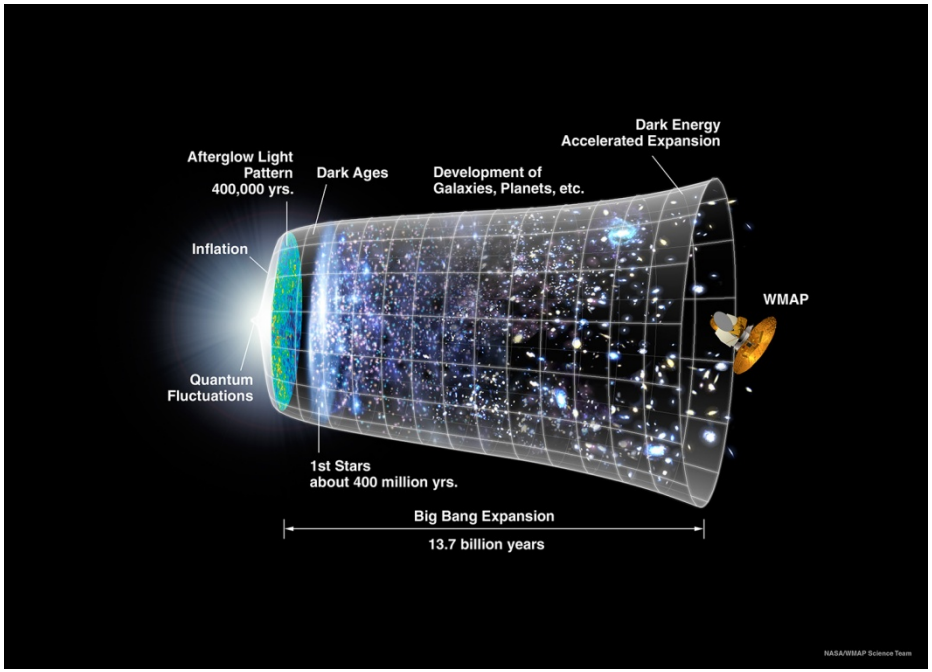
Beijing, China

Ken Kellermann, CORF member

Radio Astronomy (RAS)

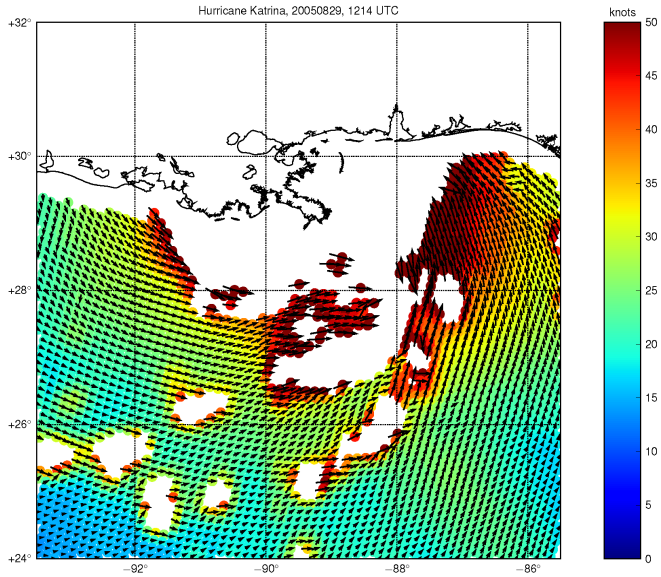
Radio astronomy has great potential for further fundamental discoveries, including the origins and evolution of the universe, the nature of matter, and life in other solar systems, which will have an enormous impact on our understanding of fundamental physics and the place of humanity in the Universe.

Artist's conception of the history of the Universe. Time runs from left to right. The Universe was born in an explosion popularly called the "Big Bang." After a period of inflation the Universe settled to a nearly steady expansion rate. As the afterglow died out the Universe became dark. After hundreds of millions of years gravitational contraction of the material in the original density fluctuations produced the first stars, which gave off light, and so the "Dark Ages" ended. The Universe became more complex, and now is evolving rapidly, with many varieties of stars and galaxies and exotic objects. Results from the WMAP satellite were used to make the afterglow pattern.



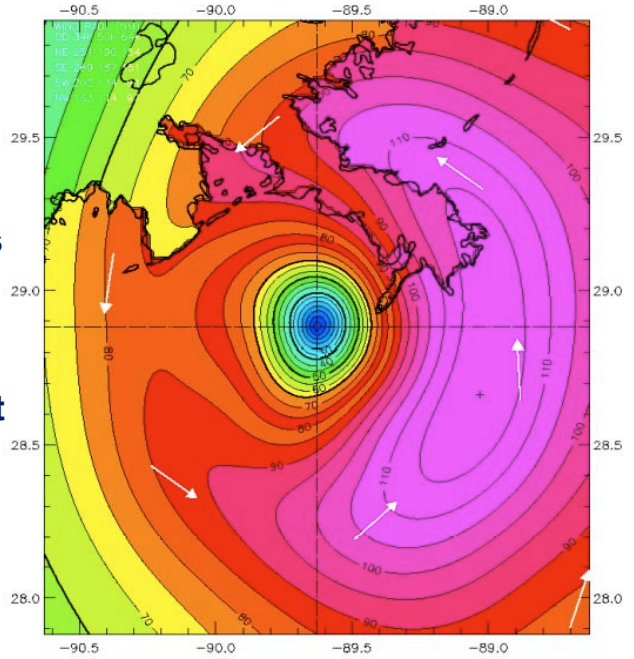
The Importance of Earth Exploration Satellite Services

Microwave measurements from satellites are vital for weather forecasting (e.g. Hurricane Katrina) and long-range climate studies (e.g. ice cover)



(Left) Image of the wind speed of Hurricane Katrina (in knots), observed by passive microwave radiometers on WindSat, a Naval Research Laboratory satellite, as the hurricane makes landfall near New Orleans on August 28, 2005.

(Right) Output from a model that combines data from WindSat and other remote sensing instruments. The model provides information on the hurricane's wind speed. The values over land are extrapolations.



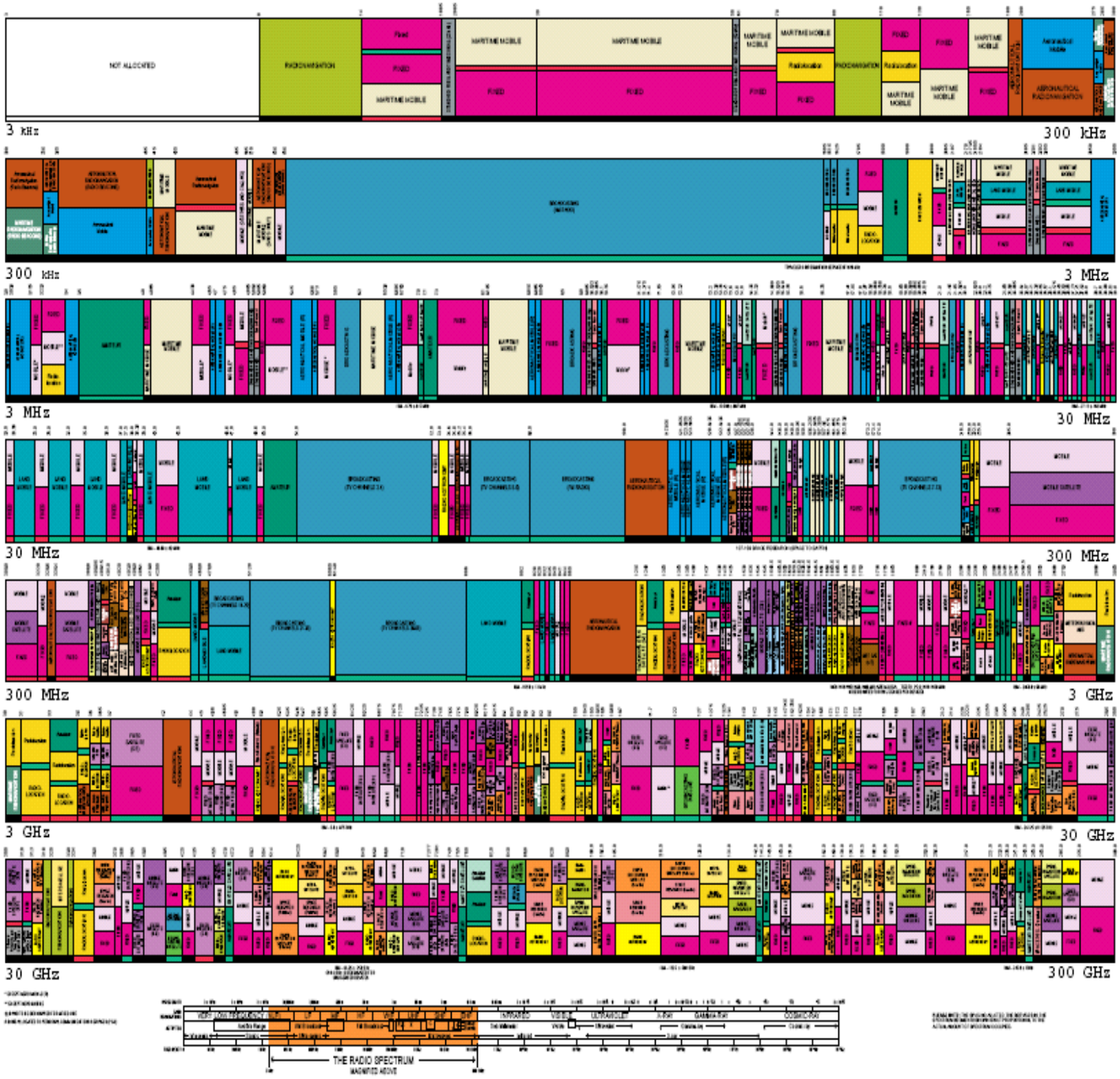
UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

ACTIVITY CODE

ALLOCATION USAGE DESIGNATION



U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management
March 1996

Interference Potential

- Both the active and the passive services are increasing their use of the spectrum, and so the potential for interference, already strong, is increasing.
- Satellites cannot “hide” from ground-based interference, in the way that RAS observatories can.
- Conversely, RAS observatories can’t “hide” from satellite-based interference.
- Cars and iPhones.

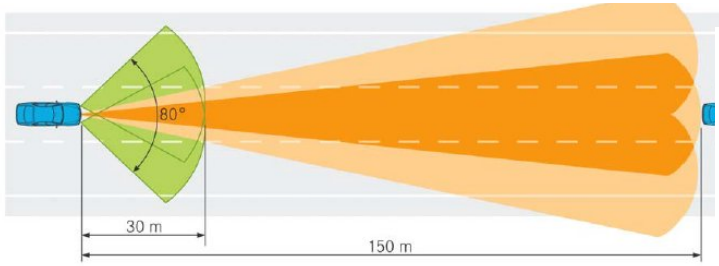


Figure 3. Combination of LRR and SRR for advanced safety features.

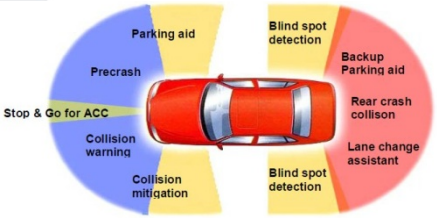


Figure 2. Possible applications using SRR.

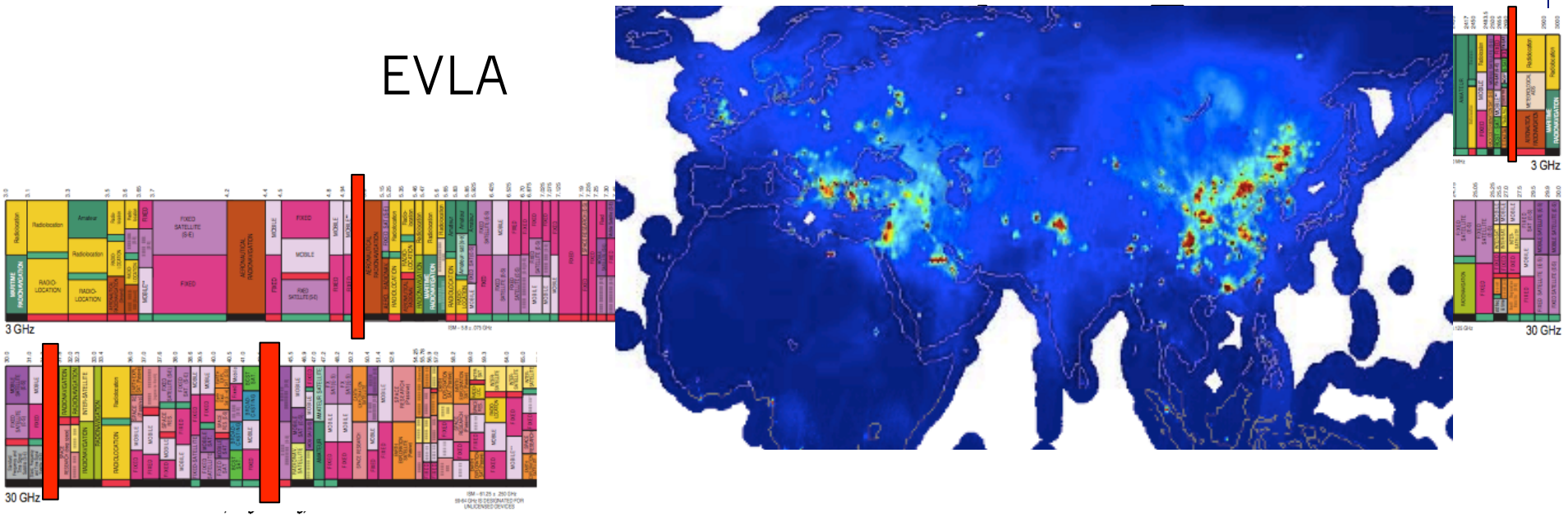
There are many issues in spectrum policy…

- Increasing demand for spectrum due to the proliferation of wireless devices/ services, market penetration
  - e.g. 1 B cell phones sold in 2006
- "Spectrum occupancy" (usage)
- Interference trends (e.g. Light-Squared)
- Policy trends and disparity of access
- Difficulty of spectrum recovery/regulation reversal
- Interference mitigation and limitations

Scientific Use Trends

- RAS – frequency allocations are becoming less important than locational protection.
- EESS – locational protection is not important, but frequency allocations are very important.
- RFI mitigation development, but not a panacea

EVLA



Committee on Radio Frequencies (CORF)

- Deals with radio-frequency requirements and interference protection primarily through filing comments under the aegis of the National Academy of Sciences in public proceedings of the FCC and NTIA.
  - Comments are drafted and developed by CORF and its legal counsel. Comments go through a detailed review process per NRC protocol, and are finally approved and signed by the NAS President's Office
- Coordinates the views of the U.S. scientists, and acts as a channel for representing the interests of U.S. scientists
- Conducts spectrum studies and maintains Handbook
- Operates under the Board on Physics and Astronomy
- Is supported by NASA and NSF

Committee on Radio Frequencies

Committee Members

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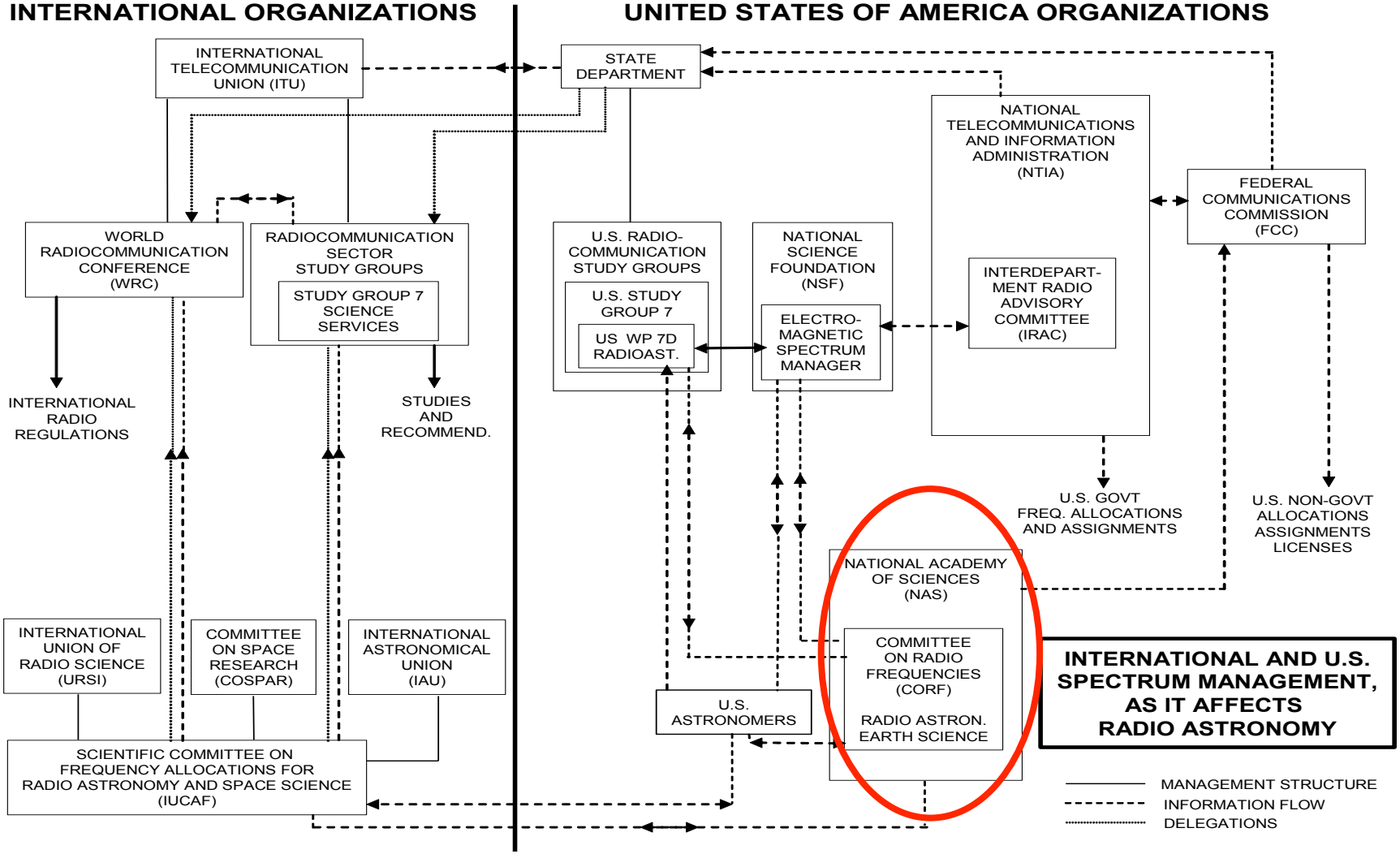
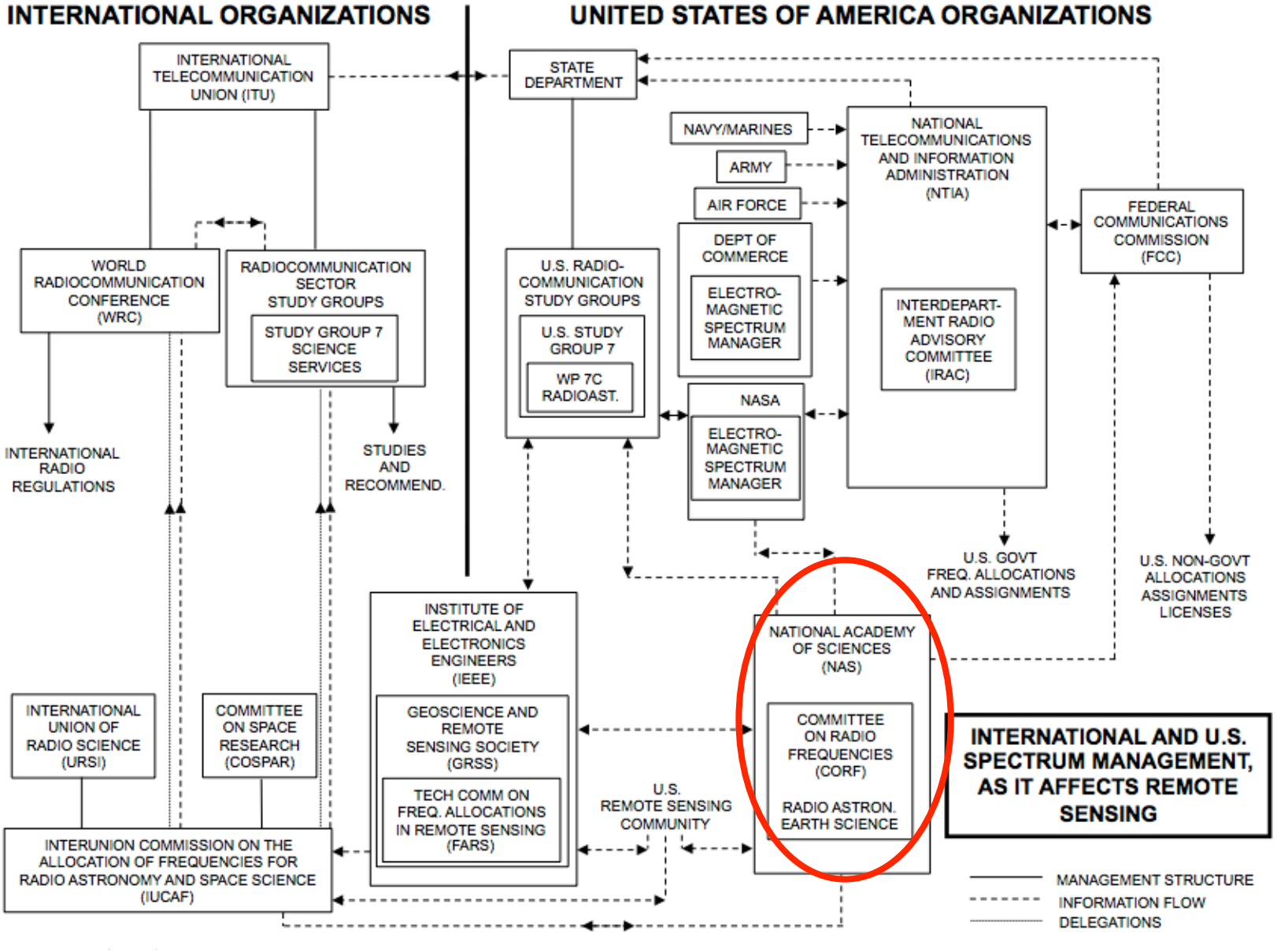
Where CORF fits in…(RAS)



Where CORF fits in…(EESS)



CORF Activities

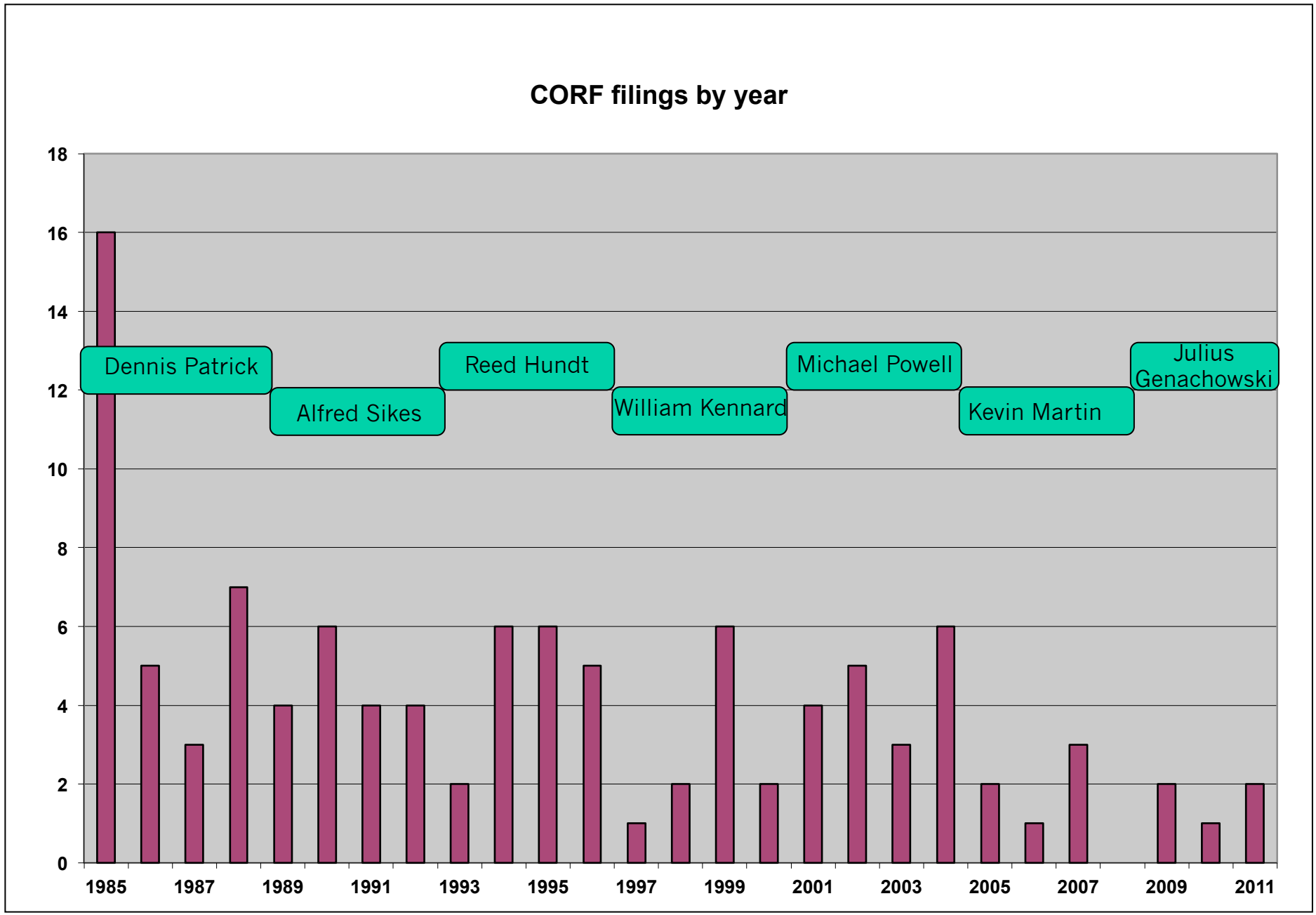
Handbook on Frequency Allocations and Spectrum Protections for Scientific Uses (2007)
(aka "CORF Handbook")

- Comprehensive resource for scientists, engineers, and spectrum managers. Detailed information including a description of regulatory bodies and issues, a discussion of the relevant scientific background, a list of science spectrum allocations in the United States, and an analysis of spectrum protection issues for RAS and EESS
- >1,200 disseminated at various conferences
- Derivative "brochures" available as well; summary of the science and protection issues for nontechnical audience

CORF Activities

Filings with the FCC

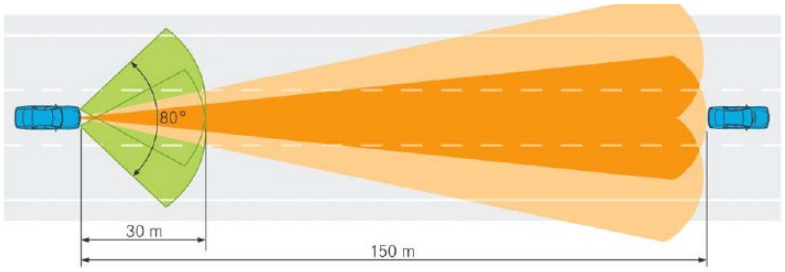
- Four filings in 2012
  - Re: Radiolocation at 78-81 GHz
  - Re: Part 15 for tank-level probing radars at mult. bands
  - Re: Rapidly deployable aerial communications architecture in response to an emergency
  - Re: Air-ground comms at 14-14.5 GHz.
- Two filings in 2011
  - Re: Fixed satellite service around 40 GHz
  - Re: Vehicular radar at 77 GHz



THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Automotive Radar

- Automotive radar works to assist the driver.
- Very fluid state: 17 automotive radar vendors deploying 80 different radar platforms[1]
- Bands at 24-26, 77-81 GHz
- Power levels 77-81 GHz +55 dBm (peak)[2]
- Plans for no provisions for off switch or geographical awareness



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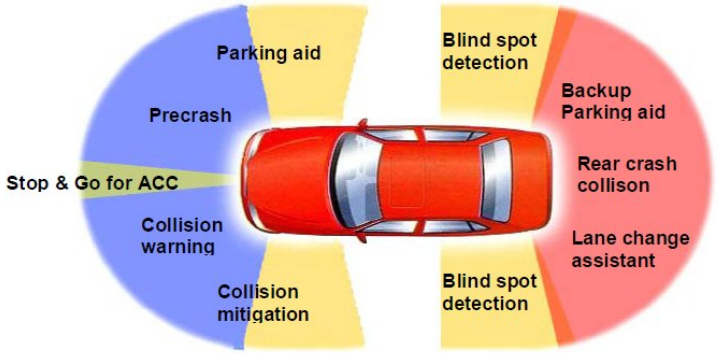
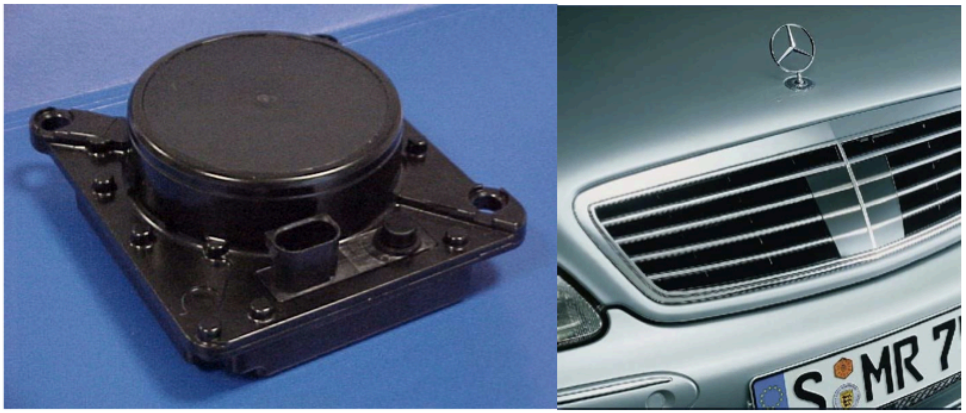


Figure 2. Possible applications using SRR.

[1] Wihl, IWPC 2011
[2] Wenger IEEE CSIC 2005

Automotive Radar

- Bosch and Continental engineers working with RAS community to measure potential impact.
- October 2011 measurements at Kitt Peak



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CORF Activities

Spectrum Management for Science in the 21st Century (2010)

- Addresses the tension between the active services' demand for greater spectrum use and the passive users' need for quiet spectrum
- Recommendations provide a pathway for putting in place the regulatory mechanisms and associated supporting research activities necessary to meet the demands of both users
- Had significant impact; good timing; high-level briefing at OMB/OSTP

Overview of Findings & Recommendations

- ***Finding:*** *Better utilization of the spectrum and reduced RFI for scientific as well as commercial applications is possible with better knowledge of actual spectrum usage. Progress toward these goals would be made by gathering more information through improved and continuous spectral monitoring. This would be beneficial to both the commercial and scientific communities.*

- ***Recommendation:*** *The Department of Commerce/NTIA, in collaboration with NSF, NASA, and NOAA, should spearhead the development of a national spectrum assessment system that measures the RF environment with appropriately high resolution in time, space, and frequency for spectrum development and management purposes, based on the spectral and spatial density of emitters.*

Overview of Findings & Recommendations

- ***Recommendation:*** *The EESS and RAS communities should be provided additional support through NSF, NASA, and NOAA to increase their participation in spectrum management forums within the ITU, FCC, NTIA, and other organizations. The goal is to foster outreach, understand interference and regulation issues, and initiate mutual cooperation in interference mitigation.*

Overview of Findings & Recommendations

- ***Recommendation:*** *Investment in mitigation technology development should be increased to be commensurate with the costs of data denial experienced using systems without mitigation. To this end, NSF and NASA should support research and development for unilateral RFI mitigation technology in both EESS and RAS systems. NASA, NOAA, and DoD should require that appropriate RFI analyses and tests, and practical RFI mitigation techniques, be applied to all future satellite systems carrying passive microwave sensors.*

- ***Recommendation:*** *The NSF, NASA, and NTIA should jointly support research and development for cooperative RFI mitigation techniques and the associated forums and outreach necessary to enable standards development for higher spectral utilization and interference avoidance.*

Future of Spectrum Management Issues for Remote Sensing

RFI Mitigation

- The scientific community have developed a number of methods for the detection of low-level signals
- Potentially useful in spectrum surveys
- Remote sensing community needs to continue to develop methods and put them to use in future missions

Cooperative Spectrum Use

- Passive science relies on measurements of very low level signals which are often broadband in nature
- Science improved if measurements can be made over wider band, enabled by cooperative spectrum use techniques
- As the spectrum becomes more crowded as well as more economically important, we must develop ways to work cooperatively with other users

Future CORF Activities

Stewardship of "SMS 2010"

Key activity that marks a shift in how the community may engage in spectrum management

– will need community input and support

– will need to be collaborative and work with other users

– will take time!

Location, allocation, mitigation, ***collaboration***

It likely won't be a "spectral fortress" approach

"The Radio Spectrum:
Shared Use, Shared Responsibility"

Future CORF Activities

- *CORF Colloquium,* Mexico, 2012?
  - To continue to stimulate dialogue and communication between radio scientists, engineers, and civil servants from across the Americas
  - Motivated by desire to precipitate interest in pan-American CORF as exists in Europe (CEPT)

- *Other*
  - Outreach (FCC briefing presentation)
  - Monitor U.S. spectrum inventory activities