What is it, exactly?

• ‘Everyone’ knows that there is heavy demand on the finite resources of the RF spectrum
• So, use of the spectrum is heavily regulated
• Making the regulations work/making new regulations is called “spectrum management”
• The lowliest job at any observatory
• There are far more “spectrum managers” than astronomers (in the real world, that is)
What is interference?

- Interference happens when SM FAILS
- Unwanted extraneous signal detected
  -----IN A RADIO ASTRONOMY BAND-----
- Outside the radio astronomy bands you are quite likely seeing *intentional* radiation which is legally someone else’s SIGNAL and THIS ISN’T INTERFERENCE
- Inside a RA band, unwanted signal is quite likely to be generated by the observatory

What is the Radio Astronomy Service?

- Few services (official uses) are “passive”
  - Radio astronomy is a radio communication service only when interfered with
  - Earth Exploration Satellite Service (passive)
- Concept of “use” for passive services somewhat elusive
  - FCC considers spectrum “unused” just where RAS works best
Did you say “international”?

On the other bank …
The ITU-R

- A UN agency in Geneva

Harvey Liszt
Arecibo July 2005
Entire ITU-R structure mirrored in US
USWP7A,B,C,D
ITU Regions

International Alphabet Soup

- **IUCAF**
  - ICSU-chartered for IAU, COSPAR, URSI
  - Historically, the vehicle for RAS representation
  - Now being pressured to be more interdisciplinary

- Regional groups
  - 1: Committee European Post Telegraph (CEPT)
    - Committee Radio Astronomy Frequencies (CRAF)
  - 2: **CITEL** (organ of OAS)
    - Committee on Radio Frequencies (CORF) of NAS in US
  - 3: Asia Pacific Tel. APT shadowed by **RAFCAP**
What’s a WRC?

- World Radio Conference (WRC97,00,03,08)
  - Crafts INTERNATIONAL TREATY
    - Ratified by individual administrations (nations)
      - Nations are allowed their sovereignty
  - Considers agenda items which result in
    - Recommendations (such as RA-769)
    - Regulations (the rules including frequency tables)
    - Resolutions and questions for future WRC

Agenda item, WRC07

- **1.21** to consider the results of studies regarding the compatibility between the radio astronomy service and the active space services in accordance with Resolution **740 (Rev. WRC-03)**, in order to review and update, if appropriate, the tables of threshold levels used for consultation that appear in the Annex to Resolution **739 (WRC-03)**;

- **[740] resolves**
  1 to invite ITU-R to study the compatibility between the RAS and the corresponding active space services as listed in the Table only, with a view to updating or developing ITU-R Recommendations, if appropriate;
  2 that WRC-07 should consider the results of the studies as identified in resolves 1, in order to review and update, if appropriate, the tables of threshold levels for consultation in the Annex 1 to Resolution **739 (WRC-03)**.
Part of the frequency table

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>International Table</th>
<th>United States Table</th>
<th>FCC (Rule Party)</th>
</tr>
</thead>
<tbody>
<tr>
<td>47-90 MHz</td>
<td></td>
<td></td>
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<tr>
<td>30-300 MHz</td>
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<tr>
<td>300-3000 MHz</td>
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</tr>
</tbody>
</table>

ITU-R defines ‘radio’ as extending up to 3000 GHZ!

Allocations now extend up to 275 GHZ

Harvey Liszt
Arecibo July 2005
ITU-R defines 'radio' as extending up to 3000 GHz!

Allocations now extend up to 275 GHz

US74

US74 In the bands 25.55-25.67, 73.0-74.6, 406.1-410.0, 608-614, 1400-1427, 1660-1670, 2690-2700, and 4990-5000 MHz, and in the bands 10.68-10.7, 15.25-15.4, 23.6-24.0, 31.3-31.5, 86-92, 100-102, 109.5-111.8, 114.25-116, 148.5-151.5, 164-167, 200-209, and 250-252 GHz, the radio astronomy service shall be protected from extraband radiation only to the extent that such radiation exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates. Radio astronomy observations in these bands are performed at the locations listed in US311.

- FCC now considering cell phones on planes
- 1st harmonic in protected OH band @ 1665
- Harmonic isn’t heavily regulated, nor need it be
- But once pigs can fly ...
WRC07 Agenda items

- **1.5** to consider spectrum requirements and possible additional spectrum allocations for aeronautical telecommand and high bit-rate aeronautical telemetry
  - Will likely be in band 4800-4940

- **1.17** to consider the results of ITU-R studies on compatibility between the fixed-satellite service and other services around 1.4 GHz …
  - 1390-1392 (up), 1430-1432 MHz feeder links
  - Loathed by passive services, DoD (bad for awacs)

---

What’s hot now

- Broadband over Power Lines (BPL) Q218, 221

- CloudSat radar at 94.05 GHz
  - From the evil twin (active) branch of a sister passive service EESS (passive)

- Compatibility studies for ultrawideband
  - Vehicular radar at 24, 76 GHz
  - Unlicensed portable devices
    - FCC mask 3.1-10.6 GHz
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How Ofcom treated uwb

Ultra Wideband

Summary and reaction to responses received to the consultation
In summary ...

1.2 Conclusions

In summary, the responses to the consultation led us to conclude that the approach that we proposed is broadly appropriate, considering that further study is underway into BFWA and the 2.5GHz band, with the following exceptions:

- Further study is needed to confirm that interference into radio astronomy can be mitigated.

2 Summary of responses

2.1 Outline of the responses

Overall 66 responses were received. The consultation document was strongly supported by around 20 respondents, broadly supported by 12 respondents and broadly criticised by 12 respondents. The remainder took a stance that was overall neutral or only addressed a sub-section of the document.

The essence of the responses was that:

- Conversely, most responses suggest that there may not be a problem with radio astronomy although further studies are needed to confirm this.

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Arecibo July 2005

What commenters said

Q6: Would it be possible to achieve sufficient isolation between radio astronomy and UWB through practical methods of physical separation?

Responses: The responses were broadly polarised between the radio astronomy community and all other respondents:

- Many thought that it would be possible to achieve sufficient isolation, given that most UWB devices would be indoors and most radio astronomy antennas would be pointing predominantly upwards. They noted that astronomy sites already protected themselves against out-of-band and spurious interference and that UWB would be little different from this. Some provided specifications showing, eg that W-LAN spurious emissions were higher than proposed UWB emissions.

- One respondent noted that in the case of MERLIN and Methanol line studies in the 6650-6675.2 MHz band, such studies are typically performed at night with narrow channel bandwidths, significantly reducing the effects of wideband or ultra wideband emissions because of pulse desensitization effects. As a result, they thought a perimeter fence restriction would be acceptable.

- One respondent recommended a small levy on each UWB device sold which would be used to provide the astronomy community with funds to mitigate the interference.

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What’s wrong with this picture?

- One respondent noted that protecting astronomy at low elevation angles was probably excessive given that, somewhere in the world, there would be an observatory able to monitor the same part of the sky with a high elevation angle.

- Many noted that if the protection requirements stated were real then "radio astronomy would already be impossible" due to the spurious emissions from other devices.

- The astronomy community said that relocation would be impractical and that perimeter fences would not provide sufficient isolation. They claimed that restricting observations to night time would devalue the scientific nature of their research.

Reaction: On the balance of evidence provided there seems a strong likelihood that a means could be found whereby sufficient isolation could be achieved. This might be through the combination of a perimeter fence and a recognition that certain measurements could be performed differently in the case of interference. We will consider further studies to confirm whether this is the case.

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What can RAS have in the near future?

- Allocations above 275 GHz
  - Spectrum 275-1000 GHz will open next
  - ITU-R is considering extending definition of radio above 3000 GHz

- Consideration of radio quiet zones
  - Presently exist in US, Chile, India
  - Lesser coordination zones elsewhere
  - SKA will need a quiet zone
    - US couldn’t provide one, dropped out as host

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It’s a long way from here to Geneva

- How do things appear on the WRC agenda?
  - Services like radio astronomy may foster issues
    - RAS procured mm-wave allocations at WRC00
    - Now sponsoring ITU consideration of Quiet Zones
  - Countries/blocks may tout initiatives
    - Europe’s Galileo RNSS (GPS competitor)
    - At WRC03 US pushed
      - Ku-band links for airborne mobile broadband
      - Increased 5 GHz allocation for WiFi
      - Primary status for L-band feeder links, HAPS

Inside the US

- Unusual parallel structure
  - FCC for commercial (non-government)
  - NTIA for government + shared
    - NTIA does the testing and is supposed to be the president’s technical expert advisor
- FCC has been dominant in technology
  - Industry proposes to FCC, FCC orders NTIA to show everything is OK, NTIA complies
  - Dept of State uses FCC to control WRC access
Inside the US

- FCC under Michael Powell frequently infuriated both industry and public interests and lost some big court cases
  - Immediately after Powell’s resignation the FCC pulled back on many of its wackier initiatives
  - Present realignment of FCC ongoing
  - FCC won two big cases very recently
    - Cable access not regulated
      - Services are data, not telecommunications

Recent NRAO FCC Filings

- ESV (Ku band links on ships for broadband)
- Interference temperature
- Cognitive radio
- Unlicensed use of TV broadcast bands
- Airborne use of cellular telephones
- Airborne mobile Ku band satellite links
- Comments on draft US WRC position on L-band feeder links
Problematic:

- Observing outside protected bands
- Bandwidths far exceed width of protected bands (at lower frequencies)
- No amount of geographic separation protects against satellites, planes, HAPS etc.
- Perhaps best viewed as a gradual process of deracination, isolation & marginalization
  (think of QZ as reservations)