
INTERNATIONAL SPECTRUM MANAGEMENT, BASICS AND IMPLICATIONS FOR RADIOASTRONOMY

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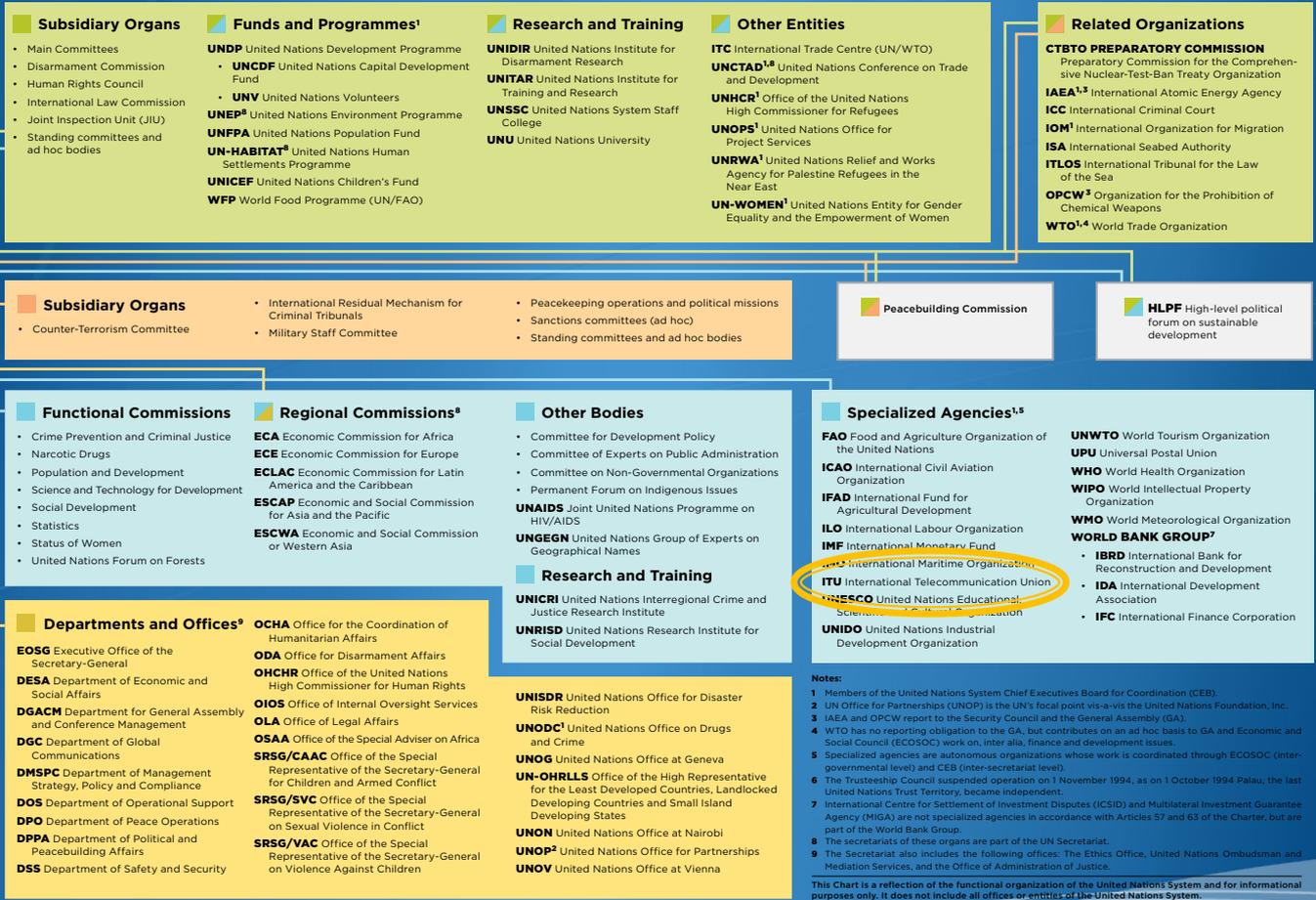
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SECRETARIAT

INTERNATIONAL COURT OF JUSTICE

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ITU overview

Since 17 May 1865

193 Member States
+900 Sector Members & Academies

ITU-T

Standardization of telecommunication, ICTs, regulation of numbering, international tariffs



ITU-D

Assisting implementation and operation of telecommunications in developing countries

ITU-R

Radiocommunication standardization and global radio spectrum management

ITU-R activity



World Radiocommunication Conference (WRC)

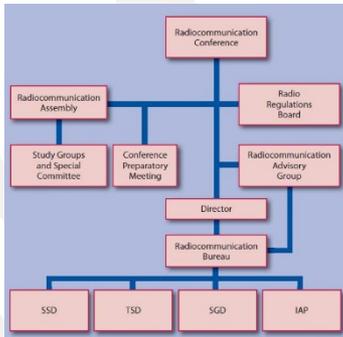
Establish and update international regulations governing use of the spectrum- **Radio Regulations**

Study Groups (SG)

Efficient management and use of the spectrum/orbit resource; characteristics and performance of radio systems; distress and safety matters of radiocommunication- **Recommendations, Reports, Handbooks**

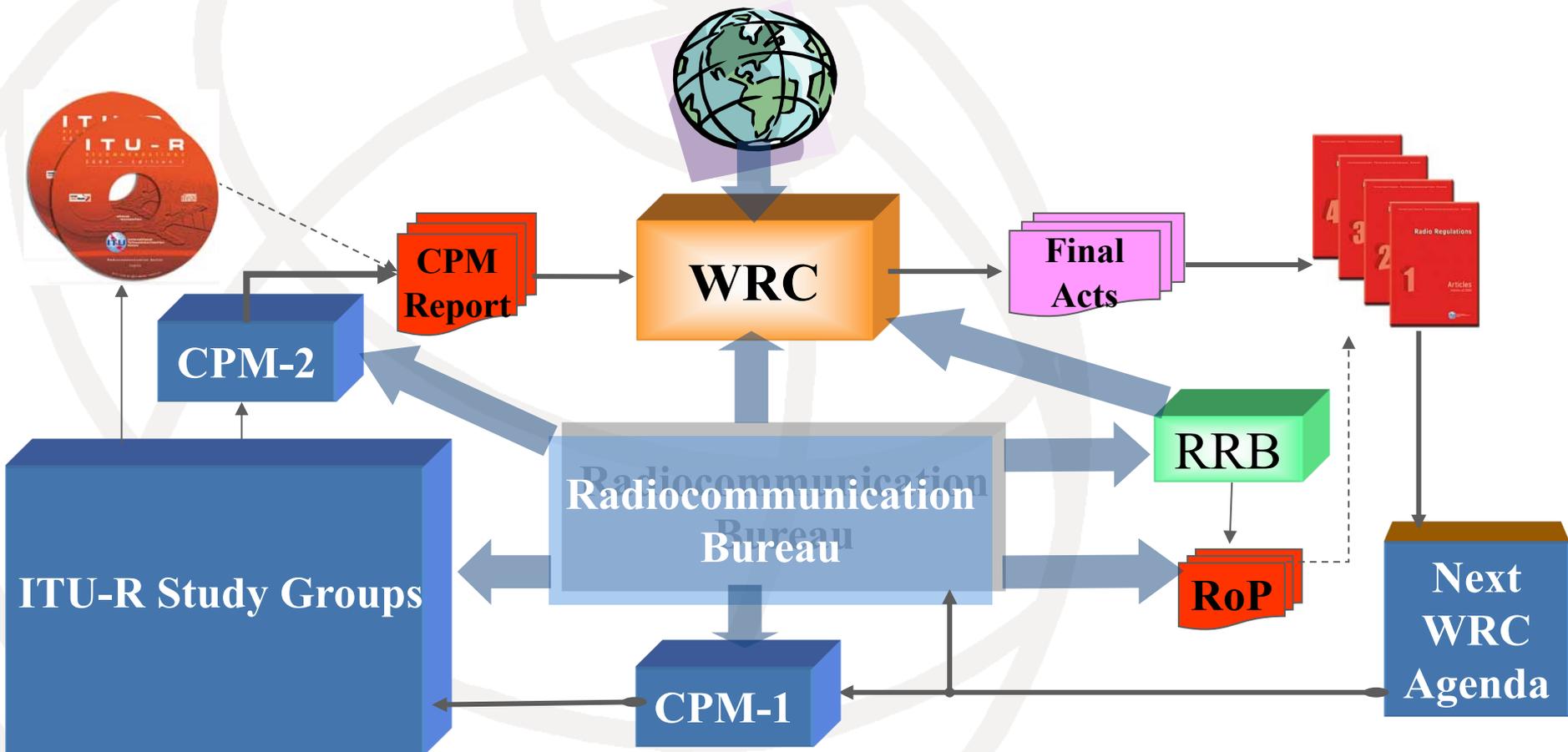
Radiocommunication Bureau (BR)

Apply the international regulations governing use of the spectrum – to ensure the most **efficient use of the orbit/spectrum resource** for operation of radiocommunication services free from harmful interference- **MIFR, Service publications, BR software**



WRC process

ITU Member States



Radio Regulations

Concept:

- Frequency block allocations intended for use by radio services (from 8.3 kHz to 3000 GHz)
- Regulatory and technical provisions

Objectives:

- International spectrum sharing and protection
- Interoperability and roaming: public mobile networks, maritime and aviation communications (Cospas/Sarsat etc.)
- Mass production and roadmap for industry, operators and investors
- Worldwide passive bands protection



81-86 GHz

Allocation to services		
Region 1	Region 2	Region 3
81-84	FIXED 5.338A FIXED-SATELLITE (Earth-to-space) MOBILE MOBILE-SATELLITE (Earth-to-space) RADIO ASTRONOMY Space research (space-to-Earth) 5.149 5.561A	
84-86	FIXED 5.338A FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY 5.149	5.561B

RR (Radioastronomy)

Article 1- Definitions

- **1.58 radio astronomy service:** A service involving the use of *radio astronomy*.

Article 4 Assignments

- **4.4** Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations
- **RoP 5.340.** Notification concerning any other use than those authorized in the band or on the frequencies concerned cannot be accepted even with a reference to No. 4.4; furthermore the administration submitting such a notice is urged to abstain from such usage.

- **4.6.**

RR (Radioastronomy)

8.3 Any frequency assignment recorded in the Master Register with a favourable finding under No. **11.31** shall have the right to international recognition. For such an assignment, this right means that other administrations shall take it into account when making their own assignments, in order to avoid harmful interference...

11.12 Any frequency to be used for reception by a particular radio astronomy station may be notified if it is desired that such data be included in the Master Register

29.5 § 2 The locations of the radio astronomy stations to be protected and their frequencies of observation shall be notified to the Bureau in accordance with No. **11.12** and published in accordance with No. **20.16** for communication to Member States

RR-special provisions

■ No.5.149- urged to take all practical steps to protect RA

13360-13410 kHz, 25550-25670 kHz, 37.5-38.25 MHz, 73-74.6 MHz in Regions 1 and 3, 150.05-153 MHz in Region 1, 322-328.6 MHz, 406.1-410 MHz, 608-614 MHz in Regions 1 and 3, 1330-1400 MHz, 1610.6-1613.8 MHz, 1660-1670 MHz	1718.8-1722.2 MHz, 2655-2690 MHz, 3260-3267 MHz, 3332-3339 MHz, 3345.8-3352.5 MHz, 4825-4835 MHz, 4950-4990 MHz, 4990-5000 MHz, 6675.2 MHz, 10.6-10.68 GHz, 14.47-14.5 GHz, 22.01-22.21 GHz,	22.21-22.5 GHz, 22.81-22.86 GHz, 23.07-23.12 GHz, 31.2-31.3 GHz, 31.5-31.8 GHz in Regions 1 and 3, 36.43-36.5 GHz, 42.5-43.5 GHz, 48.94-49.04 GHz, 76-86 GHz, 92-94 GHz, 94.1-100 GHz, 102-109.5 GHz, 111.8-114.25 GHz, 128.33-128.59 GHz	129.23-129.49 GHz, 130-134 GHz, 136-148.5 GHz, 151.5-158.5 GHz, 168.59-168.93 GHz, 171.11-171.45 GHz, 172.31-172.65 GHz, 173.52-173.85 GHz, 195.75-196.15 GHz, 209-226 GHz, 241-250 GHz, 252-275 GHz
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■ No.5.340- all emissions are prohibited

1400-1427 MHz	31.5-31.8 GHz	100-102 GHz	182-185 GHz
2690-2700 MHz	48.94-49.04 GHz	109.5-111.8 GHz	190-191.8 GHz
10.68-10.7 GHz	50.2-50.4 GHz	114.25-116 GHz	200-209 GHz
15.35-15.4 GHz	52.6-54.25 GHz	148.5-151.5 GHz	226-231.5 GHz
23.6-24 GHz	86-92 GHz	164-167 GHz	250-252 GHz
31.3-31.5 GHz			

RR (Radioastronomy)

- **5.208B** In the frequency bands: 137-138 MHz, 157.1875-157.3375 MHz, 161.7875-161.9375 MHz, 387-390 MHz, 400.15-401 MHz, 1 452-1 492 MHz, 1 525-1 610 MHz, 1 613.8-1 626.5 MHz, 2 655-2 690 MHz, 21.4-22 GHz, Resolution **739** (Rev.WRC-19) applies.
- Unwanted emission *pdf* and *epfd* threshold levels

TABLE 1-2

epfd thresholds⁽¹⁾ for unwanted emissions from all space stations of a non-GSO satellite system at a radio astronomy station

Space service	Space service band	Radio astronomy band	Single dish, continuum observations		Single dish, spectral line observations		VLBI		Condition of application: the API is received by the Bureau following the entry into force of the Final Acts of:
	(MHz)		<i>epfd</i> ⁽²⁾	Reference bandwidth	<i>epfd</i> ⁽²⁾	Reference bandwidth	<i>epfd</i> ⁽²⁾	Reference bandwidth	
	(MHz)		(dB(W/m ²))	(MHz)	(dB(W/m ²))	(kHz)	(dB(W/m ²))	(kHz)	
MSS (space-to-Earth)	137-138	150.05-153	-238	2.95	NA	NA	NA	NA	WRC-07
MMSS (space-to-Earth)	157.1875-157.3375 161.7875-161.9375	150.05-153	-238	2.95	NA	NA	NA	NA	WRC-19
MMSS (space-to-Earth)	157.1875-157.3375 161.7875-161.9375	322-328.6	-240	6.6	-255	10	-228	10	WRC-19

WRC-19 Highlights (Radioastronomy)

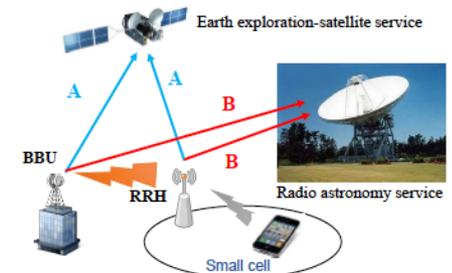
- **IMT** global identification: 24.25-27.5 GHz and 37-43.5 GHz with unwanted emission levels to protect passive 23.6-24 GHz and 36-37 GHz bands
- **HAPS** global identification: 31–31.3 GHz; 38–39.5 GHz; 47.2–47.5 GHz and 47.9–48.2 GHz with relevant unwanted emission levels to protect passive bands in the 22.21-22.5/23.6-24 GHz in Region 2 and 31.3-31.8 GHz
- Identification 275-296 GHz, 306-313 GHz, 318-333 GHz and 356-450 GHz for **fixed and land mobile services** without restriction, the specific conditions (e.g. minimum separation distances and/or avoidance angles) for the protection of radio astronomy applications in the frequency range 275-450 GHz
- **GMDSS** development

World Radiocommunication
Conference 2019
(WRC-19)

Provisional Final Acts



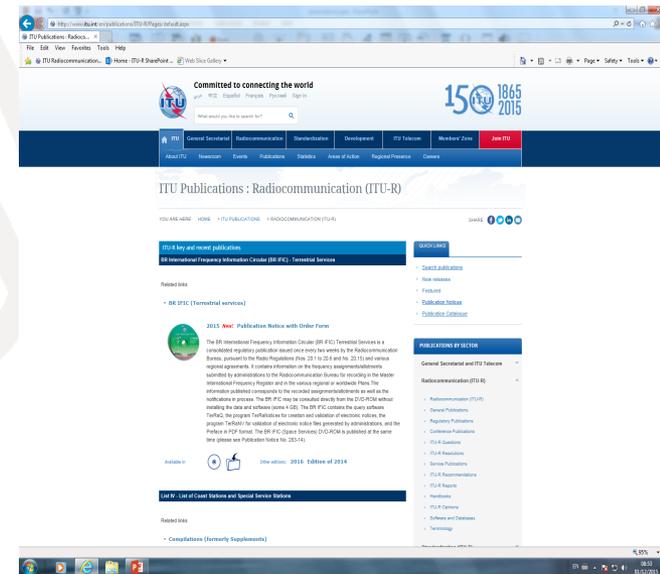
ITUWRC
SHARM EL-SHEIKH 2019
23 November - 22 December
Sharm El-Sheikh, Egypt



BBU-base station's baseband unit, **RRH**- remote radio head, **CPMS**- close proximity mobile systems

ITU-R Study Groups

- **SG 1: Spectrum management** (Wireless Power Transmission, SRD, radiomonitoring, strategies for spectrum utilization, EMF)
- **SG 3: Radiowave propagation** (radio noise recommended levels, propagation methods)
- **SG 4: Satellite services** (efficient GSO use, NGSO constellation, small satellites)
- **SG 5: Terrestrial services** (IMT, sub-orbital flights, unmanned planes, maritime and aviation *e*-navigation)
- **SG 6: Broadcasting services** (UHDTV, IBB)
- **SG 7: Science services** (RA, space weather, leap second, planetary commercial missions)

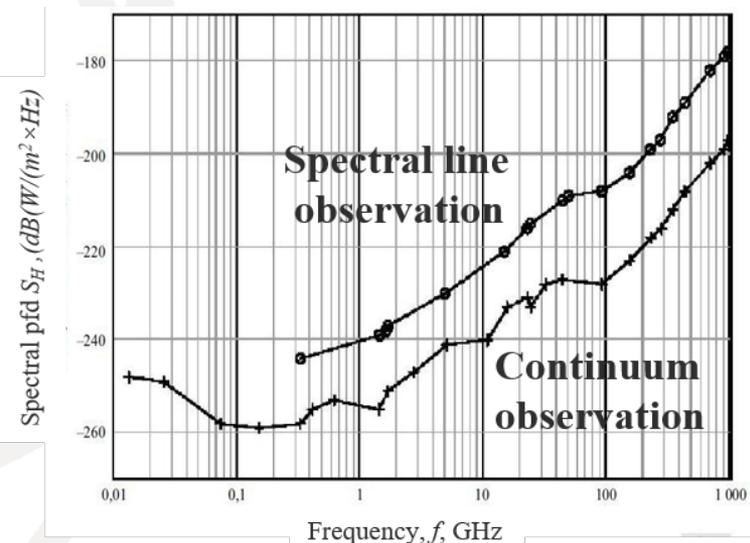


ITU-R Study Groups (RA)

- Handbook on Radioastronomy
- **RA.314 @ RA 1860** - preferred frequency bands
- **RA.769**- protection criteria
- **RA. 1513** - levels of data loss to RA observations and percentage-of-time criteria (2%-single, 5% aggregate)
- **SA.509**- radio astronomy reference antenna radiation pattern
- **RA. 517** - protection in adjacent bands
- **RA. 611** - spurious emissions
- **RA. 1237** - unwanted emission
- **RA. 1031** - shared bands

Continuum observation bands

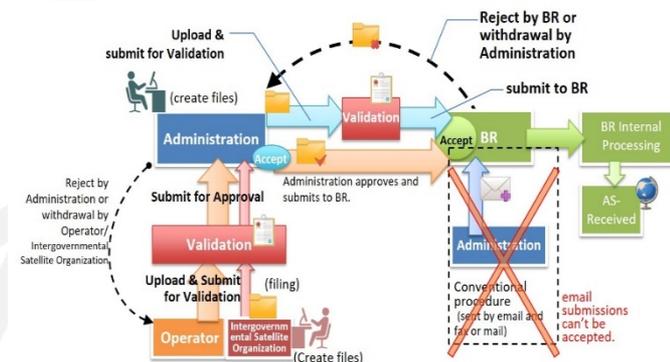
Δf (MHz)	Δf (MHz)	Δf (GHz)	Δf (GHz)
13,36-13,41	406,1-410	10,6-10,7	76-116
25,55-25,67	608-614 ⁽³⁾	15,35-15,4	123-158,5
37,5-38,25	1400-1427	22,21-22,5	164-167
73-74,6 ⁽¹⁾	1660-1670	23,6-24,0	200-231,5
150,05-153 ⁽²⁾	2665-2700	31,3-31,8	241-275
322-328,6	4800-5000	42,5-43,5	



$$\Delta P_H = 0.1 \Delta P \Delta f \quad \text{John D. Kraus (1973)}$$

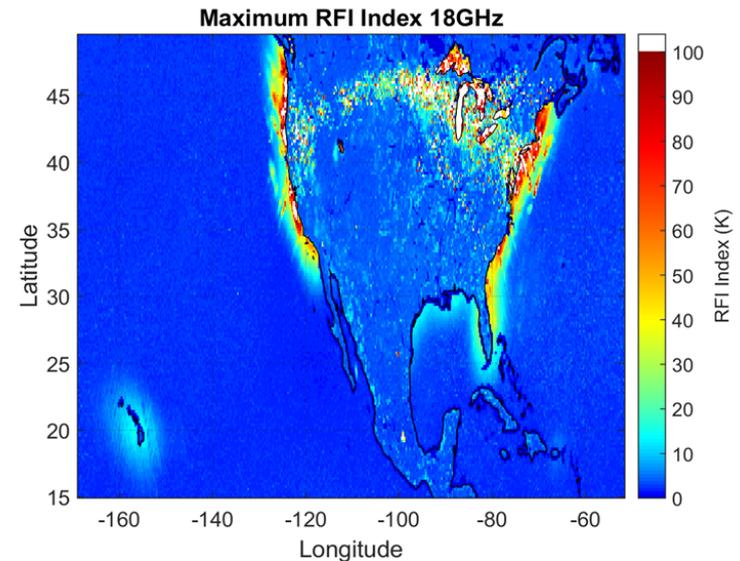
Radiocommunication Bureau

- Processing of electronic filings
- BR software to capture and validate (Report RA.2428-distributed radio astronomy systems)
- Maintaining Master International Frequency Register (space and terrestrial)
- Publication of BR International Frequency Information Circular
- List of RA stations
- International radiomonitoring system
- Assistance in interference resolution

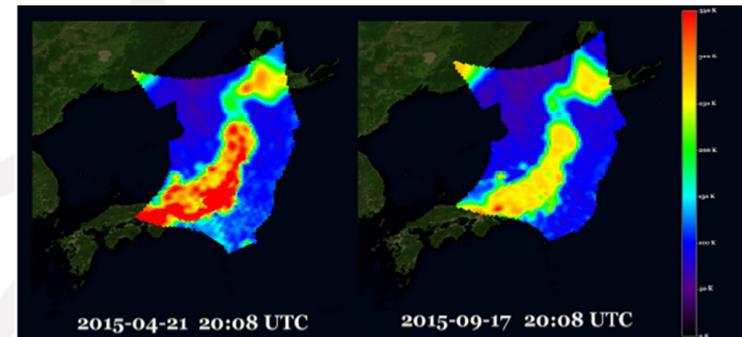


Current challenges

- Booming of spectrum demand and spectrum/orbit scarcity
- Transactional costs of spectrum access
- New interference scenarios
 - NGSO, HAPS, earth station on move
 - TV receivers (1400-1427 MHz)
 - Reflection (18.6-18.8 GHz)
- Non-conformity with RR

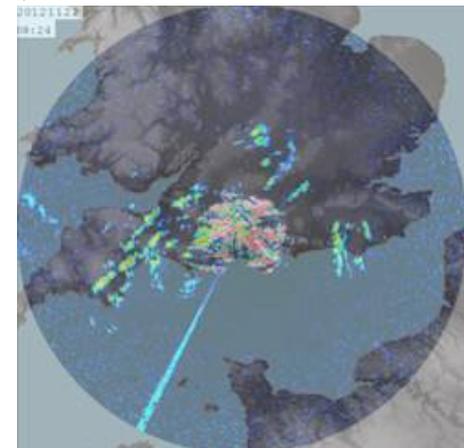
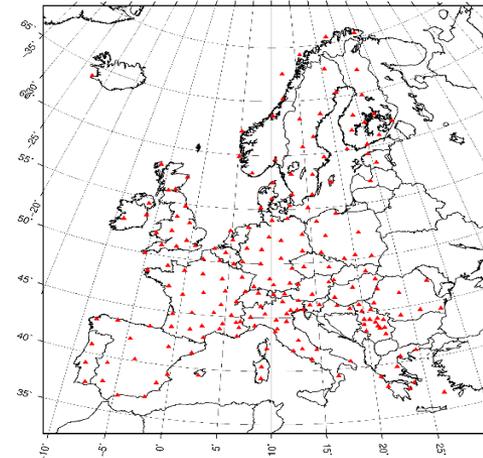


Maximum RFI index 1400-1427 MHz



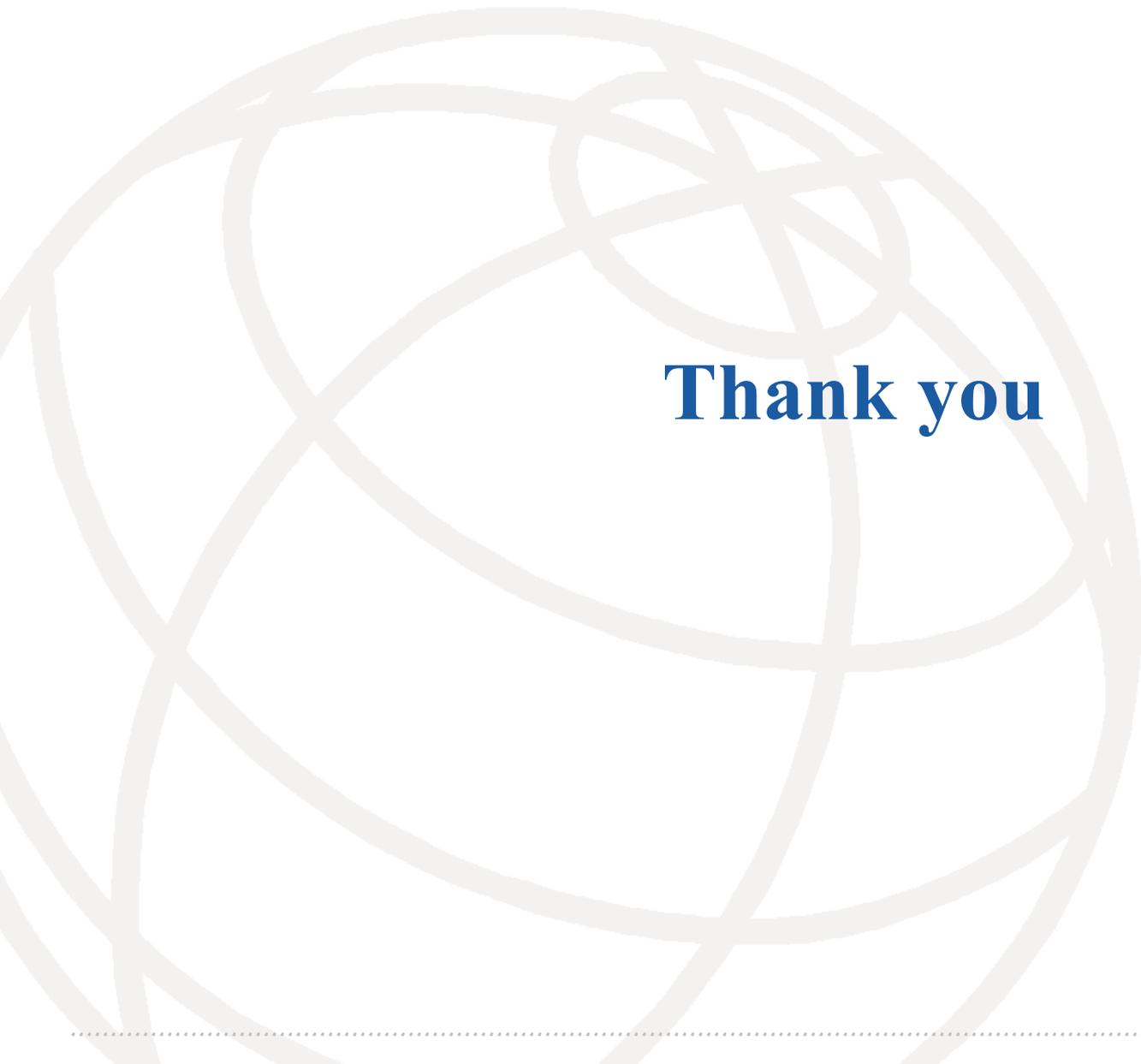
Interference case study (RLAN-meteo radars)

Starting	2006
Current status	180 existing radars only in EC (average CAPEX 1 million Euros per site)
Scale of degradation	110 radars in 21 EU States, up too thousands cases per site, 5600-5650 MHz band
Applications	the conditions of the atmosphere, severe weather detection for navigation, wind and precipitation detection and estimates, detection of aircraft icing conditions
Type approval	RTTE Directive (Self approval)
Market surveillance campaign <i>(ECC REPORT 192)</i>	64 different 5 GHz WAS/WLAN devices 38 samples: DFS function could be directly or indirectly deactivated 3 samples: DFS does not exist



Agenda for the future

- High frequency ranges - THz
- Software defined radio/cognitive radio and UWB, mitigation techniques
- International radiomonitoring and enforcement mechanism
- Improvement of spectrum management system



Thank you