INTERNATIONAL SPECTRUM MANAGEMENT, BASICS AND IMPLICATIONS FOR RADIOASTRONOMY

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ITU: A UN Specialized Agency



The United Nations System

UN PRINCIPAL ORGANS

GENERAL ASSEMBLY

SECURITY COUNCIL

ECONOMIC AND

SOCIAL COUNCIL

SECRETARIAT

INTERNATIONAL COURT OF JUSTICE

TRUSTEESHIP

Subsidiary Organs

- Main Committees
- Disarmament Commission Human Rights Council
- International Law Commission
- Joint Inspection Unit (JIU)
- Standing committees and ad hoc bodies

Funds and Programmes¹

UNDP United Nations Development Programme **UNCDF** United Nations Capital Development

- **UNV** United Nations Volunteers

UNEP⁸ United Nations Environment Programme UNEDA United Nations Population Fund

UN-HABITAT⁸ United Nations Human Settlements Programme

WFP World Food Programme (UN/FAO)

UNICEF United Nations Children's Fund

Research and Training

UNIDIR United Nations Institute for Disarmament Research

UNITAR United Nations Institute for Training and Research

UNSSC United Nations System Staff

UNU United Nations University

Other Entities

ITC International Trade Centre (UN/WTO)

UNCTAD1,8 United Nations Conference on Trade and Development

UNHCR1 Office of the United Nations High Commissioner for Refugees

UNOPS¹ United Nations Office for

UNRWA1 United Nations Relief and Works Agency for Palestine Refugees in the

UN-WOMEN¹ United Nations Entity for Gender Equality and the Empowerment of Wom

Related Organizations

CTBTO PREPARATORY COMMISSION

sive Nuclear-Test-Ban Treaty Organization

IAEA^{1,3} International Atomic Energy Agency

ICC International Criminal Court

IOM¹ International Organization for Migration

ISA International Seabed Authority

ITLOS International Tribunal for the Law

OPCW3 Organization for the Prohibition of Chemical Weapons

WTO1,4 World Trade Organization

Subsidiary Organs

- Counter-Terrorism Committee
- International Residual Mechanism for Criminal Tribunals
 - · Military Staff Committee
- · Peacekeeping operations and political missions
- · Sanctions committees (ad hoc)
- · Standing committees and ad hoc bodies

Peacebuilding Commission

HLPF High-level political forum on sustainable

Functional Commissions

- Crime Prevention and Criminal Justice
- · Narcotic Drugs
- Population and Development · Science and Technology for Development

- · Status of Women
- · United Nations Forum on Forests

EOSG Executive Office of the

DESA Department of Economic and

and Conference Management

DMSPC Department of Management

Strategy, Policy and Compliance

DOS Department of Operational Support

DGC Department of Global

Communications

DGACM Department for General Assembly

Secretary-General

Social Affairs

Regional Commissions⁸

ECA Economic Commission for Africa ECE Economic Commission for Europe

Humanitarian Affairs

OLA Office of Legal Affairs

ODA Office for Disarmament Affairs

OHCHR Office of the United Nations

SRSG/CAAC Office of the Special

SRSG/SVC Office of the Special

on Sexual Violence in Conflict

SRSG/VAC Office of the Special

on Violence Against Children

for Children and Armed Conflict

High Commissioner for Human Rights

OIOS Office of Internal Oversight Services

OSAA Office of the Special Adviser on Africa

Representative of the Secretary-General

Representative of the Secretary-General

Representative of the Secretary-General

ECLAC Economic Commission for Latin America and the Caribbean

Departments and Offices OCHA Office for the Coordination of

- **ESCAP** Economic and Social Commission for Asia and the Pacific
- ESCWA Economic and Social Commission or Western Asia

Other Bodies

- · Committee for Development Policy
- · Committee of Experts on Public Administration
- · Committee on Non-Governmental Organizations
- · Permanent Forum on Indigenous Issues UNAIDS Joint United Nations Programme on

UNGEGN United Nations Group of Experts on Geographical Names

Research and Training

UNICRI United Nations Interregional Crime and Justice Research Institute

UNRISD United Nations Research Institute for Social Development

UNISDR United Nations Office for Disaster Risk Reduction

UNODC1 United Nations Office on Drugs and Crime

UNOG United Nations Office at Geneva

UN-OHRLLS Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States

UNON United Nations Office at Nairob

UNOV United Nations Office at Vienna

UNOP² United Nations Office for Partnerships

Specialized Agencies1,5

FAO Food and Agriculture Organization of the United Nations

ICAO International Civil Aviation

IFAD International Fund for Agricultural Development

II O International Labour Organization

IME International Monetary Fund · International Maritime Organizat

ITU International Telecommunication Union

NESCO United Nations Educational UNIDO United Nations Industrial

Development Organization

UNWTO World Tourism Organization

UPU Universal Postal Union

WHO World Health Organization WIPO World Intellectual Property

WMO World Meteorological Organization

WORLD BANK GROUP?

- · IBRD International Bank for
- Reconstruction and Development IDA International Development
- Association · IFC International Finance Corporation

- 2 UN Office for Partnerships (UNOP) is the UN's focal point vis-a-vis the United Nations Fo
- 3 IAEA and OPCW report to the Security Council and the General Assembly (GA

- 6 The Trusteeship Council suspended operation on 1 November 1994, as on 1 October 1994 Palau, the la United Nations Trust Territory, became independent.

- 9 The Secretariat also includes the following offices: The Ethics Office, Unit Mediation Services, and the Office of Administration of Justice.

International Telecommunication



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)

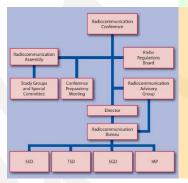
Establish and update international regulations governing use of the spectrum- Radio Regulations



Study Groups (SG)

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

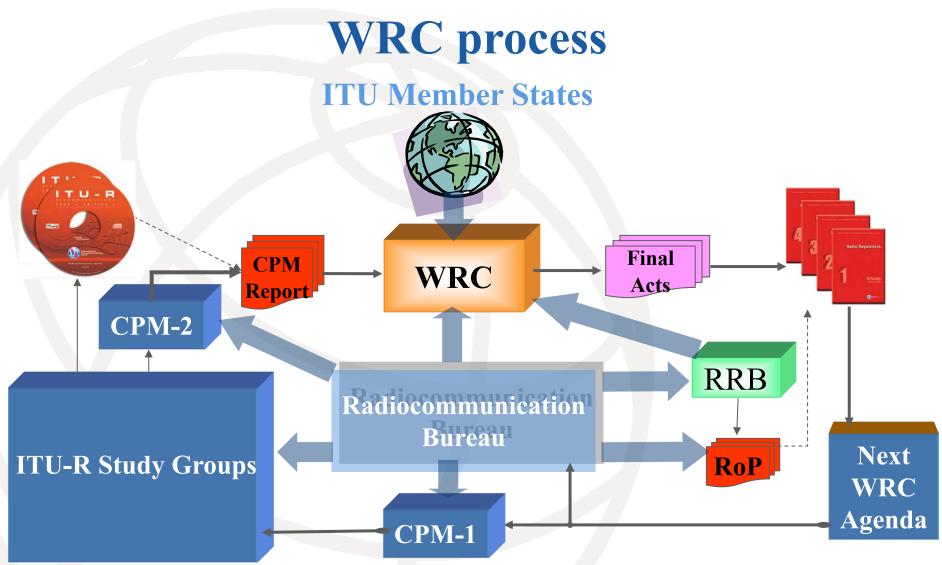
Recommendations, Reports, Handbooks



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**







Radio Regulations

Concept:

- Frequency block allocations intended for use by <u>radio services</u> (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-SA	ATELLITE (Earth-to	o-space) 5.561B				
	MOBILE RADIO ASTRONOMY 5.149						

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

	1718.8-1722.2 MHz, 2655-		129.23-129.49 GHz, 130-
	2690 MHz, 3260-		134 GHz, 136-148.5 GHz,
	3267 MHz, 3332-3339		131.3-130.3 GHZ, 100.37-
	MHz, 3345.8-3352.5 MHz,		100.55 GHZ, 171.11
153 MHz in Region 1, 322-	4825-4835 MHz, 4950-	and 3, 36.43-36.5 GHz,	171.45 GHz, 172.31-
328.6 MHz, 406.1-	4990 MHz, 4990-	42.5-43.5 GHz, 48.94-	172.65 GHz, 173.52-
410 MHz, 608-614 MHz in	5000 MHz, 6650-	49.04 GHz, 76-86 GHz, 92-	173.85 GHz, 195.75-
Regions 1 and 3, 1330-	6675.2 MHz, 10.6-	94 GHz, 94.1-100 GHz,	196.15 GHz, 209-
1400 MHz, 1610.6-	10.68 GHz, 14.47-	102-109.5 GHz, 111.8-	226 GHz, 241-250 GHz,
1 613.8 MHz, 1 660-	14.5 GHz, 22.01-	114.25 GHz, 128.33-	
1670 MHz	22.21 GHz,	128.59 GHz	

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 pfd 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

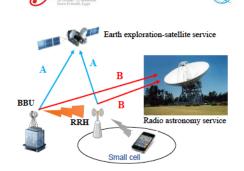
	Space service Found	Radio astronomy band	Single dish, continuum observations		Single dish, spectral line observations		VLBI		Condition of application: the API is
Space service			epfd ⁽²⁾	Reference bandwidth	epfd ⁽²⁾	Reference bandwidth	epfd ⁽²⁾	Reference bandwidth	received by the Bureau following the
	(MHz)	(MHz)	$(dB(W/m^2))$	(MHz)	(dB(W/m ²))	(kHz)	(dB(W/m ²))	(kHz)	entry into force of the
									Final Acts of:
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



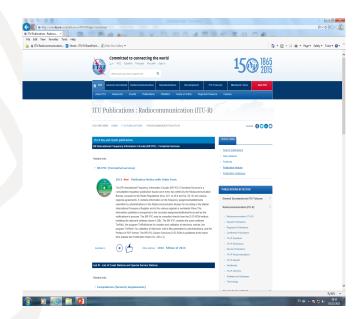


BBU-base station's baseband unit, RRH- remote radio head, CPMS- close proximity mobile systems



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)



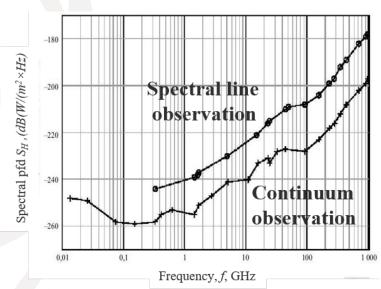


ITU-R Study Groups (RA)

- 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 (ΜΓц)	Δf (ΜΓц)	Δf (ΓΓц)	Δf (ΓΓц)
	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
١	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	



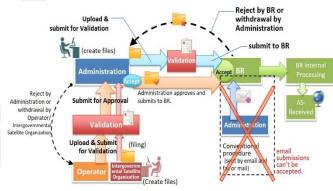
 $\Delta P_H = 0.1 \Delta P \Delta f$ John D. Kraus (1973)



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

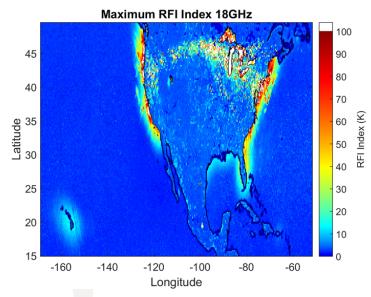




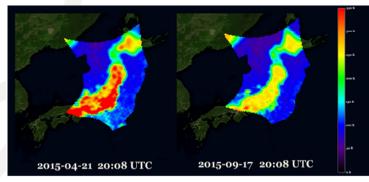


Current challenges

- 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)
 - o 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 110 radars in 21 EU States, up too thousands

degradation 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

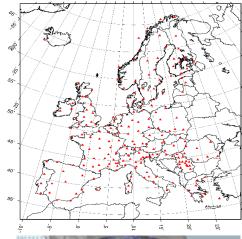
RTTE Directive (Self approval) Type approval

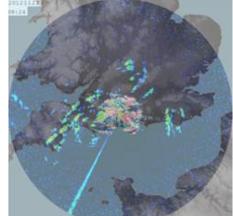
Market surveillance 64 different 5 GHz WAS/WLAN devices

campaign 38 samples: DFS function could be directly or (ECC REPORT 192)

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