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Managing Spectrum-Orbit Resources to ensure the success of your Space Mission

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Topics:

1. ITU-R and the Space Sector

2. Regulatory Mechanisms to ensure co-existence among Space and other Systems sharing the RF Spectrum

3. Current RFI situation reported to ITU

4. The case of EESS (passive) in 1.4 GHz

5. Summary and Key Messages

ITU-R and Spectrum Management Actors

193 MEMBER STATES

299 PRIVATE SECTOR ORGANIZATIONS

166 ACADEMIA MEMBERS

- ITU-R Study Groups
- Conference Preparatory Meeting (CPM)
- Radiocommunications Advisory Group (RAG)

- World Radiocommunications Conference (WRC)
- Radiocommunications Assembly (RA)
- Radio Regulations Board

- Radiocommunications Bureau (BR)
- Space and Terrestrial Departments execute RR and contributes to the work of WRC, RA, CPM, RRB, SGs, RAG and capacity building

Main Strategic Goal → To ensure Interference-Free Operation

Why ? → **To Maximize Quality and Availability of Service**

→ **To Prevent loss of investment, customers and revenue by minimizing unusable satellite capacity due to interference**

How ? → **International Regulations (CS, CV, RR)**

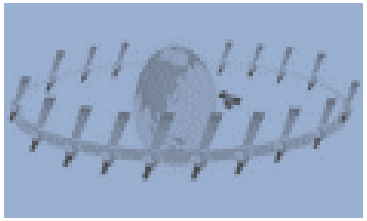
→ **Global Standards & Guidelines (mobility, Economy of Scales)**

→ **Assistance to administrations**

ITU and Space Services in Numbers

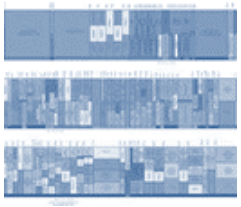
193 Member States

60 years of Space Regulation

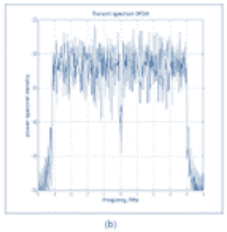


72 Members States with access to Space Resources

1900 Satellite Networks Operating



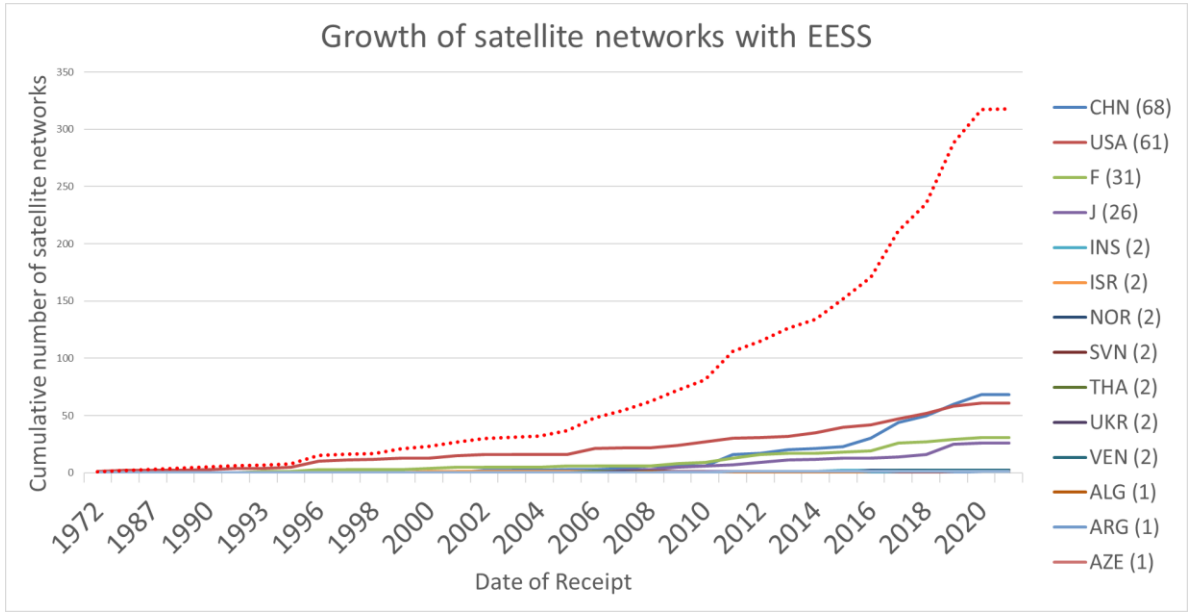
6 THz of Spectrum Coordinated and Recorded

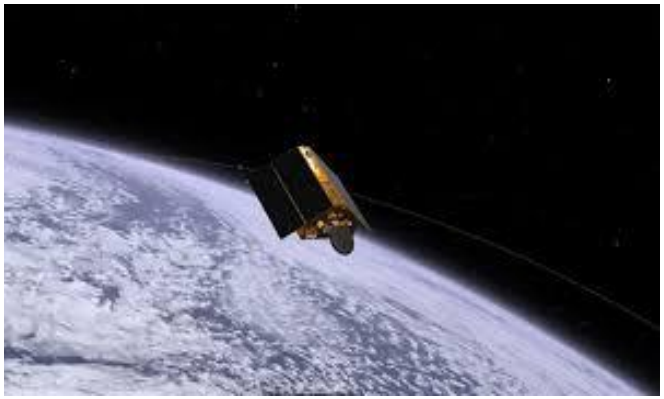


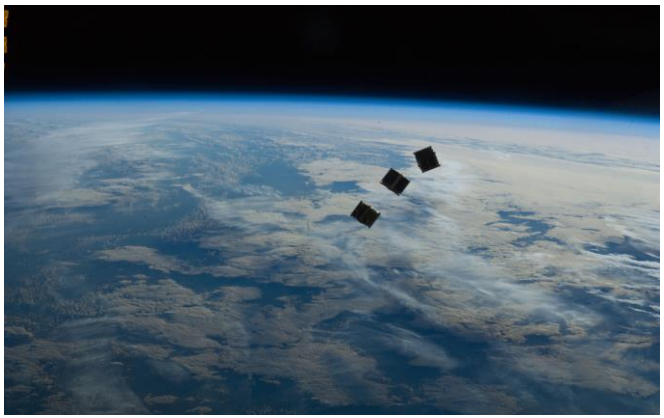
99.94% Spectrum Free of Harmful Interference

< 0.1 % Interference Variation per year

Evolution of NGSO Satellite Networks in the EESS Notified to ITU







- Increasing number of Space Actors and diversity of Space Technologies sharing the same RF spectrum

- Over 300 satellite networks have been deployed and notified by 25 Administrations.

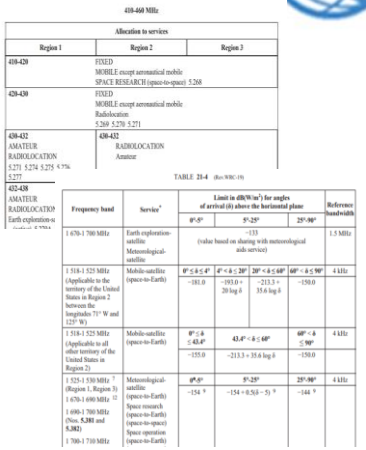
How ITU is ensuring spectrum reliability ?

- **Interference Prevention:** ITU-R Study Groups → RadioAssembly → World RadioConference → BR and Administrations apply Radio Regs (Coordination and Notification Procedures)
- **Correction:** Art 15, No.13.2 of RR → Radio Regulations Board
- **International Monitoring System**
- **SIRRS** online application for Interference Reporting and to request assistance from the Bureau (https://www.itu.int/en/ITU-R/space/SIRRS/Pages/default.aspx)
- **Informative Fora** to raise awareness of the impact of the interference and the need of cooperation to resolve it, presenting and discussing technical regulatory solutions. (e.g.: 22nd ISRMM)
- **ITU-R Recommendations, Reports and Handbooks**

Regulatory Mechanisms to control the level of Interference

Frequency Allocation

- Article 5
- Frequency separation depending on space service and geographical region



410-460 MHz

Allocation to services		
Region 1	Region 2	Region 3
410-420	FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-space) 5.268	
420-430	FIXED MOBILE except aeronautical mobile Radiolocation 5.269 5.270 5.271	
430-432 AMATEUR RADIOLOCATION 5.271 5.274 5.275 5.276 5.277	430-432 RADIOLOCATION Amateur	
432-438 AMATEUR RADIOLOCATION Earth exploration-s		

TABLE 21-4 (Rev.WRC-19)

Frequency band	Service*	Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane			Reference bandwidth
		0°-5°	5°-25°	25°-90°	
1 670-1 700 MHz	Earth exploration-satellite Meteorological-satellite	−133 (value based on sharing with meteorological aids service)			1.5 MHz
1 518-1 525 MHz (Applicable to the territory of the United States in Region 2 between the longitudes 71° W and 125° W)	Mobile-satellite (space-to-Earth)	0° ≤ δ ≤ 4° −181.0	4° < δ ≤ 20° −193.0 + 20 log δ	20° < δ ≤ 60° −213.3 + 35.6 log δ	60° < δ ≤ 90° −150.0	4 kHz
1 518-1 525 MHz (Applicable to all other territory of the United States in Region 2)	Mobile-satellite (space-to-Earth)	0° ≤ δ ≤ 43.4° −155.0	43.4° < δ ≤ 60° −213.3 + 35.6 log δ	60° < δ ≤ 90° −150.0	4 kHz
1 525-1 530 MHz 7 (Region 1, Region 3) 1 670-1 690 MHz 12 1 690-1 700 MHz (Nos. 5.281 and 5.382) 1 700-1 710 MHz	Meteorological-satellite (space-to-Earth) Space research (space-to-Earth) (space-to-space) Space operation (space-to-Earth)	0°-5° −154 9	5°-25° −154 + 0.5(δ − 5) 9	25°-90° −144 9	4 kHz

Power Limits

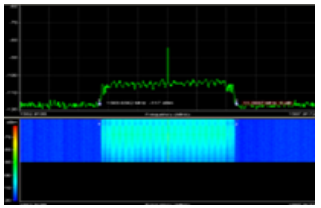
- Articles 21 and 22
- Power Flux Density and EIRP Limits to protect Terrestrial and Space Services
- EPFD limits to protect GSO from NGSO systems

Coordination

- Article 9
- Coordination between Administrations/Operators to reach mutual agreed levels

Recording

- Article 11
- Recording in the Master International Frequency Registry to obtain International Recognition and Protection



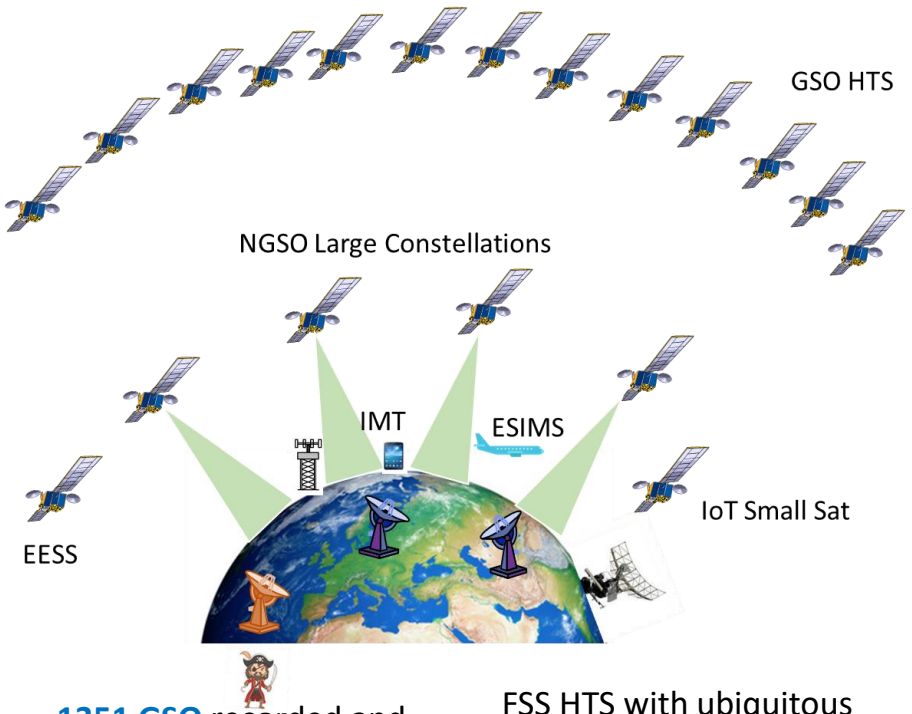
Monitoring

- Article 16
- ITU International Monitoring System to be used in case of harmful interference

Harmful Interference Reported to ITU

- Earth Exploration Satellite Service (passive) in 1400-1427 MHz band
- Mobile-Satellite-Service in the frequency bands 1 626.5-1 660.5 MHz, 1 980-2 010 MHz and 2 670-2 690 MHz
- Radio Astronomy Service in the frequency band 1610.6-1613.8 MHz
- Radio Navigation Satellite Service (RNSS) in the frequency bands 1575.42 ±15.345 MHz (L1) and 1227.60 ± 11 MHz (L2)
- Space Operation in 2 GHz not formally reported but increasingly being interfered

RFI environment



1351 GSO recorded and operating
615 NGSO recorded and operating

+ in coordination

+ emerging small sat (IoT, EESS)

+ Terrestrial

FSS HTS with ubiquitous deployments

Mobility → IMT , MSS and ESIMS

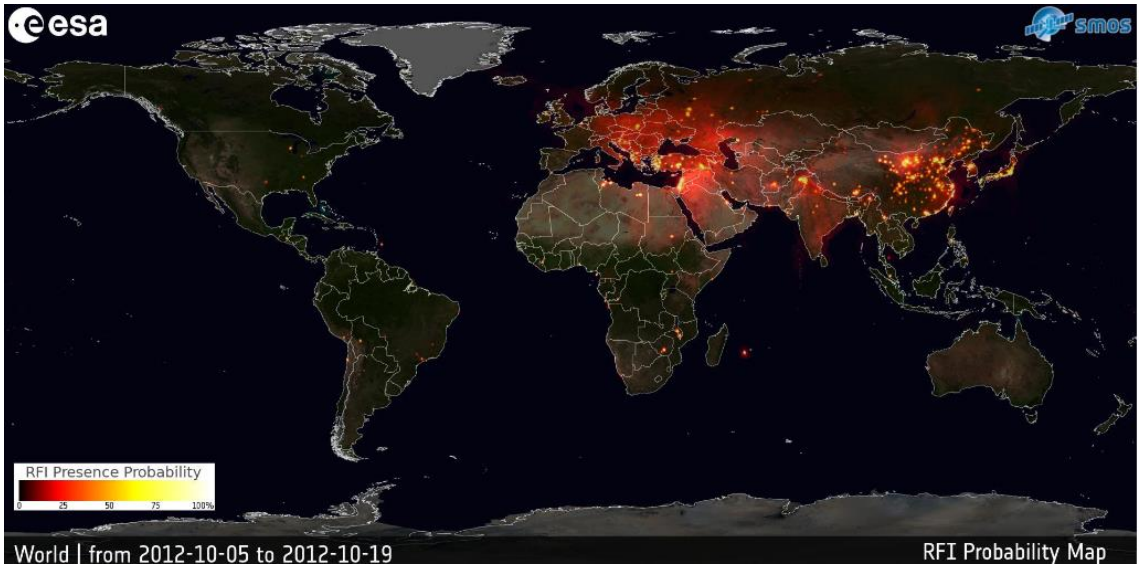
Scientific Services (EESS, RAS)

RNSS used intensively

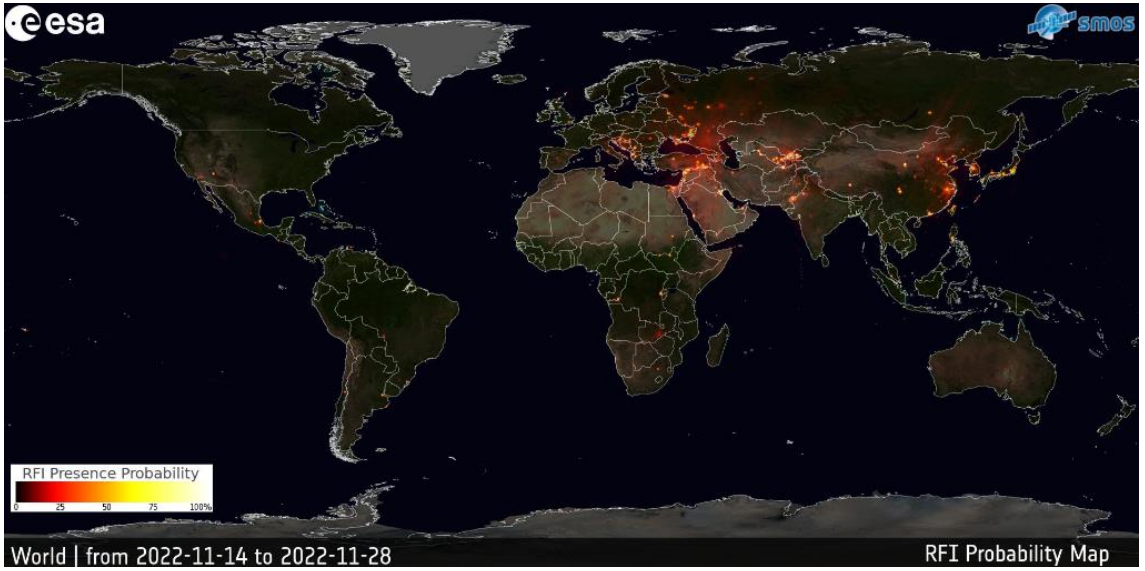
More…

Earth Exploration Satellite Service (passive) in 1400-1427 MHz

October 2012



November 2022



Earth Exploration Satellite Service (passive)

- The frequency bands used for passive sensing are determined by physics and the needed data cannot provided by other frequency bands.
- Passive services, especially those in the passive only bands, are particularly susceptible to interference.

Impact of Interference:

Lost or Corrupted Data due to interference that is undetected produces flawed conclusions with potentially serious consequences.

Typical Sources of Interference:

- Excessive unwanted emissions from the active services in adjacent bands, typically caused by malfunctioning of stations in the radiolocation service.
- Use of unauthorized devices operating within the passive band. (e.g., CCTV cameras or other short-range devices using spread spectrum techniques).
- Intermediate Frequency (IF) Radiation from BSS receivers due to poor shielding of cables and connectors

Earth Exploration Satellite Service (passive)

Interference Mitigation (regulatory and technical)

- Regular monitoring and consequent reporting to the Administration having jurisdiction over the source(s) of interference and ITU. (Art No.15, No.13.2, Rec.2106)

- Strategic communication campaign to raise awareness in the international community about the importance of protecting the passive bands and the use of only authorized equipment and operation of stations in conformity with international regulations.

- Spacecraft onboard and on the ground signal processing: detecting and flagging interference pulses to be filtered .

- To refine the spacecraft capabilities to geolocate sources of RFI to a small area.

WRC-23 Space Science Issues

- 1.12 - possible new secondary allocation to the EESS (active) for spaceborne radar sounders around 45 MHz

- 1.13 - possible upgrade to Primary allocation of 14.8-15.35 GHz to the space research
  - to identify relevant scenarios for compatibility studies
  - to determine the technical and regulatory conditions

- 1.14 -possible adjustments of existing allocations or possible new primary allocations to EESS (passive) in the frequency range 231.5-252 GHz, to ensure alignment with more up-to-date remote-sensing observation requirements
  - Frequency range to be used for ice-cloud analysis
  - To review existing primary allocations EESS (passive) in this range to analyze if they are aligned with the observation requirements of passive microwave sensors, and to study possible adjustments in allocations
  - To study the impact that any change may have on other primary services

Key Messages:

- ITU Regulatory Framework is the International Mechanism to Manage Spectrum-Orbit Resources in order to ensure the success of your space mission while protecting incumbent systems.

- Interference reporting to ITU is key to assess the actual situation and prevent re-occurrence.

- Cooperation between Administrations is essential

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