ORBIT/SPECTRUM INTERNATIONAL REGULATORY FRAMEWORK
Challenges in the 21st century

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Global Space Industry in 2015

$335.3 billion

Source: SSIR 2016 Tauri Group
Global Impact and Usage

- Satellite Radio
- Corporate networks
- Maritime communication
- National Security & Defense
- E-learning
- Agriculture
- Cellular Backhaul
- Aviation Security
- SNG
- Internet
- Telemedicine
- Global Flight Tracking
- VSAT
- Disaster Relief
- Satnav
- DTH
1957 .. 1965
Development of communication satellites

**SPUTNIK 1 (Спутник-1)**
First artificial Earth satellite launched on 4th October 1957 with external radio antennas to broadcast radio pulses

**TELSTAR**
First television pictures, telephone calls, and fax images, and provided the first live transatlantic television feed

2016
## FREQUENCY SPECTRUM

Limited natural resource

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.467 GHz to 1.492 GHz</td>
<td>Satellite Audio Broadcasting to fixed and mobile units</td>
</tr>
<tr>
<td>1.518 GHz to 1.675 GHz</td>
<td>Civilian Mobile-Satellite Services (two-way)</td>
</tr>
<tr>
<td>1.97 GHz to 2.69 GHz</td>
<td>Satellite television &amp; radio broadcasting to mobiles + two-way mobile services</td>
</tr>
<tr>
<td>3.4 GHz to 7.025 GHz</td>
<td>Fixed-Satellite television, &amp; data services (including broadcasting)</td>
</tr>
<tr>
<td>10.7 GHz to 14.5 GHz</td>
<td>Fixed-Satellite television, &amp; data services (including broadcasting)</td>
</tr>
<tr>
<td>17.3 GHz to 30 GHz</td>
<td>Fixed-Satellite television &amp; data services (including broadcasting)</td>
</tr>
</tbody>
</table>

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WHERE DO SATELLITES OPERATE ...

- **LEO**
  - 400 - 2,000 km

- **MEO**
  - 8,000 - 20,000 km

- **GEO**
  - 35,786 km above equator

- **Molniya**
  - Highly Elliptical Orbit – 40,000 km in apogee

- **International Space Station**

- **Sub-orbital**

- **GNSS**

**Orbits**:
- **Low-Earth Orbit**
- **Medium-Earth Orbit**
- **Geostationary Orbit**
- **Highly-Elliptical Orbit**
GEOSTATIONARY SATELLITE ORBIT RESOURCE

265 000 km belt around Earth
36 000 km above Equator
.. YET CONGESTED

Source: TLE data dated 10.08.2015
SATCAT Growth

40,000 objects and growing

Date: 2016 Sep 01

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Space debris

- Inter-Agency Debris Coordination Committee (IADC) Statement on Large Constellations of Satellites in Low Earth Orbit

- Whenever possible spacecraft or orbital stages that are terminating their operational phases in orbits that pass through the LEO region, or have the potential to interfere with the LEO region, should be de-orbited (direct re-entry is preferred) or where appropriate maneuvered into an orbit with a reduced lifetime.
1963
Extraordinary Administrative Radio Conference to allocate frequency bands for space radiocommunication purposes
TODAY
More than 2000 pages of Radio Regulations
The Sustainable Development Goals
The Sustainable Development Goals

• In 2015, the United Nations adopted 17 Sustainable Development Goals (SDGs) as part of the Agenda 2030 to achieve a better future for all.

• These goals apply to all countries, whether developing or developed.

• Radiocommunications, including satellites have a key supporting role in achieving each and everyone of these 17 SDGs.
LEGAL FRAMEWORK FOR SPECTRUM ACCESS/USE
INTERNATIONAL TREATIES

1967 “Outer Space Treaty”
Treaty on Principles Governing the Activities of States in Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies

1968 “Rescue Agreement”
Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space

1972 “Liability Convention”
Convention on International Liability for Damage Caused by Space Objects

1975 “Registration Convention”
Convention on Registration of Objects Launched into Outer Space

1979 “Moon Treaty”
Agreement Governing the Activities of States on the Moon and Other Celestial Bodies

ITU Constitution/Convention of 1982 listed under other agreements
ITU is recognized as the specialized agency responsible for telecommunication issues
UN OUTER SPACE TREATY (1967)

- Outer space free for exploitation and use by all states in conformity with international regulations
- States retain jurisdiction and control over objects launched into outer space
- States shall be liable for damage caused by their space objects
ITU RECOGNIZED AS SPECIALIZED AGENCY RESPONSIBLE FOR

• Principles of use of orbit/spectrum
• Allocation of frequency bands
• Procedures, Plans, operational measures
• Instruments (Constitution, Convention, Radio Regulations, Rules of Procedures, Recommendations)
Role of ITU in radiocommunications

- Developing and updating international regulations on the use of orbit/spectrum
- Applying these regulations
- Developing and adopting standards and best practices on the use of orbit/spectrum
- Disseminating information on these regulations, standards and best practices
ITU CONSTITUTION (Art.1)

ITU shall effect allocation of bands of the radio-frequency spectrum, the allotment of radio frequencies and the registration of radiofrequency assignments and, for space services, of any associated orbital position in the geostationary-satellite orbit or of any associated characteristics of satellites in other orbits, in order to avoid harmful interference between radio stations of different countries.
ITU Constitution
(Art.44)

Radio frequencies & satellite orbits are limited natural resources

Rational, Efficient, Economical Use

Equitable Access
RADIO REGULATIONS

- Intergovernmental Treaty governing the use of spectrum/orbit resources by administrations
- Define the rights and obligations of Member States in respect of the use of these resources
- Recording of a frequency assignment in the Master Register (MIFR) provides international recognition

RADIO REGULATIONS

- Updated every 3-4 years by World Radiocommunication Conference (WRC)
- Complemented by Rules of Procedure, revised by Radio Regulations Board (RRB)
1. Harmonize global spectrum to create economies of scale, roaming and interoperability

2. Create regulatory certainty for a multi-trillion dollars industry playing an increasingly important role in the development of our societies

3. Creating certainty requires consensus: time, efforts and patience
**UN**

**Outer Space instruments on space objects**

- Free “exploration & use” under international law
- States
  - Responsibility & licensing
  - Jurisdiction & control
- States
  - Registration OOSA
- States
  - Liable for damage

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**ITU**

**Instruments on radio frequencies**

- Equitable access & rational use of spectrum under international law
- States
  - Must license trans. radio stations
  - Shall not cause harmful interf.
- States
  - API…CR/C…MIFR
- No liability clause
REGULATION OF RADIO SPECTRUM AND SATELLITE ORBIT IN PRACTICE
<table>
<thead>
<tr>
<th>Band</th>
<th>Frequency Range</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-band</td>
<td>1.0-2.0 GHz</td>
<td>Mobile Satellite Service (MSS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radionavigation Satellite Service</td>
</tr>
<tr>
<td>S-band</td>
<td>2-4 GHz</td>
<td>Radars, MSS,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broadcasting Satellite</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space Research</td>
</tr>
<tr>
<td>C-band</td>
<td>3.4-7 GHz</td>
<td>Fixed Satellite Service (FSS), VSATs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direct-To-Home (DTH)</td>
</tr>
<tr>
<td>X-band</td>
<td>7-10 GHz</td>
<td>Radars, Satellite Imaging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space Research</td>
</tr>
<tr>
<td>Ku-band</td>
<td>10-15 GHz</td>
<td>FSS, VSAT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broadcasting Satellite, MSS</td>
</tr>
<tr>
<td>Ka-band</td>
<td>17.7 - 21.2,</td>
<td>FSS “broadband”, inter-satellite links,</td>
</tr>
<tr>
<td></td>
<td>27.5 - 31 GHz</td>
<td>MSS</td>
</tr>
</tbody>
</table>
Rain fade

- C-Band: Narrow, Large
- Ku-band: Narrow, Small
- Ka-band: Wide, Large

Bandwidth

- C-Band: Narrow
- Ku-band: Wide
- Ka-band: Narrow

Earth station antenna diameter

- C-Band: Large
- Ku-band: Small
- Ka-band: Large

Large Beams

Spot beams
INTERNATIONAL REGULATIONS

- Equitable access
- Rational, efficient, economical use
- Operation without harmful interference

SATELLITES

- Wide coverage
- Cross national borders
- Facilitate connectivity

ORBIT/SPECTRUM

- Limited
- Global/Natural/Public resource
**PROPAGATION OF RADIO**

- Laws of physics
  - Radio waves do not stop at national borders

**INTERFERENCE**

- Possible between radio stations of different countries
  - High risk in Space Radiocommunications

**RADIO REGULATIONS**

- One of its main purposes:
  - Interference-free operation of Radiocommunications
ALLOCATION
Frequency separation of stations of different services

COORDINATION
between Administrations to ensure interference-free operations conditions

POWER LIMITS
PFD to protect TERR services / EIRP to protect SPACE services / EPFD to protect GSO from Non-GSO

RECORDING
In the Master International Frequency Register (MIFR)
International recognition

MONITORING
International monitoring system
COMMON GOAL

Access to spectrum/orbit resources
Ensure rational, equitable, efficient, economical use
Interference-free operation

Source: Articles 1, 44, 45 & Res 71 of ITU Constitution & Convention
Photo credit: ESA (for educational purposes)
1. COORDINATION APPROACH

- First come, first served
- Rational, Efficient, Economical Use
- Rights acquired through coordination with administrations concerning actual usage
- Efficient spectrum/orbit management
- Dense/irregular orbital distribution of space stations

2. PLANNING APPROACH

- Plan for future use
- Equitable Access
- Congestion of GSO
- Frequency/orbital position plans
- For future use by all countries
- Predetermined orbital position & frequency spectrum

International Recognition Registration in MIFR
Radio Regulations

Articles

Edition of 2016

NON-PLANNED PROCEDURES

Articles 9 and 11
Non-planned Procedures (GSO & non-GSO) subject to coordination (Articles 9 & 11)
Non-planned Procedures (GSO&non-GSO) subject to coordination (Articles 9 & 11)

Coordination (C) -> Notification (N) through API (A)

7 years
Non-planned Procedures (GSO&non-GSO) subject to coordination (Articles 9 & 11)

C
Coordination

A
API

Interference free negotiations

Comment
≤ CR/C + 4 months

N
Notification

≤ CR/C + 7 years

≥ BIU – 3 years

BIU & DD
≤ API + 7 years

Source: Nos. 9.1, 9.5D, 9.52C, 9.43, 11.44.1, 11.25, 11.44 of Radio Regulations
APPENDIX 30 (REV. WRC-12)*
Provisions for all services and associated Plans and Lists for the broadcasting-satellite service in the frequency bands 11.7-12.3 GHz (in Region 3), 11.7-12.5 GHz (in Region 1) and 12.2-12.7 GHz (in Region 2). 

APPENDIX 30A (REV. WRC-12)*
Provisions and associated Plans and Lists for feeder links for the broadcasting-satellite service (11.7-12.7 GHz in Region 1, 12.2-12.7 GHz in Region 2, and 11.7-12.2 GHz in Region 3) in the frequency bands 11.7-12.2 GHz and 17.5-17.8 GHz in Regions 1 and 3.

General definitions:

Table of contents:

APPENDIX 30B (REV. WRC-12)*
Provisions and associated Plans and Lists for the fixed-satellite service in the frequency bands 14.5-14.9 GHz and 17.1-17.5 GHz in Regions 1 and 3.

Appendix 30, 30A, 30B
BSS Planned Procedures (GSO) (Appendix 30/30A)

Art. 4
Region 2

Plan

Art. 4
Regions 1&3

List

Plan

Art. 5

MIFR

Art. 5

4.1.26/4.1.27

MIFR
GSO vs NGSO SATELLITE NETWORKS

More than 90% GSO satellite networks

Source: Satellite networks in coordination stage, SRS database of 21.02.2014
INTERNATIONAL REGULATIONS

Lengthy & complex procedures
Lack of incentive to review underused spectrum/orbital positions

ORBIT/SPECTRUM

Scarcity due to thousands of filings

CONSEQUENCE

Difficulty to coordinate
Multiple filings
Operation without coordination
Fait-accompli approach
Fictitious recorded assignments
ITU Constitution
(Art.44)

Radio frequencies & satellite orbits are limited natural resources

Rational, Efficient, Economical Use

Equitable Access

Opportunity to resolve interference before operation

Prevents loss of investment, customers & revenue by minimizing unusable capacity due to interference
PLENIPOTENTIARY CONFERENCE 2014

RESOLUTION 86 (REV. MARRAKESH, 2002)
NOC Advance publication, coordination, notification and recording procedures for frequency assignments pertaining to satellite networks

RESOLUTION 186 (BUSAN, 2014)
Strengthening the role of ITU with regard to transparency and confidence-building measures in outer space activities
RESOLUTION 186
(BUSAN, 2014)

invites ITU Council
to consider and review any proposed cooperation agreements on the use of satellite monitoring facilities

instructs BR Director
to promote access to information, upon request by administrations concerned, related to satellite-monitoring facilities, in order to address cases of harmful interference in accordance with Article 15 of the Radio Regulations, through cooperation agreements

to continue taking action to maintain a database on cases of harmful interference, reported in accordance with relevant provisions of the Radio Regulations and in consultation with Member States concerned

invites Member States and Sector Members
to participate in the activities related to the implementation of this resolution
KEY POINTS

- Natural limited resources to be shared and regulated: orbit & radiofrequency spectrum
- Legal framework: UN Outer Space Treaty, ITU CS/CV, RR, RoP, Recs
- ITU CS/Arts. 44 & 45:
  - To avoid harmful interference
  - To ensure efficient, rational, equitable economical use
- Radio Regulations: Allocation, registration, interference free operation
- Radio Regulations constantly being improved
FREE ONLINE ACCESS

- The ITU Constitution

- World Radiocommunication Conference (WRC)

- ITU-Radio Regulations @ 2015

- ITU-R Recommendations
  - http://www.itu.int/publ/R-REC/en

- Preface to the BR IFIC (Space services)
“With a concerted effort, we can reduce, and to the extent possible remove, all obstacles impeding the development and bringing into operation of new satellite networks”

“Think carefully about how we can continue to use and improve satellite access to help connect the unconnected, and make the world a better and a fairer place for all”
MERCI

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