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
- Earth Observation
- National Security & Defense
- E-learning
- Agriculture
- Cellular Backhaul
- Telemedicine
- Aviation Security
- SNG
- Internet
- Disaster Relief
- Global Flight Tracking
- VSAT
- DTH
- Satnav
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**
Satellite Audio Broadcasting to fixed and mobile units
Civilian Mobile-Satellite Services (two-way)
Satellite television & radio broadcasting to mobiles + two-way mobile services
Fixed-Satellite television, & data services (including broadcasting)
Fixed-Satellite television & data services (including broadcasting)
Fixed-Satellite television & data services (including broadcasting)
WHERE DO SATELLITES OPERATE ...

- **MEO** 8,000 - 20,000 km
- **LEO** 400 - 2,000 km
- **GEO** 35,786 km above equator
- **Molniya** Highly Elliptical Orbit – 40,000 km in apogee
- **GNSS**
- **International Space Station**
- **Sub-orbital**
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: 2015 Sep 08
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.

- [http://www.iadc-online.org/](http://www.iadc-online.org/)
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

• 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

**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
# Satellite Frequencies and Services

<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, 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>
### C-Band
- Bandwidth: Narrow
- Rain fade: Less
- Earth station antenna diameter: Large
- Large Beams

### Ku-band
- Bandwidth: Wide
- Rain fade: Severe
- Earth station antenna diameter: Small
- Spot beams

### Ka-band
INTERNATIONAL REGULATIONS

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

SATELLITES

Wide coverage
Cross national borders
Facilitate connectivity

ORBITI SPECTRUM

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

- 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
CONTROL OF INTERFERENCE

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
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)

C
Coordination

N
Notification

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

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

PLANNED PROCEDURES

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

- **Plan**
  - Art. 4
  - Region 2

- **List**
  - Art. 4
  - Regions 1&3

- **Plan**
  - Art. 5

- **MIFR**
  - Art. 5

- **MIFR**
  - 4.1.26 / 4.1.27
FSS Planned Procedures (GSO) (Appendix 30B)

Art. 7
Plan
Allotment

Art. 6
Additional Systems

Art. 8
List
Assignments

MIFR
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

CONSEQUENCE

Difficulty to coordinate
Multiple filings
Operation without coordination
Fait-accompli approach
Fictitious recorded assignments

ORBITAL SPECTRUM

Scarcity due to thousands of filings
**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”
THANK YOU FOR YOUR ATTENTION