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

Yvon HENRI
Chief of Space Services Department
SPUTNIK 1 (Спутник-1)
First artificial Earth satellite launched on 4th October 1957 with external radio antennas to broadcast radio pulses

1957 .. 1965
Development of communication satellites

TELSTAR
First television pictures, telephone calls, and fax images, and provided the first live transatlantic television feed
FREQUENCY SPECTRUM
Limited natural resource
WHERE DO SATELLITES OPERATE …

- **LEO**
  - 400 - 2,000 km
  - International Space Station

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

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

- **HIGHLY-ELLIPTICAL ORBIT**

- **LOW- EARTH ORBIT**

- **MEDIUM-EARTH ORBIT**

- **GEOSTATIONARY ORBIT**

- **Molniya**

- **Sub-orbital**
40,000 objects and growing
GEOSTATIONARY SATELLITE ORBIT RESOURCE

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

Source: TLE data dated 10.08.2015
1963
Extraordinary Administrative Radio Conference to allocate frequency bands for space radiocommunication purposes
TODAY
More than 2000 pages of Radio Regulations
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)
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)
**UN**
Outer Space instruments on space objects

- Free “exploration & use” under international law
- States
  - Responsibility & licensing
  - Jurisdiction & control
- 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
  - Liable for damage
- No liability clause
REGULATION OF RADIO SPECTRUM AND SATELLITE ORBIT IN PRACTICE
ALLOCATION OF SPECTRUM

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Service Description</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>

© ITU 2015
### 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), Radionavigation Satellite Service</td>
</tr>
<tr>
<td>S-band</td>
<td>2-4 GHz</td>
<td>Radars, MSS, Broadcasting Satellite, Space Research</td>
</tr>
<tr>
<td>C-band</td>
<td>3.4-7 GHz</td>
<td>Fixed Satellite Service (FSS), VSATs, Direct-To-Home (DTH)</td>
</tr>
<tr>
<td>X-band</td>
<td>7-10 GHz</td>
<td>Radars, Satellite Imaging, Space Research</td>
</tr>
<tr>
<td>Ku-band</td>
<td>10-15 GHz</td>
<td>FSS, VSAT, Broadcasting Satellite, MSS</td>
</tr>
<tr>
<td>Ka-band</td>
<td>17.7 - 21.2 GHz</td>
<td>FSS “broadband”, inter-satellite links, MSS</td>
</tr>
<tr>
<td></td>
<td>27.5 - 31 GHz</td>
<td></td>
</tr>
</tbody>
</table>
Rain fade

- Less
- Severe

Earth station antenna diameter

- Large
- Small

Bandwidth

- Narrow
- Wide

C-Band  Ku-band  Ka-band

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
Laws of physics
Radio waves do not stop at national borders

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

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
SHARING ORBIT/SPECTRUM RESOURCE

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 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

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

Yvon HENRI
Chief of Space Services Department