



**ITU Symposium and Workshop on small satellite
regulation and communication systems**

**The ITU - Challenges in the 21st century
related to
SMALL SATELLITES**

Yvon Henri

Chief, Space Services
Department

Yvon.henri@itu.int

Prague, Czech Republic, 2-4 March 2015

A photograph of the Sputnik 1 satellite in orbit above Earth. The satellite is a spherical metal ball with several external antennas protruding from its surface. The Earth's blue and white horizon is visible in the background against the blackness of space.

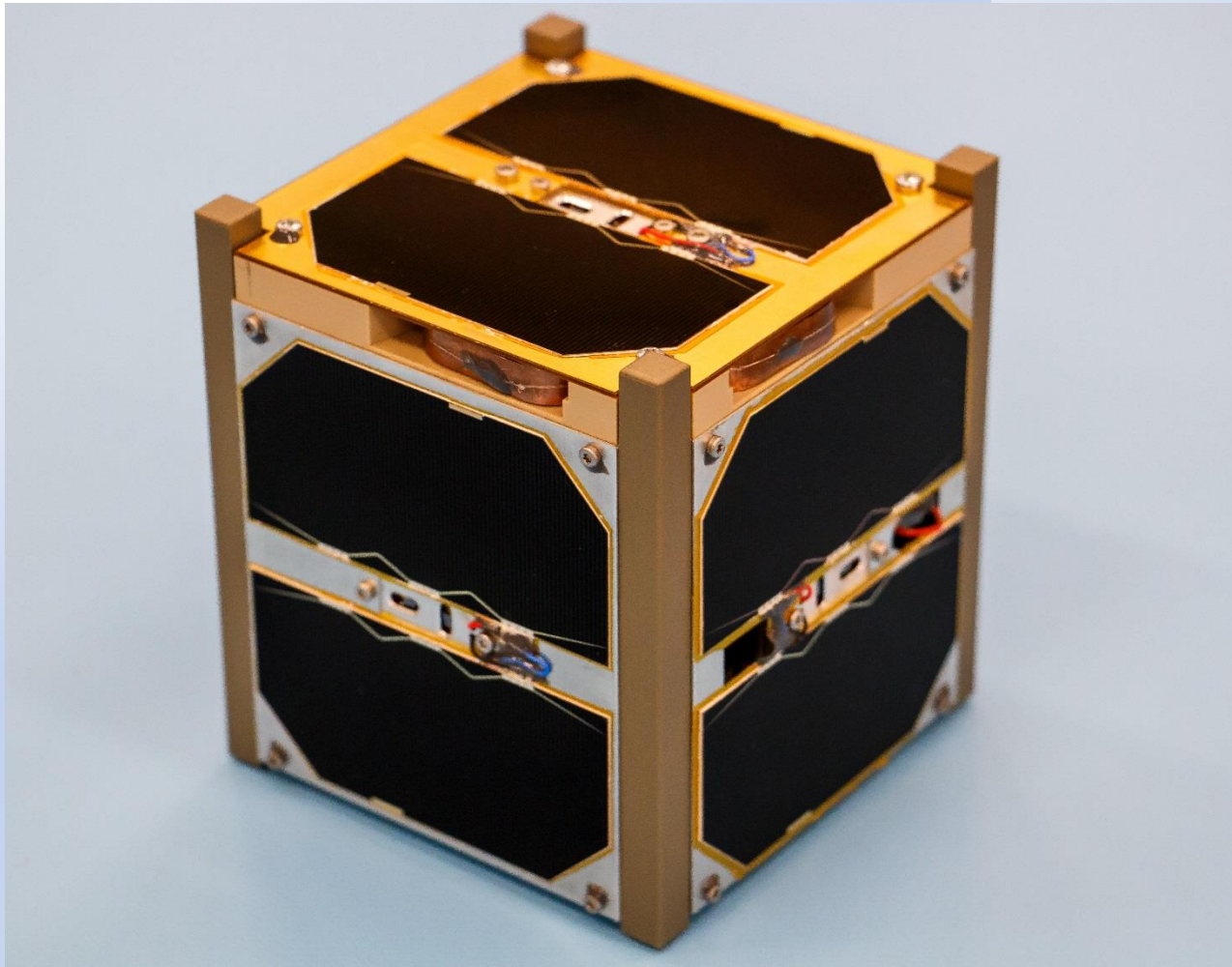
1957....

development of
communication
satellites

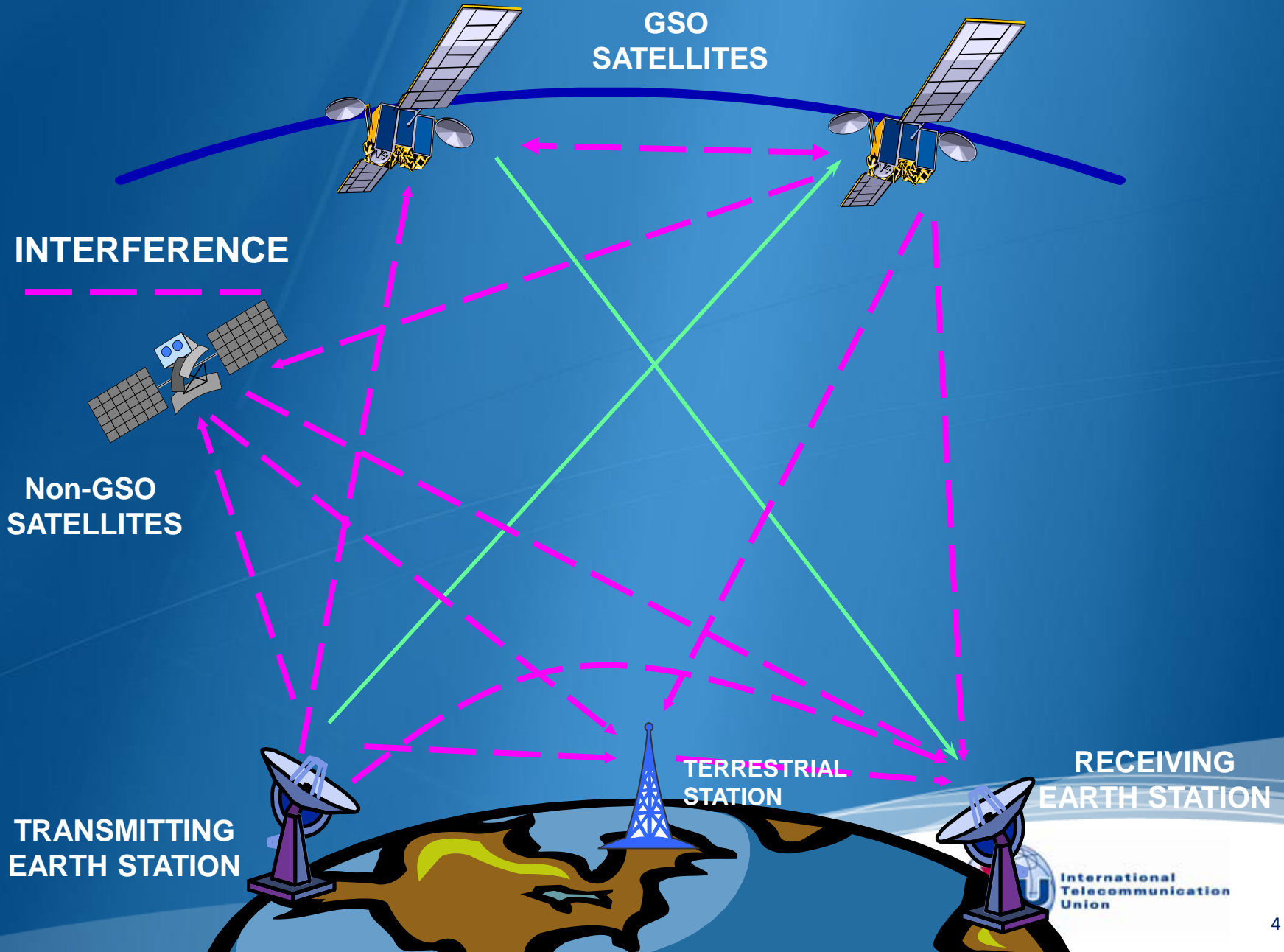
Sputnik 1 was the first artificial Earth “**SMALL**” satellite launched on 4th October 1957 with external radio antennas to broadcast radio pulses. It was a 58 cm diameter, 83 kg polished metal sphere with a 1 W transmitter on 20.005 and 40.002 MHz.

Analysis of the radio signals was used to gather information about the electron density of the ionosphere. Temp and pressure were encoded in the duration of radio beeps.

...2015



A “standard 1U” CubeSat has a volume of one liter - 10 cm cube and a mass of 1 kg, orbiting at 300-600 km circular orbit, 1W transmitter on 145 or 435 MHz amateur-satellite service band. It’s used for academic education, research and technology validation applications but also for complex science and governmental use.



Propagation of Radio waves

- 
- A large blue arrow pointing downwards, indicating a logical flow or consequence.
- Laws of physics
 - Radio waves ***do not stop at national borders***

Interference

- 
- A large blue arrow pointing downwards, indicating a logical flow or consequence.
- *Possible* between radio stations of *different countries* and/or different services
 - This risk is ***high*** in Space Radiocommunications

Radio Regulations

- One of its main purposes - ***Interference-free operation of Radiocommunications***



Why Small Satellites ?

"Faster, Cheaper, Better, Smaller"

- **Faster** to build/launch (**<1 year**)
- **Cheaper** to build/launch (**10's of k\$**)
- **Easy** modular & standardised (**CubeSats**)
- **Smaller** latest technology (**lighter and efficient**)

Also promotes:

**Technology transfer, Collaboration, Education, Earth Science,
Testing innovative technologies, ...**

But this comes with drawbacks



Drawbacks!

no regulatory definition for small satellites
in the ITU RR (only geostationary (GSO) and non-GSO satellites)

- **Limited Launching opportunities**
 - > **mission delays**
- **No/Little Orbit Control**
 - > **higher collision risks**
- **Small/Unreliable Power Source**
 - > **large & costly ground stations**
- **Limited Lifetime**
 - > **low reliability of electronics**
- **Limited Mission Types**
 - > **commercially unsustainable**
- **Limited Regulatory Certainty**
 - > **Lengthy time for Space Activity License**
 - > **Lengthy ITU frequency/coordination**



Legal Framework for Spectrum Access/Use





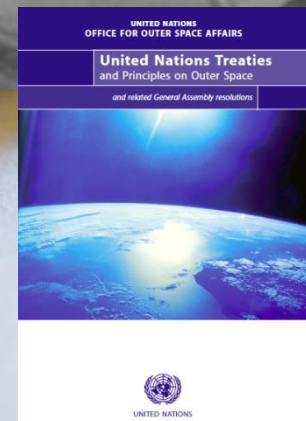
1963

Extraordinary Administrative Radio
Conference to allocate frequency bands for
space radiocommunication purposes



United Nations 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 they have launched into outer space
- States shall be liable for damage caused by their space objects





Legal Framework for Spectrum Access/Use

United Nations Outer Space Treaty (1967)



ITU Constitution, Article 44



Radio frequencies & satellite orbits are limited natural resources



**Rational, Efficient,
Economical Use**



Equitable Access





ITU Constitution – Article 44

Objectives:

- *To avoid harmful interference*
- To establish global standards and associated material to assure the necessary required performance, interoperability and quality
- To ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum and satellite-orbit resources





Legal Framework for Spectrum Access/Use

Radio Regulations

- Updated every 3-4 years by World Radiocommunication Conferences, WRCs
- Rules of Procedure and Radio Regulations Board

33 Agenda items (Successfully addressed without a vote)

First ITU paperless World conference in 6 Languages

Participants: 3042

Countries: 165

Companies: 101



Legal Framework for Spectrum Access/Use 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 - Mechanisms

Control of Interference

ALLOCATION

Frequency separation of stations of different services

POWER LIMITS

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

MONITORING

International monitoring system

COORDINATION

between Administrations to ensure interference-free operations conditions

RECORDING

In the Master International Frequency Register (**MIFR**)

International recognition





International Legal Framework for Space Services

UN Outer Space instruments (on space objects)

- free “exploration and use”
under international law

OST Art. I

Art. VI

States

- “responsibility” & “licensing”

Art. VIII - “jurisdiction & control”

States

Art. VIII Registration OOSA

Art. VII

States

“liable” for **damage**

ITU Instruments (on radio frequencies)

- **Equitable** access and **rational** use
of spectrum **CS Art. 44**
under international law

States

- must **license** transmitting radio
stations **RR Art. 18**

- shall **not cause harmful interference**
RR Art. 15

API_CR/C_MIFR

RR Art. 9, 11

No liability clauses





Amateur-satellite service (Article 25) regulatory notes

- ❖ **ITU Cost recovery fees are applicable also for small satellites**
- API for non-GSO/570 CHF / Notification/7030 CHF
 - **NO cost recovery charges for the publication of Special Sections/Notification for the Amateur-satellite service (ARS)**
- Please be aware of ***all regulatory conditions*** (including footnotes) *when using frequency bands allocated to Amateur-satellite service*
- No. **25.2** §2 1) *Transmissions between amateur stations of different countries shall be limited to communications incidental to the purposes of the amateur service, as defined in No. 1.56 and to remarks of a personal character*
- In conformity with Nos. **22.1** and **25.11** of the RR, any **amateur-satellite operator shall set up at least one TT&C station** to ensure that **any harmful interference caused by emissions from its satellite can be terminated immediately.**



Experimental Stations – Article 27

- *Experimental station concept was developed for terrestrial service usage – see No. 1.62 ... unless otherwise stated, any station is a terrestrial station.*
- *No. 1.98 - A station utilizing radio waves in experiments which a view to the development of science or technique. **This definition does not include amateur stations (ARS)** - Experimental stations cannot communicate with amateur stations and vice versa...*
- *Also for the experimental station it's necessary declare a **specific service** (not ARS-satellite service) and a related **frequency band**...*
- *Service area of the experimental station can be only the territory of the licensing administration*
- *Experimental stations **shall not cause harmful interference to /no protection from another services and services of another country***



WHAT NEEDS TO BE NOTIFIED ?

Any frequency assignments of transmitting and receiving earth and space stations ***shall be notified*** to the Bureau (No.11.2) if:

- Capable of causing harmful interference; or
- Used for international radiocommunication; or
- Subject to coordination procedure of Article 9; or
- Seeking to obtain international recognition; or
- Non conforming assignment under No. 8.4 seeking to be recorded into **MIFR** for information purposes only



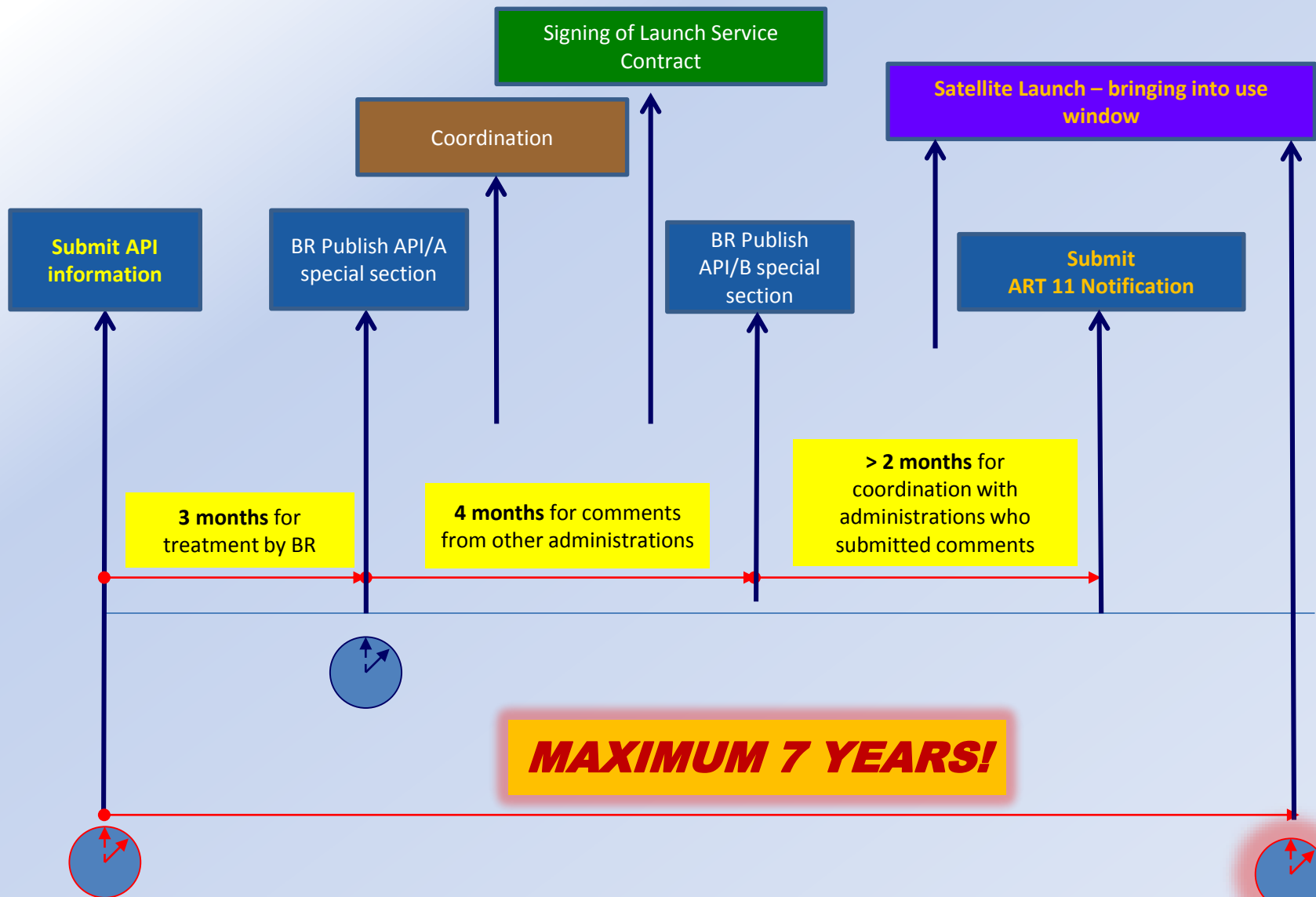
WHEN TO INITIATE THE NOTIFICATION PROCEDURE ?

- No. **9.1** of the RR stipulates that **before initiating any action under Article 11 (Notification)** in respect of frequency assignments for a satellite network, *an administration shall send to the Bureau* a general description of the network for **API** publication *not earlier than seven years* and preferably *not later than two years* before the planned *date of bringing into use (DBiU)* of the satellite network or system
 - API phase is **obligatory**
 - No priority in being first to start API
 - Starts the ***“regulatory clock” for notification***

- ❖ *The IARU informed the Bureau about revised procedures applying to coordination of small satellites using frequency in bands allocated to the amateur and amateur-satellite services.*
*As of 2014 the IARU is requiring the **API/A** Special section reference included in the small satellite project request when submitted to the IARU for coordination*



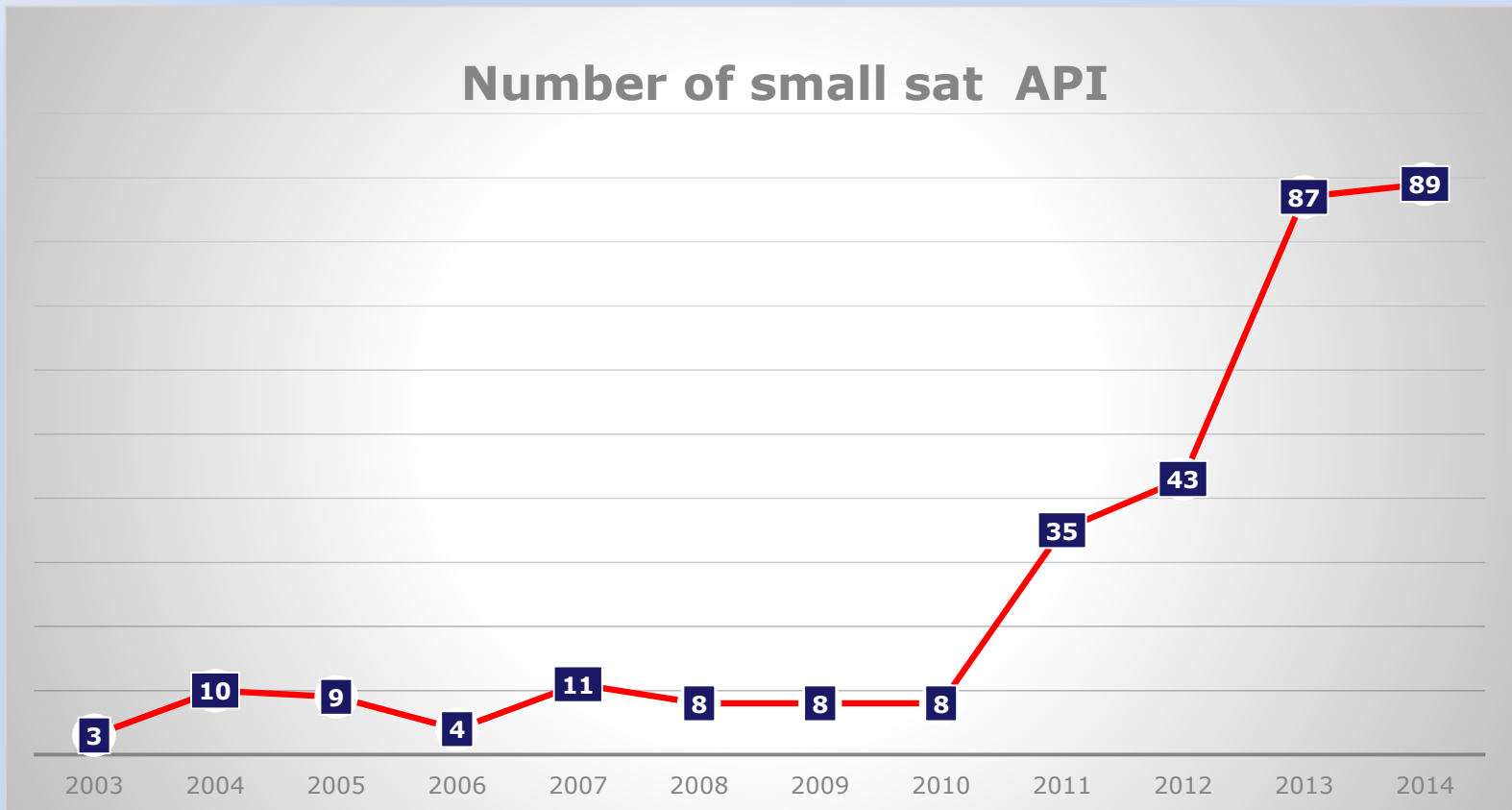
WHEN TO INITIATE THE NOTIFICATION PROCEDURE?





Small satellite ITU API *submissions*

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of small sat API	3	10	9	4	11	8	8	8	35	43	87	89





Preliminary Agenda WRC-18

Resolution 757 (WRC-12)

Regulatory aspects for nano- and picosatellites

*resolves to invite **WRC-18***

to consider *whether modifications to the regulatory procedures for notifying satellite networks are needed* to facilitate the deployment and operation of nano- and pico satellites,

and *to take the appropriate actions*





Small satellite definition

no regulatory definition for small satellites
in the ITU RR
(only geostationary (GSO) and non-GSO satellites)

Resolution 757
(WRC-12)

Regulatory aspects for
nanosatellites and
picosatellites

Question **ITU-R 254/7**

Characteristics and
spectrum requirements of
satellite systems using
nano and picosatellites



Conclusions

- **National Space Law *could* consider treating differently nano/pico satellites:**
 - > **e.g. waive liability requirements if:**
 - **restrict orbit (< 500 km);**
 - **require active de-orbiting;**
 - **require total re-entry burn-up.**
- **ITU regulatory regime:**
 - > **interference of nano/pico/small sats is difficult to control**
 - > **WRC-15/WRC-19 to study if regulatory procedures require changes to accommodate nano/pico/smallsats.**



Free on-line ITU-R help & documents

➤ **The ITU Constitution:**

<http://www.itu.int/pub/S-CONF-PLEN-2011>

➤ **ITU Radio Regulations @ 2012:**

<http://www.itu.int/pub/R-REG-RR-2012>

➤ **Support to Amateur Satellite service:**

<http://www.itu.int/en/ITU-R/space/Pages/SupportAmateur.aspx>

➤ **ITU-R Recommendations:**

<http://www.itu.int/publ/R-REC/en>



ITU Symposium and Workshop on small satellite regulation and communication systems

MERCI !

Yvon Henri

Chief, Space Services
Department

Yvon.henri@itu.int