

TOWARD AN INTERNATIONAL ORGANIZATION TO HANDLE A SUSTAINABLE SPACE TRAFFIC MANAGEMENT.

A FUNCTIONAL APPROACH OF ICSO

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SIRIUS Talks

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Existing Space Legal Setup – International layer

One legal body: the **United Nations Committee on the Peaceful Uses of Outer Space (UN-COPUOS)** established in 1959.

Five treaties regulating space activities

- 1967 Outer Space Treaty (OST),
- 1968 Astronaut Rescue and Return Agreement (ARRA)
- 1972 Liability Convention (LIAB)
- 1975 Registration Convention (REG)
- 1984 Moon Treaty (MOON)



As of 2017, COPUOS has 87 members, and is one of the largest committees of the General Assembly of the United Nations.

The main focuses of COPUOS is to promote cooperation in the peaceful use of outer space, and share information regarding outer space and its exploration. In 1962, the two COPUOS subcommittees: the Scientific and Technical Subcommittee and the Legal Subcommittee met for the first time and continue to do so annually. Many working groups exist such as the Long Term Sustainability started in 2010, ending in June 2018.

One expert group on debris : the Inter-Agency Space Debris Coordination Committee (**IADC**), founded in 1993, is an international governmental forum to exchange information on space debris research activities between member space agencies, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities, and to identify debris mitigation options.

Existing Space Legal Setup – National layer

Empowered by the two main treaties 1967/1972, each nation is capable to handle its own Space Affairs.

- Some are editing laws
- Some are issuing guidelines
- Many are not doing anything

Example with France/LOS:

- France as created the « Loi sur les Opérations Spatiales », adopted in 2008, in force since 2010. A complete technical framework, with simulation tools (Stela, Debrisk, Electra), templates, examples to regulate the commitments between the private operators and the French Nation.
- In 2017, it was already clear that the LOS was not addressing new domains such as asteroid mining or human activities in space.
- One way could be to make the French LOS evolve this way, but the coherence with international and other national rules will immediately oppose (1)

Current set of regulations are lacking many points to ensure an effective and sustainable management of the future space traffic

Examples:

- **Safety & security.** No one is currently responsible for the knowledge and for the safety of activities in space
- Since this is primarily each nation responsibility, multiple laws, guidelines and recommendations can **diverge** easily.
- Every **emerging space fairing nation** want their own “space bureau” that can deliver licenses to fly. There are also difficulties for new comers to accept restrictive rules imposed by established players.
- The existing **UN registry** is used a posteriori, after the national ones. We could change the order (get the license first, before flying) and associate this with a registration fee depending of the quality of the design or the cleanliness, as for cars.
- Scattered space situational awareness (SSA) ; USA is providing **free services** (2lines, collisions warnings), as a part of their soft leadership, but this basic free service could evolve, enhanced paying services will be made available. And see the emergence of **private actors** for space asset tracking, without any legal rules or guidelines.
- **Sharing** the data (positions, missions...) is not obvious, space is still considered by some nations as a strategic domain, whereas some private operators are ready to share.
- Many **massive constellations** are popping up and will need a special care, because of the number, of the orbit raising/falling, the overall impact and at the same time this new class of operators may lead the change, or even request more regulative rules such as a compulsory debris removal.
- Future **In Orbit Servicing** missions (debris removal, life extension, re-orbitation, refueling, repair) will need new guidelines and legal framework. Future **In Space Manufacturing, in Space Assembly** of spacecrafts including the repurposing and recycling of existing spacecrafts or rocket bodies will need new legal framework to handle multiple source, multiple use. As is, many current legal frameworks do not authorize these missions.

An international organization between the Treaties and the National laws ?

We could need a more efficient international STM governance body, that would manage:

- Technical requirements, guidelines, standards, interfaces
- Licenses, records, registers
- Legal aspects, case laws
- Compliance control, traffic awareness & control
- Sanctions, incentives
- Fees collection

Several options are possible, including the mimic of existing bodies.

Could we imagine an **functional** International Civil Space Organization that could manage the Civilian Space Traffic, in the middle legal layer, between every existing National law and regulation and the international treaties ?

All this is STM



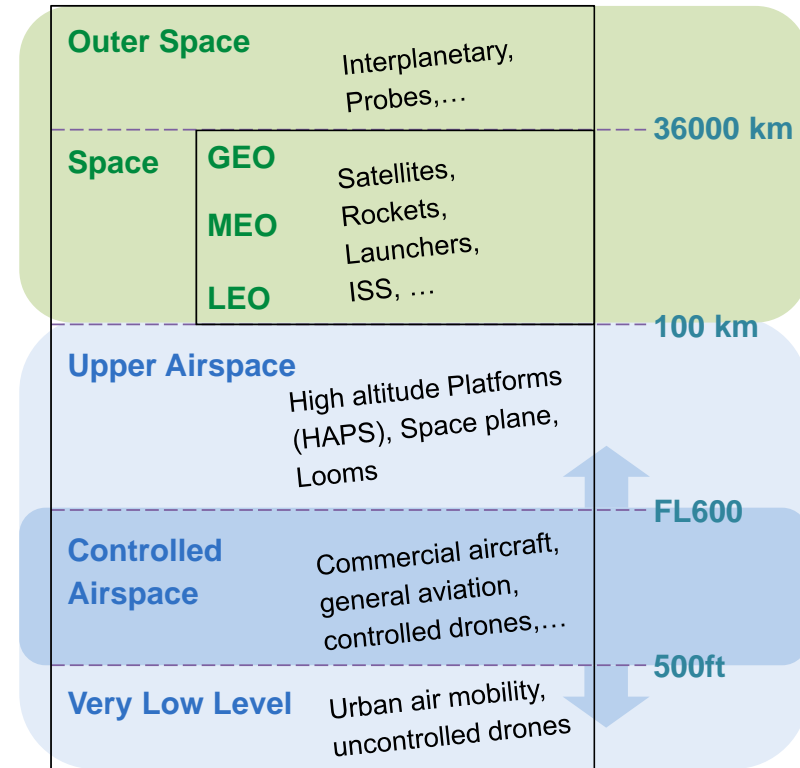
Where is the limit Air-Space, ICSO - ICAO ?

The von Kármán line is not enough

- The ICAO regulates the traffic of aircrafts flying above 500ft and below flight level 600 (60000ft, 20kms), this is the controlled domestic airspace, this is a sovereignty domain. Extension to stratospheric flights, and VLL is being discussed.
- OST (1967) does not define the « Outer Space ». *In fact, a precise physical limit of the atmosphere does not even exist, unless one considers the von Kármán line, at 100 km above the Earth, as the theoretical line where aeronautical flight becomes impossible (1).*
- Some differentiates Space and OuterSpace with the property of orbiting the earth, but the apogee of such an orbit could go well above 36000km !
- Sub-orbital trajectories (sounding rockets, space tourism, missiles...) may pass through all the domains up to altitudes that can be several 100's of kms

Altitude limits are not enough, dynamic conditions should be used

- If the object is orbiting around the earth (speed above 7km/s for example), it has to be controlled by ICSO. Same for objects escaping the earth gravity (speed above 11,2km/s)
- If the object is entering into the Space domain, with an insufficient speed to make one revolution (tbc), or stays less than 4 hours (tbc), it is not to be fully controlled by ICSO ; a simple declaration should be sufficient.
- *Similarly, if a space vehicle is passing by the controlled airspace, a declaration is needed to setup no traffic zones via NOTAMs.*



(1) Are there indications for upper and lower limits for air space and outer space in air law, space law and national legislation? by Marco Pedrazzi, IISL/ECESL Symposium, Vienna, 28 March 2011



A building of 5 connected and interdependent levels

Level 4: Sanctions & Enforceability

Level 3: Traffic awareness, control

Level 2: Access fees

Level 1: Registrations & licenses

Level 0: Technical & Standards



ICSO Level 0: technical & standards



Build upon the existing IADC, with extended capabilities:

- Define protected zones
- Define technical rules to match (lifetime, post mission disposal, passivation, demise...) → **asset registration**
- + Define **forbidden orbits**, permanently or temporarily
- + Define the technical capability of the operator to follow precisely the position of his assets, and their capability to dispatch this information to the control layer, Define the minimum competency of the operator to manage collision avoidance maneuvers → a **space driving license**
- + Define the necessary assets to be captured by an active debris removal system, kind of "**ADR ready**" stamp.
- + Define the technical rules to match when dealing with **In Orbit Servicing**, repair, refuel, re-orbit...
- + Define the rules to follow when dealing with **In Space Manufacturing** and Assembly, using materials and parts from earth or existing in space
- + **Link with ITU** frequency regulations

**A undisputed tech group able
to tackle quickly the new questions**

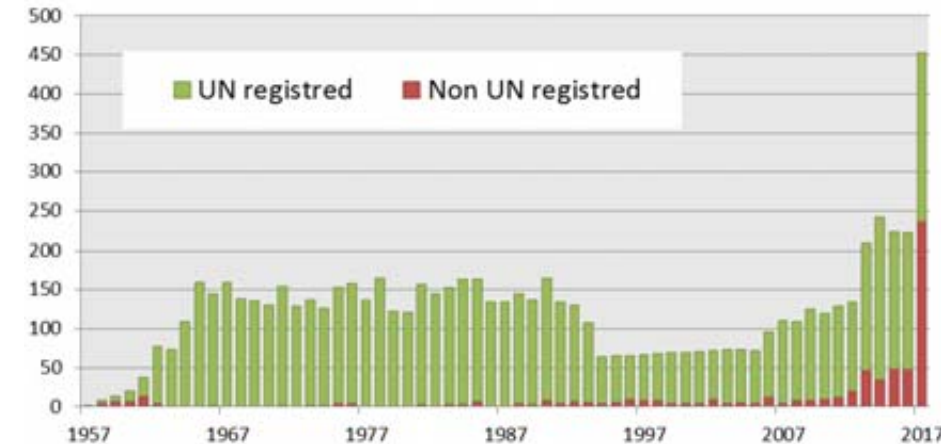
ICSO Level 1: registrations & licenses



Build upon the existing UN registry (REG 1972 treaty), with minor changes, including the safety criterias that have to be managed.

250 objects have to be registered every year

- So far, the UN registration is a copy of the National registers, and that explains **the delay** that may reach several years. This is also a **dead copy**, that does not take into account any change in the satellite definition such as a re-orbitation, or a repurposing, or a loss.
- We could imagine to have this registration verified and done, **before** the launch, together with the payment of a registration fee (level 2).
- Of course, the registration of assets **and** the license for operators are given following a careful analysis of their compliance to tech rules defined in level 0.



number of objects launched (UNOOSA site).

ICSO Level 2: Access fees



A very new layer, that will make the system sustainable, and allow some capabilities.

This fee to get the access to space can be modulated:

- With the mass of the assets installed in space
- Via a bonus/malus, regarding the compliance of the asset and its operator to the rules defined at level 0. Grade is from 0, A to E
- Via a discount with quantity
- Via the capability of feeding the SSA data base
- ...

Grade		Bonus Malus
0	Sounding rockets, space tourism, re-entering in less than 4 hours (tbc)	0%
A+	Orbiting objects re-entering atmosphere in less than 48h	---
A	Full compliance with significant margin on every parameters	--
B	Full compliance with significant margin on some points (ex: 2years disposal instead of 25 years)	-
C	Full compliance with no margin	100%
D	One rule slightly not compliant (ex: 83% of PMD success rate instead of 85%)	+++
E	One rule strongly not compliant (ex: 80% of PMD success rate instead of 85%)	++++
F	Many rules not compliant	

The grade (A-E) is decided by the levels 0 and 1, it could be decided by a hybrid body made of civil servant, and a private operator association.

The access fees can be collected by states, or by ICSO, and share between states and ICSO to take into account the residual liabilities.

ICSO Level 3: Traffic awareness, Compliance control



There is no possible management without awareness and compliance control.

Once a space system has been registered, the license given to an operator (level 0+1), the fees paid (level 2), the space system can be developed, manufactured, deployed and retrieved at the end of its life.

The ICSO is then in a control mode as soon as the registration and license are given, by means of declaration and audits, in **all the phase of the lifecycle**.

On top of this controlling tasks, ICSO has a space situational awareness capability, primarily based on **compulsory dump by operators**, augmented by voluntary data feeds from private or national organization willing to cooperate, and buying tracking data provided by private companies. Ultimately the organization could be able to operate **owned** tracking systems.



Once the ICSO reaches a good level of confidence in the tracked asset data bases, it can perform a periodical « all against all » **collision prediction process** and issue collision warning messages to operators, in full complementarity with the US/DoC system (formerly managed by the US/JSpOC)

ICSO Level 4: Sanctions & Enforceability



This level manages the complete assembly, by means of guidelines, good practices. It can guide, decide and issue sanctions.

Privilege incentive measures to insure adherence and compliance of all space actors.

- Provides **good practices and standards**, codes of Ethics, guidelines, examples, templates (think about an university Cubesat)
- Use feedback and **reputation**, through an open register accessible on a website
- Define a **Trustmark**, delivered by the ICSO
- Use « **Name and Shame** » technique
- Permanent evaluation, anomaly analysis, **breach analysis** (from level 3 control)
- Fine edition, **penalty points** endorsement, license control & eventually removal
- **Bonus points** could be defined to track and record good behaviors for future registrations.
- Further on, define and triggers **clean space missions**, or space awareness means and tools, in coherence with level 0,1 and 3.



Compliance with existing bodies

- Fortunately, the setting up of such ISCO is de-facto compatible with the UN Space treaties since it promotes a sustainable, safe, equitable use and share of it.
- In addition, the combination of OST's articles VI, VII and VIII allows and even requires the governments to bear the international responsibility to authorize and to supervise continuously private space activities and space objects under their jurisdiction (registration) and the associated liability as launching state.
- We don't see neither any potential conflict with domestic space laws. There are many examples of international bodies dealing with national offices and even private actors : ESA, Eurocontrol, Intelsat, the former Arianespace...

The way to go



- The setting up of such organization is de-facto compatible with the UN Space treaties since it promotes a sustainable, safe, equitable use and share of it, and we don't see neither any potential conflict with domestic space laws.
- In the facts, ICSO can, immediately, **take over the role of IADC and the UN Register**, act as a consultant for existing space fairing regulatory offices, and a substitute for all other countries. ICSO can be immediately tasked to deliver rules of conduct for new missions (IoS, ADR, ISM, ISAD...). Eventually, ICSO could take over the residual responsibilities currently handled by nations and be the unique space registration office.
- This will take time, and many bottom-up or top-down analysis.
- An ideal trigger would be a **COP21 like international conference** to start the process of creation, exactly like the convention of Chicago in 1944 started the creation of ICAO.

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