# SMALL SATELLITES & LARGE DEBRIS:
# REGULATING THE SURGE IN SMALL SATELLITES FOR A SUSTAINABLE SPACE ENVIRONMENT

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# BROAD STRUCTURE

THE GENERAL CONTEXT

- Small Sats = Large Debris.
- The Present Status.
- The likely future.

THE LEGAL CONTEXT

- GIL, OST, ITU Regs, IADC guide
- Clash of Fundamental Principles
- Balance Freedom & Sustainable Development.

THE RECOMMENDATIONS FOR A SUSTAINABLE ENVIRONMENT

- Legal Review & Reform.
- Definitional and Substantial issues in IADC & ITU.
- Exploring solutions beyond Space Treaties in GIL.
- Drawing on legal analogies.

# The General Context

- 1st Satellite was a micro satellite.
- Small satellite trends.

| Year | 2000- 12 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Satellites | 20 -25 | 92 | 158 | 131 | 101 | 300 |

- 2018: Rise/race of Mega Constellations.

**Small Sat = Large Debris**

# Space Debris

- Legacy debris: 23,000 > 10 cm, 500,000 < 1 cm.

| Debris Size | Effect |
|---|---|
| < 0.01 | Surface Erosion |
| 0.01 -1 cm | Significant Damage |
| > 1 cm | Catastrophic |

- SSN & STM underdeveloped & unlikely to change.
- Nano sats have high failure rate of around 50%
- 18% Cube sats dead on arrival or within 1st week.
- Typical life is barely 2 years compared to 5-10 yrs of normal sat.

# The *Lex Lata*

- Applicable legislation:
- General Principles of International Law.
- Specific Principles of Space Law.
- ITU Regulations.
- Soft Law- IADC guidelines, resolutions.
- Analogous legal prescriptions.

# Issues in *Lex Lata*

- Small sat not defined:
  > Space Object, LC-1972, Art-1(d)
  > Space Craft, ITU R.R 1.178 & 1.179
- Art-VI OST
  > *States bear international responsibility…& continued authorisation & supervision by states*
- Art-VII OST
  > *State internationally liable for damage*.
- 1972 LC & RC.

# Recommendations *de Lege Ferenda*

- Legal Review and Reform
- Definitional Issues:

> Space Obj (LC-72): *Term space obj includes component parts of a space obj as well as launch veh & parts thereof*.

> Space craft (ITU -3.2.1): *Manmade vehicle intended to go beyond the Earth's atmosphere*.

> Space craft (IADC): *An orbiting object designed to perform a specific function or mission (Comm, nav , EO)*

- Modify and standardise IADC Space craft to satellite. (soft law, mega consellations).

# Recommendations *de Lege Ferenda-2*

- Substantive Issues

> IADC (Art 3.3.2) recognises unique nature of GEO and LEO to ensure their safe, sustainable use and state these regions should be protected w,r,to space debris. Guidelines.

> ITU CS-RR (Art-44): ..*RF & associated orbits, including GEO are limited natural resources & they must be used rationally, efficiently and economically…so that countries have equitable access, taking into account special needs of developing countries*."

- Associated orbits now include LEO (all mega constellations in LEO), and Art-44 principle of rational, effective and efficient should apply. Implicit → Explicit mention. Amend?

# Recommendations *de Lege Ferenda-2A*

- Provision for sanction and rewards as in case of GEO needs to be extended to LEO for sustainable development in space.
- Application of principle of rational, efficient, economic use on limited natural resource enables adoption of legal standards for debris remediation.
- Extend '*Apriori*' allotment of orbital slots in LEO to developing nations for equitable access.

# WRC-15 AI.7 *Satellite issues* Decision

**SUP RES-757(WRC-12)** Consider *whether modifications to the regulatory procedures for notifying satellite networks are needed to facilitate the deployment and operation* of small (nano- and pico) satellites…

- **WRC-15 – decision**

➢ **NO need for any special regulatory procedures** *to facilitate the deployment and operation of nano- and pico satellites*

WRC-19 may include in Agenda

# Recommendations *de Lege Ferenda-3*

- OST addresses debris to limited extent vide Art-VI (*states bear int responsibility, continued auth & supervision*) & Art-VII (*int liab*).
- But, to a great extent through Art-III, (…*states shall carry on activities in use of space in accordance with international law…)*
- Art-III opens space to application of International Environmental Law.

# Recommendations *de Lege Ferenda*-3A

- General principles of Int'l Environment Law apply which significantly impact debris remediation.
- Specifically, Precautionary Principle (PP) of Environmental law applies to a great extent.
- In PP, states interested in undertaking space activity bear onus of proving such activities will not produce adverse environmental consequences.
- VCLT: Law has to be read in its entirety. Hence, combined reading of Art-VI & Art-III (PP) is essential.

# Recommendations *de Lege Ferenda-3B*

- Combined reading of Art-VI, Art-III (PP) indicate

→ States are duty bound to avoid debris creation (PP).

→ States are duty bound to undertake debris remediation. Continued supervision extends to remediation since sovereignty remains unaffected.

- However, above is long term activity, for the clear present and imminent issue of mega constellation

# Recommendations *de Lege Ferenda-4*

- UNCOPUOS Guidelines → Custom →Standards.
- Suggest adoption of SARP concept of aviation.

*'Standards: Specification for physical characteristics, configuration, ….or procedure, the uniform application of which is recognized as necessary for safety or regularity and to which the Contracting States confirm in accordance with the Convention '.*

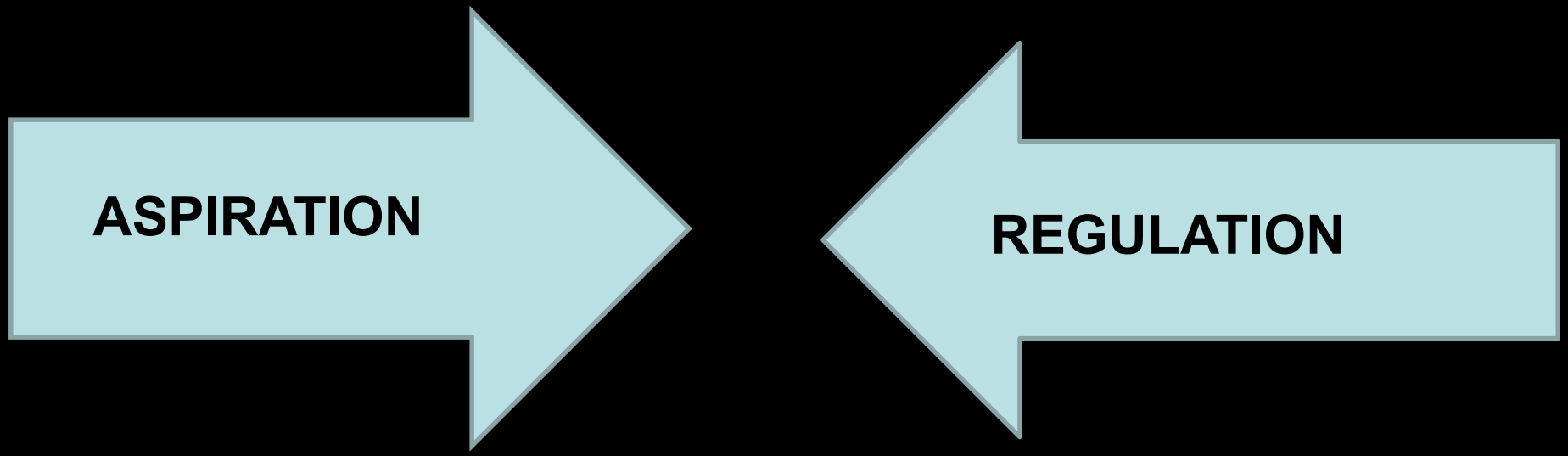
*'Recommended Practices: Specification for physical characteristics,…which is recognized as desirable*

- SARP is a mix of both hard & soft law.

# Recommendations *de Lege Ferenda-4B*

- *Consensus* areas like mitigation guidelines are increasingly practised by states indicating *custom*, practice be concretised to *Standards* and *Contentious* issues like remediation be treated as *Recommended Practices* for the interim.
- Increased consensus on RP → Standards.
- UNCOPUOS under authority vested by Principles in Art-VI, Art-III (international environmental law) and Art-IX of OST may consider raising debris mitigation guidelines to the status of *Standards And Recommended Practices (SARPs).*

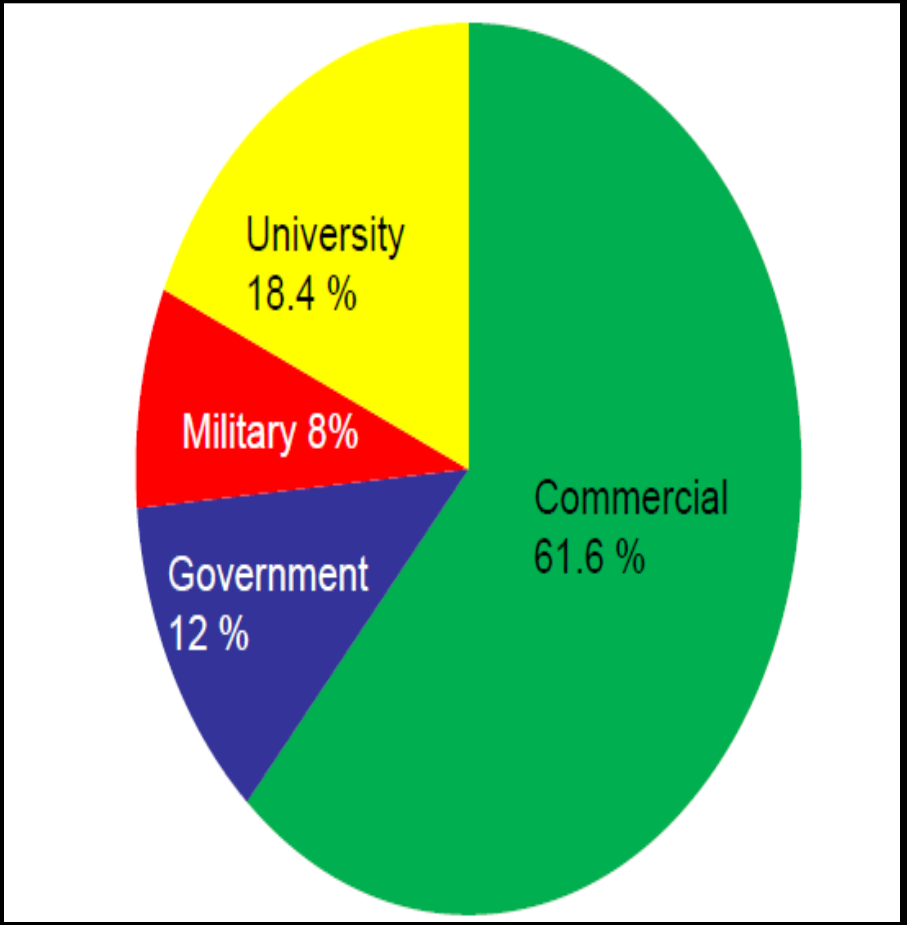
# Recommendations *de Lege Ferenda*-5



# CUBE SAT USERS-2015

- **Educational & Amateur Radio Missions**
- **Experimental & Research Missions**

- **Commercial Missions**
- **Aspiration → Monopolisation**
  - **Freedom of Seas**
  - **Freedom of Air Waves**
  - **Freedom of Outer Space**
- **Pre-empt Monpolisation**




$ 30 Bn Market (2017-2026)-Euroconsult

# Recommendations *de Lege Ferenda*-5

- Segregate small sat missions based on "*no pecuniary interest*" clause defined in Art-1 of RR.
- RR No. 1.56: "*A radio communication service for the purpose of self training, intercommunication & technical investigations carried out by amateurs, i.e., duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest*".

# Recommendations *de Lege Ferenda*-5A

| **Non- Pecuniary Missions**<br>**Education, R&D** | **Pecuniary Missions**<br>**Commerce, Industry** |
| --- | --- |
| • Simplify: Legislation and Procedures.<br>• Reduce processing time.<br>• Reduce filing costs. | • In addition to standard allocation, coordination, notification, publication, integration of Precautionary Principle may be considered.<br>• Application of concept of “Administrative due diligence” for LEO. |

Institutionalise Non-pecuniary (University) small sat cooperation under BSTI

# NEST: Non pecuniary Educational Smallsat Training Program

- General terms*:*

→ Reduce duplication, frivolous experimentation, disseminate information, & other International Organisation virtues apply automatically.

→ BR may accept University filings directly through NEST & NEST coordinates the procedure.

- Specific terms:

→Common testing, certification, standards platform.

→Common repository of knowledge & training.

→ Common mentoring platform.

→ Common funding, job, innovation platform.

1966), p. 8; United Arab Republic, *ibid.*, p. 11; Canada, *ibid.*, p. 14; Hungary, U.N. Doc. A/AC. 105/C. 2/SR 71 and Add. 1 (21 October 1966), p. 22; Bulgaria, *ibid.*, p. 23; The delegate of the United Kingdom (U.N. Doc. A/AC. 105/C. 2/PR. 71, at p. 2) stated that

"The States represented in this Sub-Committee have recorded their unanimous wish that a solemn treaty obligation should be created. This treaty obligation should confirm with legal force that outer space including the moon and celestial bodies, . . . should be free for exploration and use for the benefit and in the interests of all countries. We are indebted to the representative of Brazil for his urging which had led the Sub-Committee to underline that this must be for the benefit and in the interests of all countries, irrespective of the degree of their economic and scientific development";


Thank You

| Launch System | 500km SSO Payload (kg)[1] | Stated IOC Date | Target Launch Price | Configuration |
|---|---|---|---|---|
| Electron | 150 | 2017 | $33K/kg | Ground-launched two-stage rocket |
| LauncherOne | 300 | 2017 | $33K/kg | Air-launched expendable rocket |
| Kuaizhou 1A | 250 | 2017 | $57K/kg[2] | Ground-launched four stage rocket |
| Vector-R | 28 | 2018 | $54K/kg | Ground-launched two-stage rocket, with optional electric third stage |
| LandSpace-1 | 400 | 2018 | $20K/kg | Ground-launched four-stage rocket |
| GOLauncher 2 | 44 | 2019 | $57K/kg | Air launched with solid and liquid |
| Intrepid-1 | 376 | 2019 | $14K/kg | Ground-launched, two stage, hybrid rocket |
| Arion 2 | 93 | 2021[2] | $38K/kg | Ground-launched, three stage, liquid rocket |

# APPLICABLE LEGISLATION

Handout on Small Satellit | The FCC says a space star

Secure | https://www.theverge.com/2018/3/10/17102888/the-fcc-says-a-space-startup-launched-four-tiny-satellites-into-orbit-without-permission

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## The FCC says a space startup launched four tiny satellites into orbit without permission

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*Swarm Technologies reportedly didn't get a license*

By Loren Grush | @lorengrush | Mar 10, 2018, 1:49pm EST

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| Company | No of Sats | Orbit | Mass/kg | Frequency | Remarks |
|---|---|---|---|---|---|
| **Space-X** | 4425 | 1100-1325 km<br>83 Planes<br>53 -81° Incl | 100 -500 | Ku and Ka | First two satellites in orbit. (22 feb 18) |
| **Steam/ Norway** | 4257 | LEO, 43 Planes | - | Ku and Ka | - |
| **MCSAT** | 4000 | LEO | - | - | |
| **1 Web** | 900 | 1200 kms<br>18 Planes<br>87.9° Incl | 175-200 | Ku | First to register frequency with FCC |
| **Boeing (Viasat)** | 2956 | 1200 kms<br>45-88° Incl | - | V band | - |
| **Comstellation/ Canada** | 794 | LEO<br>12 Planes | - | Ka | - |
| | | | | | |