REGULATION OF SMALL & MICRO SATELLITES

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INTRODUCTION

- **TREND: Due to wide-ranging improvements in satellite and launch technologies, there is growing trend towards building and launching satellites that are smaller, faster, better & cheaper.**

- **This development undoubtedly will prove significantly advantageous to the armed forces of various nations, numerous space enthusiasts and students, universities, small companies and developing countries.**

- **CONSEQUENCES/PROBLEM: It is expected that the number of small satellites (also known as microsats, cubesats, cansats, nanosats, picosats, etc.) will significantly increase. They will possibly be endangering the safety of other space missions and sustainability of space activities in general.**

INTRODUCTION

- **It is possible that they may be launched without following proper legal and regulatory procedures, especially in countries that do not have in place adequate and appropriate regulatory systems. In other words, they might be operating outside the law.**

- **ASSESSMENT & SOULTION: It is important to assess the effectiveness of current regulatory regime governing satellites.**

- **I will address some legal and regulatory issues that relate to licensing and registration, use of radio frequencies, space debris mitigation and remediation, responsibility and liability**

OVERVIEW OF INTERNATIONAL LEGAL REGIME

- **Small satellites, irrespective of their size, weight & scope of missions, are space objects that are governed by current international space legal regime.**

- **Secondly, the launching and/or operation of such satellites constitute space activities, thus they are subject to such legal regime.**

- **Current international space law regime consists of five major international treaties negotiated through the UN COPUOS.**

- **In addition, there are several UN Regulations and guidelines, principles and rules of general international law, and several other international agreements that are applicable to small satellites.**

- **It can be said that, in general, all international rights and obligations of the States with respect to big satellites are equally relevant for the conduct of space activities with the use of small satellites.**

- **It should be kept in mind that international law is essentially applicable to States.**
- **In the exercise of their rights, States allow their respective nationals or private companies, and impose restrictions on such use, as they consider necessary.**
- **States also pass on their international obligations to their respective nationals or private companies.**
- **This is essentially done under national legal and regulatory regimes and policies.**

- **Each States adopts its national space laws and regulations, the nature, scope and timing of which is essentially on the bases of its politico-economic policies and priorities.**

- **The U.S. is a world leader in national regulation of space activities.**

- **Recently, a few other States have started adopting some forms of national space laws and regulations.**

- **However, a large majority of States (including space-faring nations) do not have effective national laws and regulations that could govern space activities, including the launch and use of small satellites.**

LICENSING

- **Under international space law, States are internationally responsible for their national (public and private) activities in outer space.**

- **The activities of non-governmental entities (i.e. private citizens, companies, universities, etc.) in outer space must be carried out pursuant to "authorization and continuing supervision" by the appropriate State Party to the Outer Space Treaty.**

- **The most common and important tool for nationally regulating a space activity is the requirement of a licence (authorization) from a designated governmental entity.**

- **A national licence creates legal nexus between the issuing State and the licensee.**

- State practice shows a variety of licensing requirements and processes related to small satellites.

- For example, in Canada the Department of Foreign Affairs and International Trade (DFAIT) has issued several licenses remote sensing systems under the Canada Remote Sensing Space System Act.

- However, Canada's small satellite weighing only 65 kilograms NEOSSat (Near Earth Object Surveillance Satellite), which has recently been launched into 800 kilometer orbit, was not licensed by the DFAIT since it is a "space telescope dedicated to detecting and tracking asteroids and satellites" and is not a remote sensing satellite as defined in the Act.

- The main implication of this legal lacuna in licensing jurisdiction on the part of the DFAIT is that though NEOSSat is an unlicensed small satellite, yet Canada is its launching State under international space law.

- **Sometime, countries lack appropriate national regulatory system to issue licenses for a particularly space activity that could be carried out by big or small satellites.**

- **It is interesting to note that small satellites are being designed for carrying out on-orbit satellite servicing (OOS) activities. For example, AKT's small satellite bus (A500) has already been used "for the revolutionary DARPA Phoenix mission to conduct on-orbit satellite servicing and repurposing."**

- **Canadian company, MDA, has developed robotic capability that could be used for on-orbit satellite servicing activities. Intelsat and MDA had agreed to conduct such operations for refuelling missions.Though the deal failed to mature mainly due to lack of significant business prospects, it would have been difficult for MDA to procure a licence in Canada since the currently applicable Canadian regulatory regime makes no provision for such activities.**

- **In the U.S., a licence is required to operate a private remote sensing space system by any person who is subject to the jurisdiction or control of the U.S.**

- **The license is issued by the Secretary of Commerce, who has delegated this authority to the National Oceanic and Atmospheric Administration (NOAA).**

- **To procure a license, the applicant (and the licensee) is required to comply with several onerous and broad requirements, some of which include the duty to respect international obligations and national security concerns of the United States as well as the maintenance of operational control of satellite from within the U.S., limitations on the collection and dissemination of data, dispose of end-of-life satellite in a manner approved by NOAA, etc.**

- **The current U.S. law is applicable to all individuals, universities and private companies that are planning to launch big or small remote sensing satellites.**

- **NOAA is realising that it will be difficult to strictly apply the requirements of the law to small satellites, particularly, since "[d]esign of some CubeSat systems makes it impossible to comply with standard licensing conditions, e.g., limitation of imaging operations when required by national security concerns."**

- **NOAA believes that, in addition to the development of guidelines and codes of conduct, there is a need to change current remote sensing regulations to provide NOAA with the "discretion to determine that certain CubeSats that propose to image the Earth do not require a license."**

- **Therefore, one can expect lessening of licencing burden on small satellites in the U.S.**

- As space technologies develop, satellites that are small in size might be carrying out more advanced remote sensing activities.
- Such 'small' satellites if perform 'big' activities would be regulated more rigorously.
- It is not the 'size' or the 'weight' but the 'capability' of a satellite that determines the nature and scope of applicable regulatory regime.
- There is a growing trend not only towards the construction of small satellites but also the development of small reusable launch vehicles.
- Such launchers will be placing small satellites, including personal satellites, routinely and possibly four or more times a day.

- For example, Virgin Galactic's 'LauncherOne' - an unmanned rocket – that will be air-launched by WhiteKnightTwo, and will be capable of delivering as much as 225 kg to low Earth orbit.

- Licenses for such small launches with small payloads will pose challenges for regulatory authorities.

- In the U.S., all launch services are regulated under the 1984 Commercial Space Launch Services Act (as amended).

- The launch licenses are issued by the Secretary of Transportation, who has delegated his authority to the Office of Commercial Space Transportation (AST) within the Federal Aviation Administration (FAA).

- A license is issued after the conduct of thorough safety and mission reviews that involve consultations with and decisions by various agencies of the U.S. Government.

- Legal requirements and process for procuring launch licenses will prove cumbersome for routine launches of small satellites by small reusable launch vehicles like, LauncherOne.

- However, the U.S. law entitles the Secretary of Transportation to waive any requirement, including the requirement to obtain a license, for an individual applicant.

- After first licence, this authority could/should be used to waive licensing requirement launch vehicles like, LauncherOne, for routine operations.

- South Africa's first spacecraft, Sunsat, weighed about 64 kilograms satellite, was launched in 1999. This small satellite was not licensed in South Africa.

- However, the second South African small satellite weighing 80 kilograms, Sumbandilasat, is a government-commissioned satellite that was launched in September 2009 into 600 kilometre orbit. A launch licence for this satellite was issued in June 2009 to National Department of Science and Technology by the South African Space Affairs Council under the Space Affairs Act of 1993.

- ZACUBE-1, South Africa's first student built nanosatellite weighs only 1.3 kg and measures 10cmx10cmx10cm. This spacecraft may be launched in mid-2013 and is yet to be licensed.

- Like several other nations, in Japan there is no law authorising the grant of licenses either for launches or for satellite operations. So no governmental license is issued for small satellites.

REGISTRATION

- **Under international space law each launching State is obliged:**
- **(a) to register satellites belonging to its public entities, nationals or private companies in its national register and**
- **(b) to register them with the UN Secretary-General.**
- **The requirement of international registration of space objects was adopted pursuant to a belief that a mandatory system of registering space objects would assist in their identification and would contribute to the application of international space law, particularly in determining responsibility and liability in cases of accidents.**

- **There has been a good State practice as space-faring nations have been regularly registering their space objects in their national registers as well as in the international register**

- **Though international registration is mandatory under the Convention, nevertheless, States have recently started lowering the number of international registrations of their launched space objects. According to an ILA Study:**

- **"Before the 1975 Registration Convention, and under UNGA Resolution 1721B (XVI), 129 objects were launched into outer space in 1972, all of which were registered (0 % unregistered objects). …… In 2004, 72 objects were launched into outer space of which only 50 were registered (30.5 % unregistered objects). Indeed we are going downhill in this regard."**

- One of the main reasons for this growing reluctance towards international registrations is that such registration is required to be effected after a satellite has been launched and has been registered on a national registry.

- There is no specific time limitation for international registration.

- States tend to delay or decide not to send the required information to the UN Secretary General, particularly regarding those satellites which have been launched by foreign launch vehicles and those that might remain in orbit only for a short time.

- For example, American satellite Iridium 33 was launched by Russia. On 4 March 1998, Russia informed the UN that "seven Iridium satellites were placed in Earth orbit by a single Proton carrier rocket . . . The satellites are owned and operated by the Motorola company (of the U.S.)."

- **On the other hand, the official U.S. Registry of Space Objects Launched into Outer Space enlists Iridium 33 and affirms that the satellite was *not* registered with the UN by the U.S., and that it was "[M]entioned by Russian Federation in ST/SG/SER.E/332."**

- **Moreover, as of 22nd May 2013 the U.S. Registry still shows that Iridium 33 satellite is in orbit, though it has been destroyed more than four years ago.**

- **In Nigeria, Nigeriasat-II and Nigeriasat-X have not yet been registered with the UN, and it is believed that a process that will certainly be followed in due course.**

- **Nigeria had submitted the required registration information to UN for registering Nigeriasat-I (the precursor of Nigeriast II) was registered in 2005 pursuant to UN General Assembly Resolution 1721 B (XVI).**

- **It is expected that with an exponential increase in the launch of small satellites, especially picosatellites or nanosatellites that will remain in orbit for a very short period of time.**

- **States may <u>not</u> be registering them with UN and perhaps *not* even on their own national registries.**

- **That will <u>eventually cause problem in their identification</u>, particularly if they happen to be involved in accidents in outer space or, if they survive on re-entry, on Earth causing damage.**

USE OF RADIO FREQUENCIES

- **For their proper functioning, all satellites – big or small – need to use radio frequencies.**
- **In order to avoid possible harmful interference, radio frequencies are heavily regulated both at international and national levels.**
- **Radio frequencies are limited international nature resource to be used by all countries on equitable basis and they do not respect national borders.**
- **Therefore, international community has devised an extensive international regulatory system through the International Telecommunication Union (ITU).**

- **The ITU regulatory requirements are applicable to big, small and microsatellites.**

- **Most of the small satellites use radio frequencies that are allocated to Amateur Satellite Service in ITU Radio Regulations.**

- ***This service is defined as a radiocommunication service using space stations on earth satellites for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.***

- **Several technical and regulatory limitations are placed on the use of Amateur Satellite Service bands.**

- **During only a few years of start of the launch of small satellites, Amateur Satellite Service bands are getting increasingly crowed mainly due to the increasing number of such satellites.**

- **Concerns are being expressed about this situation, which could be expected to get worse when more small satellites are launched.**

- **In view of the problem of over-crowding in Amateur Satellite Service bands the by micro satellites, ITU's World Radiocommunication Conference that was held in Geneva in 2012 (WRC-12) adopted Resolution COM6/10 (WRC-12).**

- **This Resolution recognizes that:**

- **(a) currently, many nano- and picosatellites use spectrum allocated to the amateur satellite service and the MetSat service in the frequency range 30 - 3000 MHz although their missions are potentially inconsistent with these services, and**

- **(b) the existing provisions of the Radio Regulations for coordination and notification of satellites under Articles 9 and 11 may need to be adapted to take account of the nature of these satellites.**

- **WRC-12 invited ITU-Radiocommunications Bureau to study the procedures for notifying space networks and consider possible modifications to enable the deployment and operation of nano- and picosatellites**

- **WRC-12 instructed the Radiocommunication Bureau to report to WRC-15 on the results of these studies.**

- **The Conference also invited 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 picosatellites.**

- **This is a positive action that might help in the accommodation of the growing need for sufficient radio frequencies by micro satellites.**

- **Under ITU Constitution, Convention and Radio Regulations, each State is obliged to:**

- **(a) allow its small satellite operators only to use radio frequencies as allocated under the Radio Regulations,**
- **(b) prevent them from causing harmful interference to the radio services of others,**
- **(c) require them to operate their satellites in accordance with the ITU Radio Regulations, and**
- **(d) require them to obtain licenses from the designated governmental agency.**

- **In the U.S., all satellites must be licensed by the Federal Communications Commission (FCC) under the Communications Act of 1934 (as amended) and the Federal Satellite Communications Regulations.**

- **In addition, the FCC also applies international regulations and procedures as specified in ITU Radio Regulations.**

- **Therefore, the FCC procedures for a radio license could be a lengthy and time consuming process for small satellites, especially when they need to be coordinated internationally through the ITU.**

- **FCC recognizes the difficulties that are being faced by small satellites.**

- **FCC recently issued simplified guidelines to provide guidance to small satellite operators concerning FCC licensing for use of radio frequencies allocated to Amateur Satellite Service.**

- **This certainly will be quite helpful to the operators of small satellites (particularly, pico-satellites, nano-satellites and cubesats) since most of them are generally unaware of the complexities of the FCC satellite licenses.**

- **Since most of the small satellites use radio frequencies allocated to Amateur Satellite Service, the concerned Administrations (States) are obliged to respect the following requirements specified in ITU Radio Regulations:**

- *"No. 25.11 -Administrations authorizing space stations in the amateur satellite service shall ensure that sufficient earth command stations are established before launch to ensure that any harmful interference caused by emissions from a station in the amateur-satellite service can be terminated immediately (see No. 22.1)*

- *No. 22.1 -space stations shall be fitted with devices to ensure immediate cessation of their radio emissions by telecommand, whenever such cessation is required under the provisions of these Regulations."*

- **In certain cases, the concerned Administration of a small satellite may be further obliged to notify to, and coordinate through, ITU if the use of radio frequencies of transmitting and receiving earth and space stations.**

- **National implementation of ITU requirements and procedures could be highly cumbersome, time consuming and expensive process for the operators of small satellites.**

- **Free online ITU Support to Amateur Satellite service is available at:**

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

SPACE DEBRIS MITIGATION AND REMEDIATION

- **The amount of space debris has been increasing, particularly by the intentional destruction of space objects and by recent accidents.**

- **It is believed that the safe and sustainable use of outer space will continue being increasingly threatened:**

- **firstly as a navigation hazard to operational satellites of all space-faring nations, an example of which is the destruction of Iridium 33 during its collision with Cosmos 2251 in 2009; and**

- **secondly as a major risk from space debris is to humans, property and environment on the surface of the Earth. The example of the later risk is the re-entry of COSMOS 954 in 1978 that scattered radioactive debris over a large area of Northern Canada.**

- **The expected launch of small satellites, particularly in low Earth orbits, will further expand the amount of space debris as these satellites generally have short life spans.**

- **"Historically, nanosatellites have relatively high failure rate of 52 percent."**

- **Through several efforts, both at international and national levels, some technical standards and softlaw guidelines have been adopted to mitigate generation of space debris. They are:**

- **ESA issued European Space Debris Safety & Mitigation Standards (2002)**
- **IADC Space Debris Mitigation Guidelines (2002)**
- **COPUOS Space Debris Mitigation Guidelines (2007)**

- **Guidelines:**
- ***Limit debris released during normal operations;***
- ***Minimize potential for break-ups during operational phases;***
- ***Limit the probability of accidental collision in orbit;***
- ***Avoid international destruction and other harmful activities;***
- ***Minimize potential for post-mission break-ups resulting from stored energy;***
- ***Limit the long-term presence of spacecraft and launch vehicle orbital stages in LEO after the end of their mission;***
- ***Limit the long-term interference of spacecraft and launch vehicle orbital stages with GEO region after the end of their mission.***

- **It is important to note that these guidelines are not legally binding under international law and are to be implemented through national mechanisms.**

- **Domestic application of these guidelines, particularly to small and micro satellites, will be challenging, especially in those countries which do not have national regulatory mechanisms, or do not issue or require any licence for such satellites.**

- **Some technical so solutions are being researched and sought:**

a. **"Scottish engineers have developed a sail system that pulls small satellites out of orbit to avoid increasing the amount of space debris."**
b. **"MIT-developed 'microthrusters' could propel small satellites."**
c. **"How can small satellites be used to Support Orbital Debris Removal Goals Instead of Increasing the Problem?"**

- **Practical viability of these and other technical solutions is not yet fully confirmed.**

RESPONSIBILITY AND LIABILITY

- **Under Article VI of the Outer Space Treaty, each State Party to the Treaty is internationally responsible for national activities in outer space whether such activities are carried on by governmental agencies or by non-governmental entities.**

- **Introduction: The phenomenon growth of small satellites will give rise to serious problem related to the liability for damage, if caused, by small satellites, mostly under international space law.**

- **Since, the number of public and private players launching, or procuring the launch of, small satellites will increase, it is possible that several of them might not be governed by international space law; thus the issue of their liability will need to be addressed under general international law.**

- **Liability of small satellites as space objects: Small satellites will be like any other space objects involving launchings of payloads, the possibility of collisions in outer space, and the likelihood of debris falling back to Earth from the failed or dead system(s).**

- **However, in some ways constellations of small satellites will have implications different from any another space object launched and operated to date.**

- **Even if there are significant advances in launch technologies, the launch activities for small satellites will be enormous, thus might have high probabilities of mishaps causing damage on orbit in outer space, in the air, and/or on the Earth.**

- **Liability under international space law: There are mainly two international space law treaties that directly apply to the cases of liability for damage occurring during the conduct of space activities, including the launching and operation of small satellite(s); i.e. the 1967 Outer Space Treaty and the 1972 Liability Convention.**

- **A State Party to these treaties, or its nationals, has the option to make a claim for compensation under either of these agreements, if damage suffered is caused by any other State Party to these two agreements.**

- **Liability under Outer Space Treaty:**

- **Under international law, responsibility includes liability. Thus, liability claim for compensation for damage or injury or death can be made under Article VI of the Outer Space Treaty.**

- **Article VII of the Outer Space Treaty, holds a launching State liable if the damage is caused "to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space."**

- **The Outer Space Treaty neither places limitation on the time for making a claim, nor on the amount to be claimed, nor defines the term "damage." Thus, in some cases, it could be more advantageous to the victims, than the Liability Convention.**

- **Liability under the Liability Convention:**

- **Article II of the Liability Convention, in unambiguous terms, holds the launching State "absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight."**

- **This feature of the Convention made possible straight forward and expedient settlement of Canada's claim against the U.S.S.R. for compensation for damage caused by dead Soviet space object (i.e. space debris) Cosmos 954 when it intruded into Canadian air space, depositing on Canadian territory hazardous radioactive debris from the satellite.**

- **On the other hand, Article III of the Convention creates fault-based liability for damage caused in outer space "to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State."**

- **In other words, the claimant State must establish not only that the damage has been caused by a space object (or its component parts or debris created by it) belonging to another State, but also that the damage was due to the latter State's fault or the fault of persons for whom that State was responsible.**

- **It should be noted that due to limited space monitoring (space surveillance) capability, especially on the part of a claimant State that is not a well-developed space-power, it will be difficult, if not impossible, to clearly and convincingly establish fault on the part of the State whose small satellite (including an untracked small piece of space debris) that will be believed to have caused the damage.**

- **According to the Liability Convention, the term "damage" "means loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations." Since compensation for "other impairment of health" is recoverable, it is reasonable to assume that mental or psychological damage without any physical manifestation would also be covered by the term 'damage'.**

- **International space law only imposes liability for damage on States and not upon their private entities. There are and, will certainly be, numerous private companies, universities and even NGO's undertaking the construction and operation of a small satellite systems.**

- **If a private company or a university builds and gets a small satellite launched, the State of its nationality should have a provision under its domestic law for licensing to facilitate that State's performance of its international obligation of 'authorization and continuing supervision' as required under Article VI of the Outer Space Treaty.**

- **It will be difficult for States that do not have adequate and appropriate national space laws to regulate the activities of such entities.**

- **Thus they themselves will end up bearing the total cost of compensation, if required to pay to third parties. The authorizing State would be not only responsible but could also be held liable if any damage is caused by a small satellite owned by the authorized company or university. Similarly, States are responsible and could be held liable if any damage is caused by a small satellite even that small satellite that was not specifically authorized.**

- **I believe that the State that launches (or whose private company launches) a small satellite could become an easy target for law suits for compensation, especially when the satellite that caused damage belongs to a small country, small company or university.**

- **Risk Management: States or their entities that exposure themselves to liability for damage caused by their small satellite could manage liability risk by procuring insurance coverage. Insurance can be obtained by the satellite owner, launch provider, or the satellite operator.**

- **However, it is possible that small entities, universities or small countries may not be aware of the applicable international or national regulatory requirements, potential liability risks or possible insurance coverage or may consider the cost of insurance might be more expansive than that of the satellite itself.**

- **Thus, I believe, it will be in the interest of launching States to have appropriate regulatory regime in place that makes mandatory insurance requirements for the launch of small satellite(s).**

CONCLUSIONS

- **Because of substantial advantages of small satellites, there will be an exponential increase in their number and consequently the pieces of debris in orbit.**

- **In order to reduce space debris, national regulatory and technical solutions would need to be developed and implemented. Perhaps, all the States that actually launch satellites should be enter into agreement for requiring (a) proper end-of-life disposal of satellites before their launch and (b) compulsory insurance against third party claims.**

- **Regulatory changes that are necessary to reduce regulatory burden on and to expand the availability of sufficient radio frequencies, to micro satellites.**

- **In this regard, the efforts that being made by ITU as well as NOAA and FCC are good and should be followed by other States.**

- **International registration of all satellite ought to be followed more effectively. One may think of electronically linking national registries to international registry with the UN.**

- **Increased possibility of liability for damage by small satellites will impose regulatory and financial challenges for them.**

- **Thus, some sort of balance would be needed in the form of appropriate technical and regulatory measures; like international monitoring capabilities, space situational awareness, space traffic coordination, bilateral agreements between launch provider and satellite operator; insurance requirement, debris mitigation and removal, etc.**

Thank you for your attention !

Questions?