Space4U summer school

REGULATORY FRAMEWORK FOR CONDUCTING SUSTAINABLE SPACE ACTIVITIES

7 September 2020 I Catherine Doldirina, Dr. I D-Orbit Legal Counsel

REGULATORY FRAMEWORK FOR
CONDUCTING SUSTAINABLE
SPACE ACTIVITIES

OUTLINE

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- Introduction – definition of sustainability; application to space activities
- Sustainability tracks in space activities:
  - Sustainable access to space
  - Sustainable activities in space
  - Sustainable exit from space
- D-Orbit vision and initiative: The case for no waste – autonomous decommissioning devices as a requirement for satellites. An approach for Europe

REGULATORY FRAMEWORK FOR
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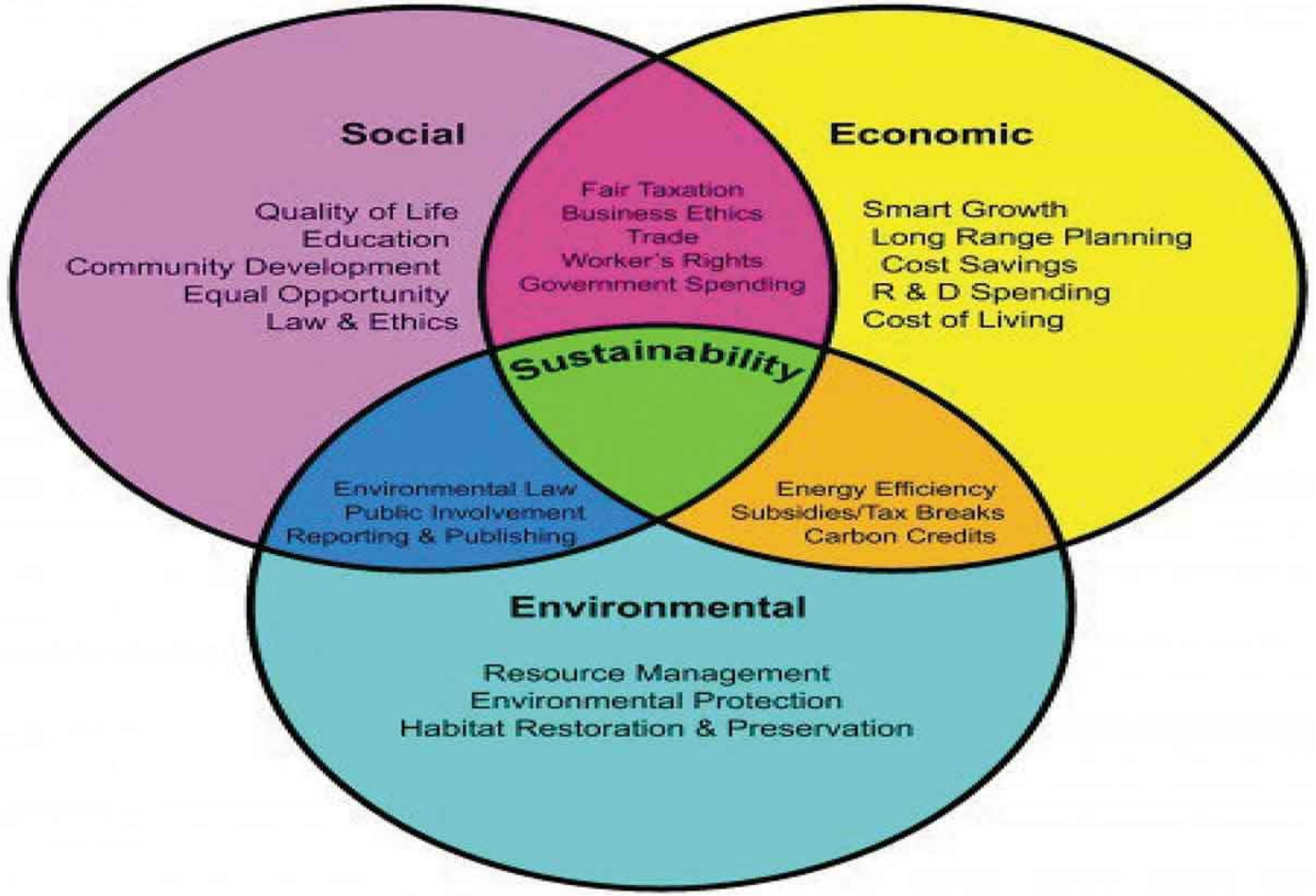
SPACE ACTIVITIES

INTRODUCTION: SUSTAINABILITY

- **Definition**
  - “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (1987, the United Nations Brundtland Commission)
- **Goal** - long-term stability of the economy and environment
- **Principles**
  - integration of environmental, social, and economic concerns into all aspects of decision making;
  - polluter pays principle – governments to require that polluting entities bear the costs of their pollution instead of others or the environment bearing those costs;
  - precaution - “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measure to prevent environmental degradation” (United Nations Conference on the Human Environment, 1992)
- **Pillars** economic social and environmental sustainability

SUSTAINABILITY



Justice Mensah, Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review *Cogent Social Sciences Journal* Vol. 5, 2019 Issue 1

SUSTAINABILITY: SPACE ACTIVITIES

- **Article I OST**
  - exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind
- **OST principles**
  - the non-appropriation of outer space by any one State;
  - the freedom of the use and exploration of outer space;
  - a liability regime applicable in the case of damage caused by space objects; the safety and rescue of space objects and astronauts;
  - the notification and registration of space activities with the UN;
  - the scientific investigation and exploitation of the natural resources of outer space;
  - the settlement of disputes arising from outer space activities.

SUSTAINABILITY: SPACE ACTIVITIES

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- **UN COPUOS Guidelines for the Long-term Sustainability of Outer Space Activities** (June 2019)
- **Definition**
  - the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations
- **Goal**
  - development of national and international practices and safety frameworks for conducting outer space activities while allowing for flexibility in adapting such practices and frameworks to specific national circumstances;

SUSTAINABILITY: SPACE ACTIVITIES

- **UN COPUOS Guidelines**
- **Guideline A.1**
  - Develop, revise, amend or adopt national regulatory frameworks to ensure and enhance the longterm sustainability of outer space activities, and the effective application of relevant, generally accepted international norms, standards and practices for the safe conduct of outer space activities

SUSTAINABILITY: SPACE ACTIVITIES

- **UN COPUOS Guidelines**
- **Guidelines A - Policy and regulatory framework for space activities**
- **Guideline A.2**
  - implement international obligations, including those arising under the United Nations space treaties to which they are party, including:
    - space debris mitigation measures;
    - risks to people, property, public health and the environment associated with the launch, in-orbit operation and re-entry of space objects;
    - minimization of the impacts of human activities on Earth as well as on the outer space environment;
    - the guidance contained in the Safety Framework for Nuclear Power Source Applications in Outer Space and satisfy the intent of the Principles Relevant to the Use of Nuclear Power Sources in Outer Space:
    - use of existing international technical standards, including those published by the International Organization for Standardization (ISO), the Consultative Committee for Space Data Systems and national standardization bodies
    - weighing the costs, benefits, disadvantages and risks of a range of alternatives to ensure that such measures have a clear purpose and are implementable and practicable in terms of the technical, legal and management capacities of the State imposing the regulation
    - encouraging advisory input from affected national entities during the process of developing regulatory frameworks governing space activities

SUSTAINABILITY: SPACE ACTIVITIES

- **UN COPUOS Guidelines**
- **Guideline A.3**
  - supervise national space activities
- **Guideline A.4**
  - Ensure the equitable, rational and efficient use of the radio frequency spectrum and the various orbital regions used by satellites
- **Guideline A.5**
  - Enhance the practice of registering space objects

SUSTAINABILITY: SPACE ACTIVITIES

- **UN COPUOS Guidelines**
- **Guidelines B - Safety of space operations**
  - Provide updated contact information and share information on space objects and orbital events
  - Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects
  - Promote the collection, sharing and dissemination of space debris monitoring information
  - Perform conjunction assessment during all orbital phases of controlled flight
  - Develop practical approaches for pre-launch conjunction assessment
  - Share operational space weather data and forecasts
  - Develop space weather models and tools and collect established practices on the
  - mitigation of space weather effects
  - Design and operation of space objects regardless of their physical and operational characteristics
  - Take measures to address risks associated with the uncontrolled re-entry of space objects
  - Observe measures of precaution when using sources of laser beams passing through outer space

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SUSTAINABILITY: SPACE ACTIVITIES

- **UN COPUOS Guidelines**
- **Guidelines C - International cooperation, capacity-building and awareness**
  - Promote and facilitate international cooperation in support of the long-term sustainability of outer space activities
  - Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange
  - Promote and support capacity-building
  - Raise awareness of space activities
- **Guidelines D - Scientific and technical research and development**
  - Promote and support research into and the development of ways to support sustainable exploration and use of outer space
  - Investigate and consider new measures to manage the space debris population in the long term

REGULATORY FRAMEWORK FOR CONDUCTING SUSTAINABLE SPACE ACTIVITIES

INTRODUCTION: SUSTAINABILITY TRACKS OF SPACE ACTIVITIES

SUSTAINABILITY TRACKS OF SPACE ACTIVITIES

- Access to space
- Activities in space
- Exit from space

REGULATORY FRAMEWORK FOR
CONDUCTING SUSTAINABLE
SPACE ACTIVITIES

ACCESS TO SPACE

ACCESS TO SPACE

- Authorisation of space activities
- Licensing
- Launch vehicles/spacecraft requirements
- Insurance

REGULATORY FRAMEWORK FOR
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SPACE ACTIVITIES

ACTIVITIES IN SPACE

Activities in space

- Near-earth orbits
- Deep space
- Celestial bodies

REGULATORY FRAMEWORK FOR
CONDUCTING SUSTAINABLE
SPACE ACTIVITIES

Activities in space: near-earth orbits

Activities in space: Near-earth orbits

- Operations
- Space situational awareness
- Space traffic management

Activities in space: Space situational awareness

- Necessity of an effective and efficient mechanism of monitoring and mitigating the risks posed by space debris to the growing number and types of space activities
- Space situational awareness as an undertaking on a global scale
- Status quo: most SSA and space debris mitigation activities are either undertaken by individual nations, or through bilateral agreements relating to sharing relevant capabilities

Activities in space: Space situational awareness

- Survey sensors
- Tracking sensors

Radar	Optical sensor
High latitudes (to cover the most populated LEOs)	Low to moderate latitudes (to optimize coverage of GEO)
No global distribution in longitude required	Global distribution required (to cover all longitudes in GEO, at least 4 sites)
Remote location, preferably in valley or depression	Low to moderate light pollution
Compliance with local telecommunications rules (to avoid interference with radio frequencies)	Telecommunications rules are not relevant
Weather conditions are of low importance	Good weather conditions, low humidity, low wind speeds

Activities in space: Space situational awareness

- SSA Arrangements - USA
  - NASA
  - DOD
  - JSpOC
  - US Strategic Command’s (USSTRATCOM)
  - Joint Force Space Component Command (JFSCC) and Combined Space Operations Center (CSpOC)
  - 18th Space Control Squadron (18 SPCS) and its Space Surveillance Network (SSN)
  - SSA data sharing agreements
  - Different tiers of access to SSA data and services

ACTIVITIES IN SPACE: SPACE SITUATIONAL AWARENESS

- SSA institutional arrangements - EU
  - Framework for Space Surveillance and Tracking Support (through EU Council Decision)
  - Civilian SST services only
  - Harmonisation of the telecommunications sector
  - Rules regarding export control and dual-use goods
  - SST infrastructure provided by participating EU Member States, and corresponding data exchange framework

Activities in space: Space situational awareness

- SSA institutional arrangements - ESA
  - SSA Programme: optional ESA programme with financial participation by 19 Member States
  - SSA: space weather, NEOs and SST segments
  - ESOC is the designated SSA Programme Office
  - Future structure: Coordination Centres, Service Centres, ESA/MS sensor infrastructure
  - SST segment is the weakest given the nature and mandate of ESA

Activities in space: Space situational awareness

- SSA institutional arrangements – Russian Federation
  - National service for space control (since 1962) reorganised in Centre of Space Control (Центр контроля космического пространства) in 1970
  - Russian Space Surveillance System
  - Recent modernisation of ground stations and significant expansion of the SSS locations, might have resulted in the Russian SST network surpassing the capacities of the US one
  - The Russian database of space objects is closed to the public. Debates on opening are on the way

Activities in space: Space situational awareness

- SSA institutional arrangements – ISON
  - Created in 2004-2008 and coordinated by the Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences
  - 35 optical observatories and observation facilities participating in ISON that operate more than 70 telescopes in 15 countries around the globe
  - Master Database of space objects currently counting over 4100 high altitude objects
  - Aims to be an independent source of data about natural and artificial space objects for scientific and applied purposes and to promote international cooperation between industrialised countries and emerging spacefaring nations

Activities in space: Space situational awareness

- Legal issues: dual use technology
  - Most of space technology is considered dual-use
  - Export control is primarily regulated by the law of the exporting state
  - Dual-use regulations (e.g. the US ITAR regulations, EU Dual Use Regulation) cover not only sensor equipment but various categories of data
  - Import or export approval is necessary both for hardware equipment (sensors, radars) and for data (information) resulting from SST activities
- Legal issues: protective measures
  - Networks used for transfer of SSA data can be considered critical infrastructure, and arrangements should be made to ensure their resilience and protection against cyber-attacks
  - Two models for data protection legislation: fragmented (USA) ad holistic (EU)

Activities in space: Space situational awareness

- Legal issues: access to data
  - Need: international SST data sharing policy or a universal framework for data sharing (e.g. within UN COPUOS)
  - Currently: bi- and multilateral data sharing agreements
  - Public-private and purely private arrangements for SST data sharing
  - Three models of sharing SSA data: national security information, not shareable (China, Russia); open data (ISON), mixed model (USA)

Activities in space: Space situational awareness

- Legal issues: responsibility and liability
  - International law foundation: Outer Space Treaty and Liability Convention: contributing to or causing outer space debris is neither seen as constituting fault
  - Soft-law rules governing space activities, e.g. ISO standards for after S/C life debris mitigation
  - National regulations
  - Issue: technical rules are non-retroactive, and responsibility for existing debris remains unharnessed
  - Provision of SSA data and services on the basis of full liability disclaimers
  - Implications for insurance practices

ACTIVITIES IN SPACE: SPACE SITUATIONAL AWARENESS

- Global coordination of SSA efforts
  - Proposed UN-run database “collecting, systemizing, sharing and analysing information on objects and events in outer space”
  - Enhancing open data model for SSA
  - Implementing the UN COPUOS Guidelines for the Long Term Sustainability of Outer Space Activities
  - Challenge: putting security and commercial interests in the picture
  - Governance and management architectures need to address implications from strategically interconnected areas:
  - (level of) Selective availability and exclusivity in inputs;
  - Levels of analysis and disclosure (selective availability in outputs);
  - Sharing of costs/resources; industrial and economic returns;
  - Institutional arrangements (e.g. EC GSA- model as civil SSAT agency or other operational entities, as well as the role of ESA);
  - Strategic complementarity/ substitutability with the US (and other) systems;
  - Discretion and rules towards strategic partnerships management.

Activities in space: Space situational awareness

- Summary
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SPACE ACTIVITIES

Activities in space: Celestial bodies

Activities in space: Celestial bodies

- Access to celestial bodies
- Contamination
  - Introduction of foreign biological matter (the bugs case on the Israeli moon rover)
- Other environmental issues
  - Terraforming
  - Use IAC presentation

Activities in space: Celestial bodies

- Space law and environmental protection
  - Outer Space Treaty, Moon Agreement, COSPAR Planetary Protection Policy
- International environmental law
  - Principles of the common heritage of mankind, of information exchange, precautionary principle and obligation conduct environmental impact assessment
- Analogy in international law
  - Serving the proper interpretation of general provisions of *leges speciales*

Activities in space: Celestial bodies

- Article IX Outer Space Treaty obligations:
  - to avoid harmful contamination of outer space
  - to consult
- Article 7 Moon Agreement provisions details Article IX OST
  - protection of outer space environment as such
- Both
  - principle of the common heritage of mankind

Activities in space: Celestial bodies

- **COSPAR Policy and Guidelines**
- Development started in 1957
- Categorisation of space missions and the degree of protection required
  - criteria – scientific interest & return to Earth
- Missions to Mars:
  - maximum levels of ‘bioburden’; ‘special regions’ where terrestrial organisms are likely to replicate
- Critique – too much focus on scientific interest, as opposed to the necessity to protect the environment as such

Activities in space: Celestial bodies

- **International environmental law**
- Principle of the common heritage of mankind
  - common concern of the international community as such & the concept of the benefit of future generations; requires cooperation
- Precautionary principle
  - prevention of environmental degradation cannot be conditioned to full certainty as to the cause of the (threat of) irreversible damage; scientific uncertainty & necessity to make decisions best for environment
  - Practically never ruled out as such
  - Legal norms of “self-contained regimes” never exist in a vacuum, but are linked with norms of general international law & jus cogens
  - Conditions for application of law norms by analogy:
  - ruled out (e.g. by principles of international criminal law)
  - regulated and unregulated issues are comparable
  - differences can be negated or are irrelevant

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  - prevention of environmental degradation cannot be conditioned to full certainty as to the cause of the (threat of) irreversible damage; scientific uncertainty & necessity to make decisions best for environment
- Environmental impact assessment
  - requirement under international law (ICJ) when risk of significant adverse impact in a transboundary context; prior to the activity; due diligence
  - shift from “react and correct” to “forecast and prevent” model of environmental protection
- Principle of information exchange
  - instrumental to all principles;
  - contributes to dialogue & transparency, timely notification & consultation, increased cooperation

Activities in space: Celestial bodies

- Analogy in international law
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  - Conditions for application of law norms by analogy:
    - ruled out (e.g. by principles of international criminal law)
    - regulated and unregulated issues are comparable
    - differences can be negated or are irrelevant
  - Obligation under the general international law to protect and preserve environment (per ICJ) includes:
    - notification & consultation; prior consent; env. impact assessment; early-warning mechanisms for damage mitigation
  - OST provides for norms directed at protecting both outer space and terrestrial environment
  - Space activities are inherently dangerous
  - Common heritage & concern link space law and env. law
  - Scope of e.g. Article IX OST can be interpreted as consistent with the meaning and context of international environmental law principles

Activities in space: Celestial bodies

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  - Common heritage & concern link space law and env. law
  - Scope of e.g. Article IX OST can be interpreted as consistent with the meaning and context of international environmental law principles
  - Protection and preservation of environment as such is an important international obligation
  - Both space and environmental law prohibit contamination
  - Principles of environmental law are more detailed due to the practice of use, codification and case-law
  - Interpretation of the environmental protection rules under space law by analogy to environmental law is only consistent with contemporary international law

Activities in space: Celestial bodies

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  - Protection and preservation of environment as such is an important international obligation
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REGULATORY FRAMEWORK FOR
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EXIT FROM SPACE

EXIT FROM SPACE: SPACE DEBRIS MITIGATION

- Space debris mitigation
  - International framework
  - National regulatory framework
  - The (il)legality of generating space debris
  - Nature of activity
  - Binding rules or soft-law
  - Validation, verification and enforcement of
  - effective space debris mitigation mechanisms
    - technical standards
    - the form if any of international coordination

EXIT FROM SPACE: SPACE DEBRIS

- Protected regions in IADC Guidelines
- Environmental concerns
  - prohibition of harmful contamination
  - permitted pollution quotas
- Obligations from international environmental law
  - relevance for outer space
  - contribution to proper enforcement of principles
  - incentive to adopt binding mechanisms

EXIT FROM SPACE: SPACE DEBRIS REGULATORY FRAMEWORK

- The COPUOS Guidelines
- The IADC Guidelines
- Other activities
  - ESA
  - NASA
  - ISO
- Left as guidelines
  - national implementation
  - coherence
  - enforcement
- International treaty
  - specifically regulating debris
  - STMS
  - space environment
- Other

EXIT FROM SPACE: COPUOS GUIDELINES

Voluntary measures for mission planning and operation of space objects

- Non-binding recommendations, but take into account provisions of the existing int-l law
- Very general – but – reference to the IADC Guidelines
- “Rationale” – set of guidelines based on the technical content and the basic definitions of the IADC Guidelines

EXIT FROM SPACE: IADC GUIDELINES

The IADC Guidelines (2002) and “Support to the IADC Space Debris Mitigation Guidelines” (2004)

• Three principles:

– prevention of space debris creation

– removal of inactive spacecraft from populated orbits

– limitation of the amount of space debris

Application: mission planning and the design; operation of spacecraft and launched orbital stages

• Definitions:

– space debris (non-functionality)

– spacecraft

– launch vehicles

– orbital stages

– protected regions

• Mitigation measures: passivation, de-orbiting, reorbiting and break-up

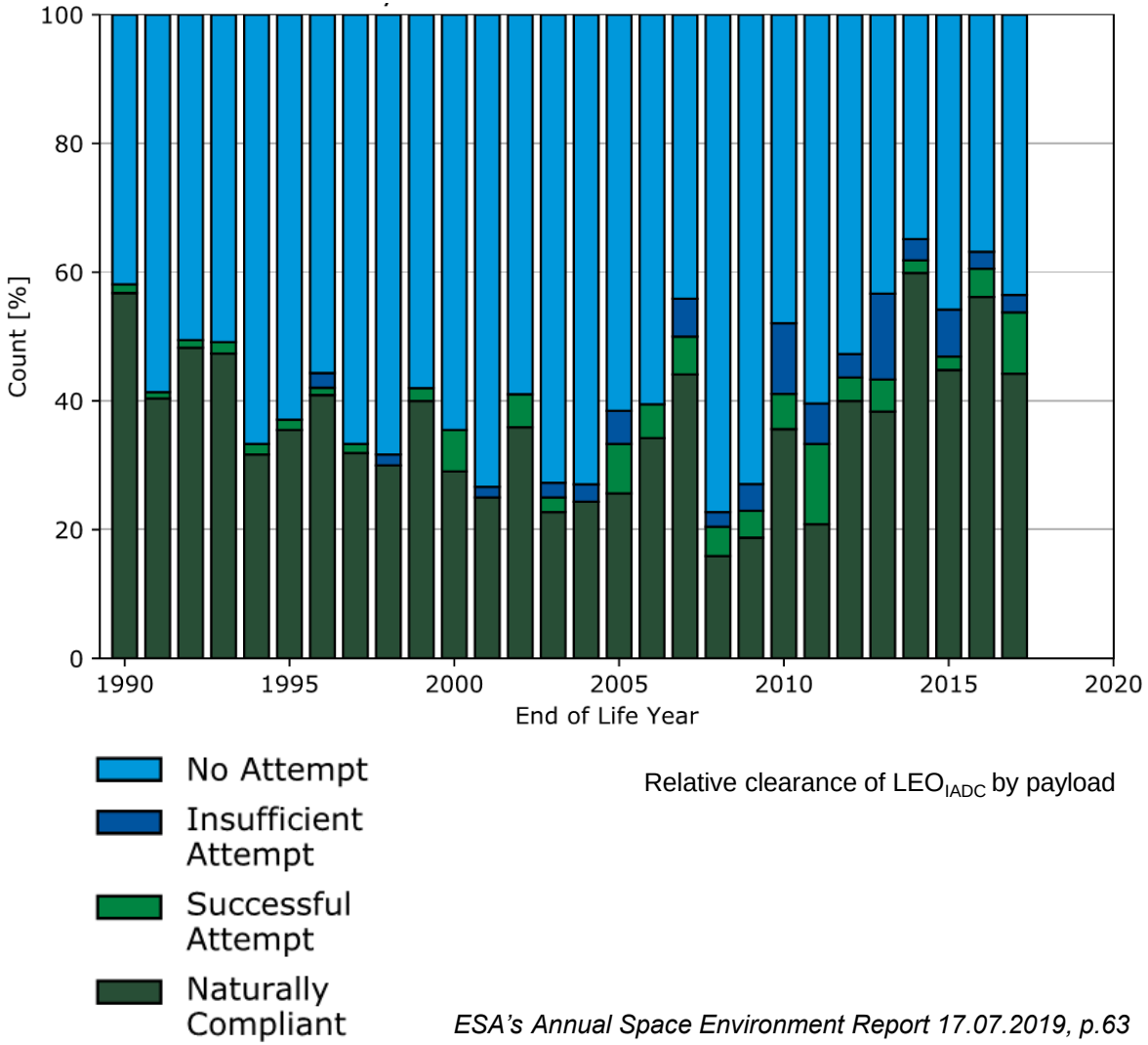
EXIT FROM SPACE: SPACE DEBRIS MITIGATION ENFORCEMENT

- Authority
- Monitoring
- Exchange of information
- Penalties for creating space debris
- Liability for damage
- Modification of information provided as per Registration Convention
- By analogy with other international mechanisms

REGULATORY FRAMEWORK FOR CONDUCTING SUSTAINABLE SPACE ACTIVITIES

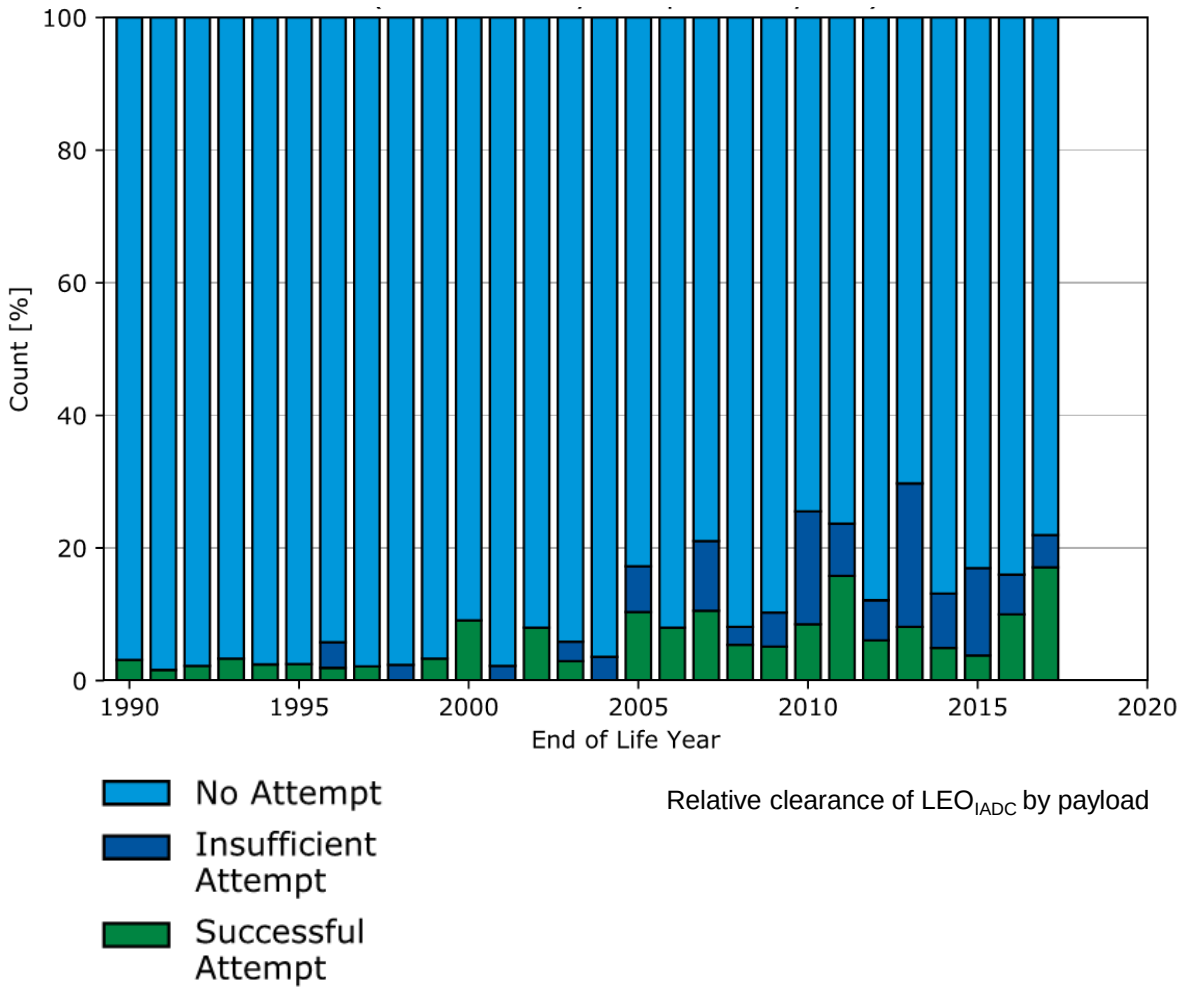
D-ORBIT VISION AND INITIATIVE: THE CASE FOR NO WASTE – AUTONOMOUS DECOMMISSIONING DEVICES AS A REQUIREMENT FOR SATELLITES. AN APPROACH FOR EUROPE

PAYLOAD CLEARANCE IN LOW EARTH ORBIT



Relative clearance of LEO_{IADC} by payload

ESA's Annual Space Environment Report 17.07.2019, p.63



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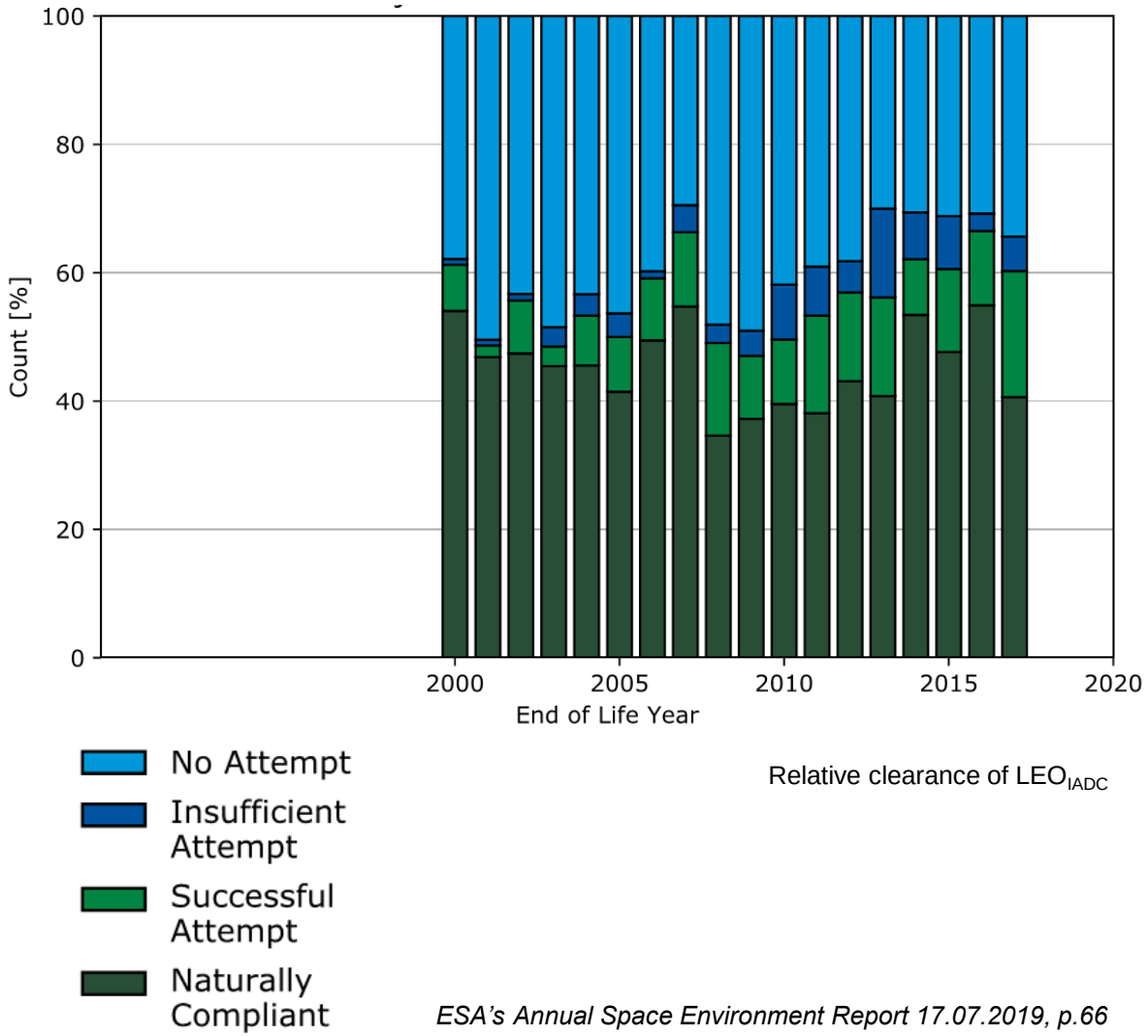
ESA's Annual Space Environment Report 17.07.2019, p.65

OBJECT CLEARANCE IN LOW EARTH ORBIT



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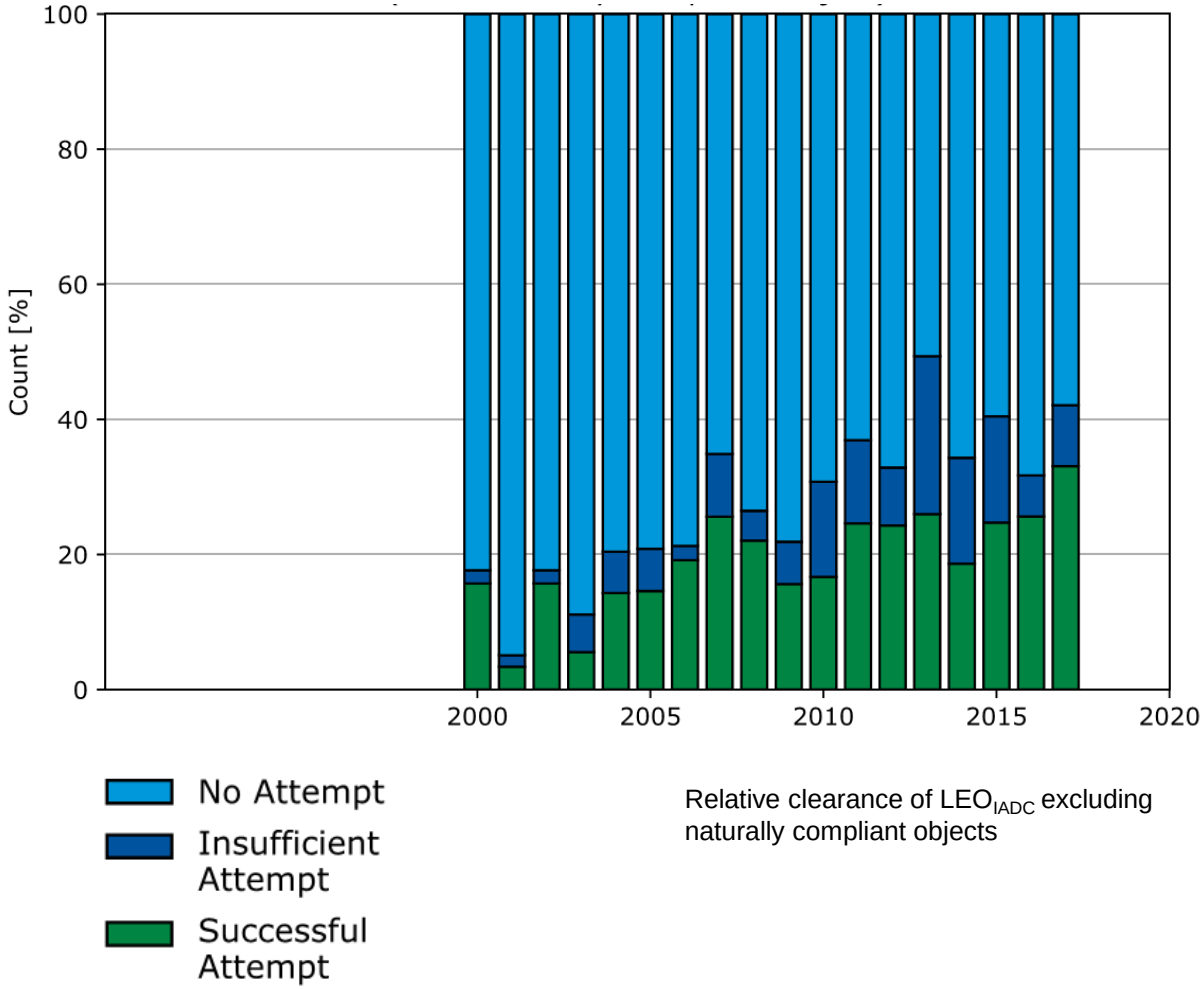


Relative clearance of LEO_{IADC} excluding naturally compliant objects

ESA's Annual Space Environment Report 17.07.2019, p.66

THE CASE FOR NO WASTE

TECHNICAL SOLUTION FOR COMPLIANCE WITH POST-MISSION DISPOSAL REQUIREMENTS

DECOMMISSIONING SOLUTIONS

- Manoeuvre by **station keeping motors** of a satellite to re-enter into Earth atmosphere or move to a graveyard orbit:
  - **Risk 1**: the fuel allocated to the decommissioning manoeuvre is more profitably used to extend the operational life of a satellite;
  - **Risk 2**: if the satellite malfunctions, the station keeping motors may not work;
  - **Risk 3**: only 60% of the satellite comply with decommissioning regulations, and only 10% of the satellites perform decommissioning manoeuvre.

- **Passive propulsion systems**:
  - **Risk**: not capable of executing a controlled manoeuvre.

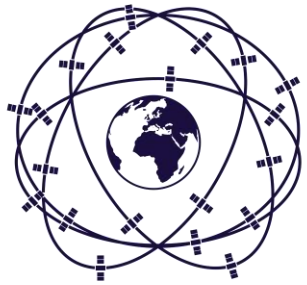
DECOMMISSIONING SOLUTIONS

- Manoeuvre by a **dedicated autonomous subsystem** of a satellite to re-enter into Earth atmosphere or move to a graveyard orbit:
  - **Advantage 1**: A system that can perform the de-orbit task without continuous guidance from ground, also if the satellite malfunctions;
  - **Advantage 2**: extremely reduced time of re-entry (within a few hours);
  - **Advantage 3**: the capability to perform an active and controlled re-entry (that is already a requirement for larger satellites).
  - **Risk 1**: current technology capabilities depending on the power of the engine and propulsion used;
  - **Risk 2:** reluctance to implement sustainable practices.

THE CASE FOR NO WASTE

NEED FOR MANDATORY END-OF-LIFE DECOMMISSIONING SUBSYSTEMS FOR SPACE OBJECTS

THE NEED IN A NUTSHELL

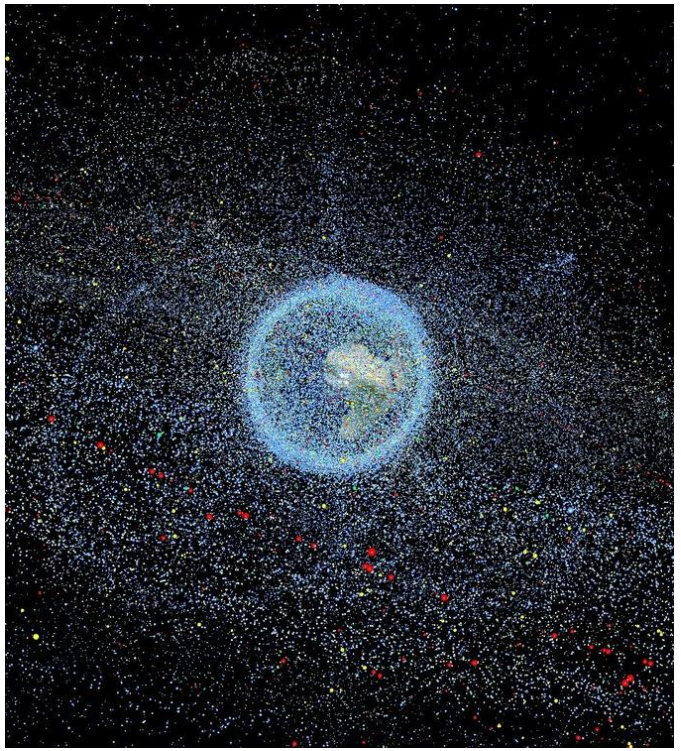


- Control and mitigate space debris and associated threats in the context of ever-expanding space activities and increased number of space objects in the near-Earth space;

- Meet strategic needs of the European Union for space safety, security and leadership as required by applicable policy and regulatory framework.

CONTROL AND MITIGATE SPACE DEBRIS

- Ensure sustainability of space activities;
- Ensure that near-Earth space does not become as congested as predicted;
- Minimise threats posed by obsolete satellites and space debris in general to the operating spacecraft.



EU STRATEGIC NEEDS

- Sustain **safe and secure space environment** while executing its space programme;
- Integrate **environmental protection requirements** into EU policies and activities;
- Sustain leadership in the area of **combating space debris**
  - including space situational awareness and space surveillance and tracking, complemented by synergies with initiatives of active removal of space debris and passivation measures;
- Increase its **competitiveness** world-wide through support to the European space industry.

THE CASE FOR NO WASTE

EU LEGAL BASIS

EU REGULATORY BASIS

- Article 189 of the Treaty of Lisbon: EU space policy shall promote scientific and technical progress, industrial competitiveness and the implementation of EU policies;
- Space Strategy for Europe (2016): strategic autonomy in accessing and using space in a secure and safe environment;
- Promotion of various space debris mitigation guidelines;
- Principles of procurement stipulating the obligation to satisfy appropriate social and environmental criteria (included in the EC 2018 Proposal for Space Programme Regulation).

REGULATORY ACTIONS

- **Goal**: reshape operational procedures and manufacturing designs to ensure responsible monitoring and control of space objects to effectively reduce generation of debris.

- **Means**:
  - public procurement mechanisms for space objects with clear and assessible requirements regarding integration of independent and autonomous decommissioning devices in procured satellites;
  - incorporation of such requirements as award criteria in the relevant tendering procedures;
  - evolution of public procurement requirements into industry standards.

MACRO-LEVEL BENEFITS

BENEFITS

- **For society**: new jobs, technology transfer and spin-offs, continuity of space-based services;

- **For the industry**: development of a new market, competitive position of domestic/regional industry, stimulation and uptake of innovation, reduction of costs of space operations;

- **For Europe**: sustained EU leadership that safeguards the strategic interest in secure and safe environment for outer space activities;

- **For space and for the future**: enhanced environmental performance of satellites; reinforcement of sustainable development goals, *inter alia* by establishing a community realisation that outer space is an environment that must be protected and respected.

CONCLUDING THOUGHTS

- The approach can be useful to space-faring nations who:
  - consider adopting **regulatory steps** to ensure long-term sustainability of space activities they conduct, authorise or supervise;
  - aim at setting up and implementing an effective **space debris mitigation strategy**;
  - wish to act as a facilitator of the uptake of **innovative and sustainable technologies** by introducing procurement mechanisms with requirements to furnish space objects capable of performing controlled and autonomous re-entry manoeuvre at the end of their operational life;
  - recognise **sustainable behavior** of its space actors.

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THANK YOU!