Dangers From Regulatory Vacuums in Outer, Inner, and Near Space

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The Main Points

Outer space is becoming accessible, useful, and habitable. McKinsey & Co. estimates 2023 global space commerce value at $630 billion, increasing to $1.8 trillion by 2035 (shttp://www.mckinsey.com/industries/aerospace-and-defense/our-insights/space-the-1-point-8-trillion-dollar-opportunity-for-global-economic-growth)

New opportunities include bridging the Digital Divide with ubiquitous and affordable broadband, tourism, mining asteroids for valuable minerals, and even colonization of the Moon and Mars.

Spent launch stages, decommissioned satellites, and debris fields created by indiscriminate anti-satellite weapons testing risk an Outer Space Tragedy of the Commons also known as the Kessler Syndrome.

Without significant amendment to space and spectrum resource management treaties, the UN and ITU will continue to lack authority to require mitigation of space debris and to address emerging conflicts triggered by space commercialization and weaponization.

The five Space Treaties, circa 1960s-70s, commit nations to peaceful uses for the benefit of all. Private ventures not anticipated.

Spacefaring nations and private ventures need financial incentives to promote sustainability foreclose scenarios where space is too risky for investment and insurance underwriting.

Recent Space Headlines

A Half-Ton Piece of Space Junk Falls Onto a Village in Kenya (Jan. 2, 2025)

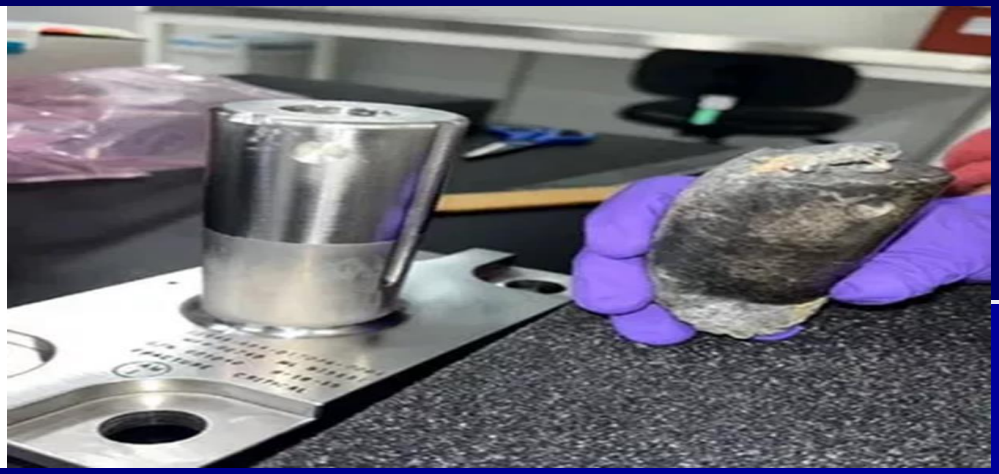
No one was hurt by the object, believed to be part of a launch rocket. Experts say the frequency of such incidents is increasing as the amount of debris in orbit around the Earth grows dramatically.

https://www.nytimes.com/2025/01/02/world/africa/kenya-space-debris-rocket.html

Recent Space Headlines

NASA Confirms Where the Space Junk That Hit a Florida House Came From

Space law just got a little more complicated.



Debris Gives Space Station Crew Members a 29,000-M.P.H. Close Call

A Dead Russian Satellite Broke Into More Than 100 Pieces in Space

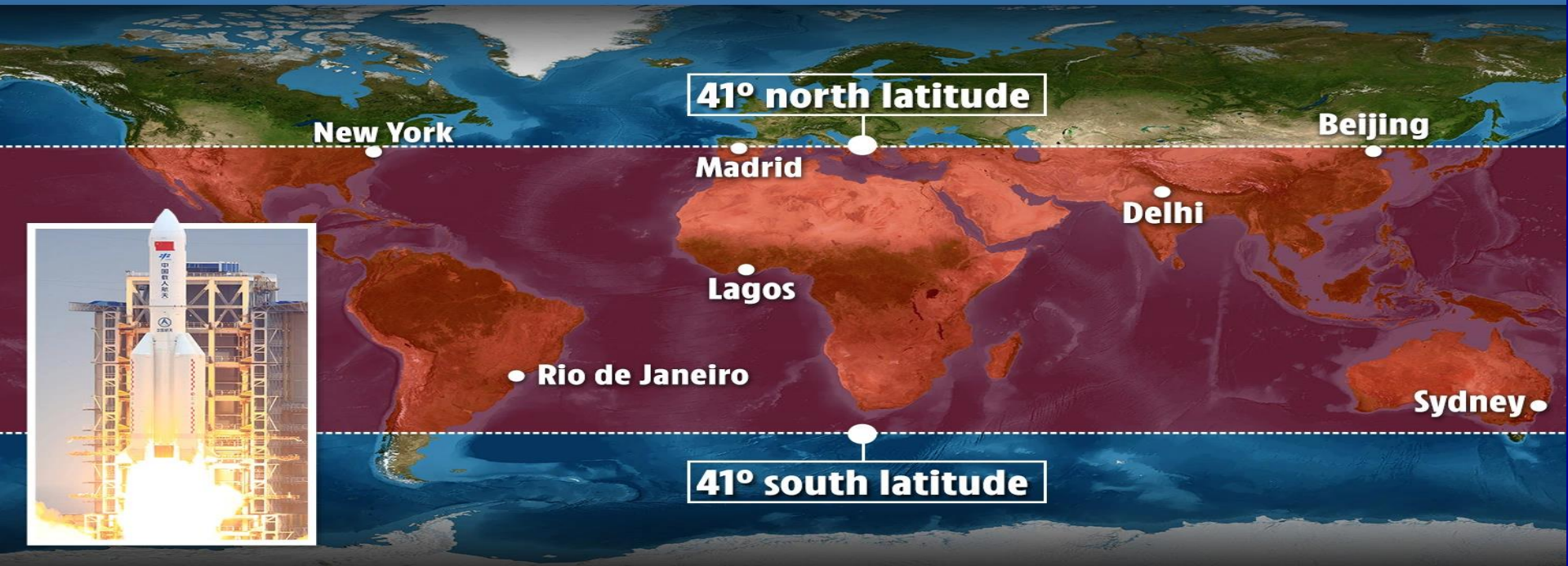
The space station just dodged debris from a 2007 Chinese weapons test.

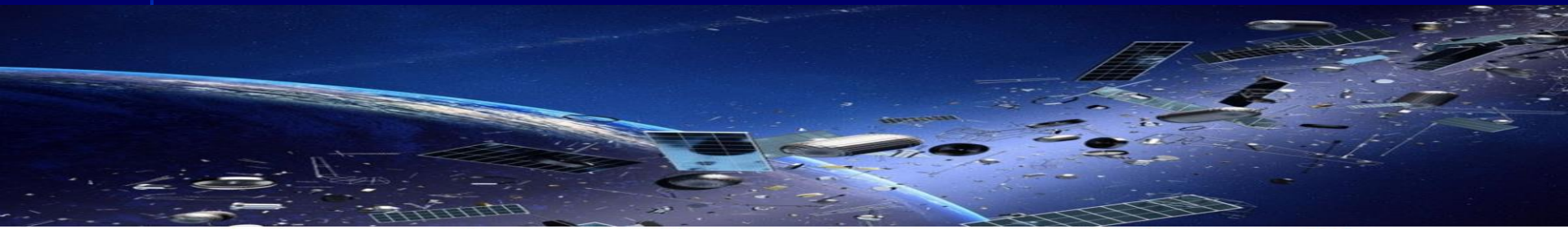
A piece of debris whizzes past the Crew Dragon

23 tons of space junk (a Chinese rocket booster) fell without much tracking certainty

HUGE CHINESE ROCKET FALLING TO EARTH

Long March 5b could land on a number of cities





Russian direct-ascent anti-satellite missile test creates significant, long-lasting space debris

By U.S. Space Command Public Affairs Office

PETERSON SPACE FORCE BASE, Colo. — Russia tested a direct-ascent anti-satellite (DA-ASAT) missile on Nov. 15, 2021, Moscow Standard Time, that struck a Russian satellite [COSMOS 1408] and created a debris field in low-Earth orbit. The test so far has generated more than 1,500 pieces of trackable orbital debris and will likely generate hundreds of thousands of pieces of smaller orbital debris.

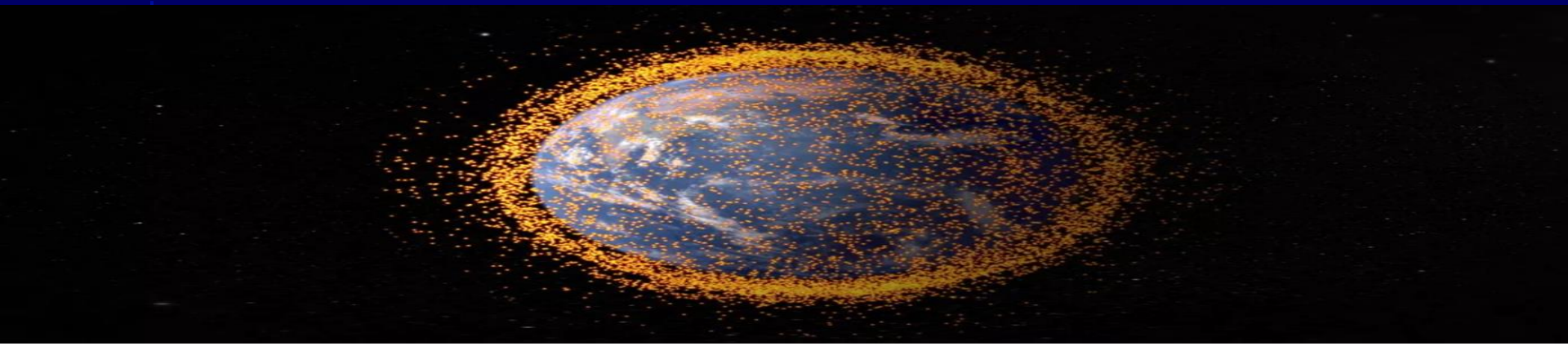
"Russia has demonstrated a deliberate disregard for the security, safety, stability, and long-term sustainability of the space domain for all nations," said U.S. Army Gen. James Dickinson, U.S. Space Command commander. "The debris created by Russia's DA-ASAT will continue to pose a threat to activities in outer space for years to come, putting satellites and space missions at risk, as well as forcing more collision avoidance maneuvers. Space activities underpin our way of life and this kind of behavior is simply irresponsible."

USSPACECOM's initial assessment is that the debris will remain in orbit for years and potentially for decades, posing a significant risk to the crew on the International Space Station and other human spaceflight activities, as well as multiple countries' satellites. USSPACECOM continues to monitor the trajectory of the debris and will work to ensure all space-faring nations have the information necessary to safeguard their on-orbit activities if impacted by the debris cloud, a service the United States provides to the world, to include Russia and China.

"Russia is developing and deploying capabilities to actively deny access to and use of space by the United States and its allies and partners," Dickinson added. "Russia's tests of direct-ascent anti-satellite weapons clearly demonstrate that Russia continues to pursue counterspace weapon systems that undermine strategic stability and pose a threat to all nations."

Media queries should be sent to U.S. Space Command Public Affairs Office at 719-554-3478 or USSPACECOM.PA.MEDIA@us.af.mil.

Chinese righteous indignation at the near collision between a SpaceX satellite and the Tiangong space station.



United Nations A/AC.105/1262

General Assembly

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Committee on the Peaceful Uses of Outer Space

Information furnished in conformity with the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies

Note verbale dated 3 December 2021 from the Permanent Mission of China to the United Nations (Vienna) addressed to the Secretary-General

Nuclear Fallout

On Jan. 24, 1978, a Soviet nuclear satellite called Kosmos 954 re-entered the Earth's atmosphere and exploded over northern Canada. Radioactive debris was spread across the eastern part of the Northwest Territories, the western part of what's now Nunavut and into northern Alberta and Saskatchewan.

Chinese government claims an off-course weather satellite did not violate U.S. sovereignty as it flew over Alaska and CONUS, including military installations

Research Questions

What chronic and potentially acute problems may trigger a calamity and subsequent calls for immediate reforms?

What factors explain why the Space Treaties have not been amended, despite substantially changed circumstances and increasing sustainability risks since enactment?

What are the key structural, administrative, and substantive reforms needed to avert weaponization of space, spacecraft collisions, toxification, and other threats to commerce and sustainability?

The Five Space Treaties

1) Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies; 18 U.S.T. 2410 (1967), 610 U.N.T.S. 205 (1967); https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html.

2) Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; 19 U.S.T. 7570 (1968), 672 U.N.T.S. 119 (1968); https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/rescueagreement.html

3) Convention on International Liability for Damage Caused by Space Objects; 24 U.S.T. 2389 (1972), 961 U.N.T.S. 187 (1972); https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/liability-convention.html

4) Convention on Registration of Objects Launched into Outer Space; 28 U.S.T. 695 (1975), 1023 U.N.T.S. 15 (1975); https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/registration-convention.html and

5) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies. 1363 U.N.T.S. 3 (1979); https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/moon-agreement.html.

Non-Enforceable Responsibilities

Article VIII of the Outer Space Treaty requires signatory nations to retain jurisdiction and control over any space object launched from their territory, and over any personnel while in outer space, or on a celestial object.

The Liability Convention specifies that a signatory nation shall provide compensation for damage caused by a space object it has launched. A nation also may incur liability for damages incurred in space for which it is at fault. Because the Convention does not define fault, it remains uncertain under what specific circumstances a launching country would incur liability.

The Convention also identifies voluntary procedures for the settlement of claims for damages.

The Space Treaties apply solely to national governments, not private ventures.

Legal Framework for Orbit/Spectrum Access/Use

UN Outer Space Treaty 1967

The UN recognizes the ITU as the specialized agency *responsible* for taking such action as may be appropriate under its basic instrument for the accomplishment of the purposes set forth therein *(Constitution (CS), Convention (CV), Radio Regulations (RR), Rules of Procedures (RoP), Recommendations (Rec))*

- **Principles of use of orbit/spectrum**
- **Allocation of frequency bands**
- **Regulatory Procedures and Plans**
- **Operational measures**

Legal Framework for Orbit/Spectrum Access/Use

UN Outer Space instruments (*on space objects*)		ITU Instruments (*on radio frequencies*)
Free "exploration and use" OST Art. I *under international law*	⇨	**Equitable** access and **rational** use of spectrum *under international law* CS ART 44
Art. VI **States** "responsibility" & "licensing" Art. VIII "jurisdiction & control"	⇨	**States** must **license** transmitting radio stations RR ART 18 shall **not cause harmful interference** CS ART 45 RR ART 15
States Art. VIII Registration OOSA	⇨	**States** RR ART 9, 11 **API_CR/C_MIFR**
Art. VII States "liable" for **damage**	⇨ (crossed out)	*No liability clauses*

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Source: Atilla Matas, ITU orbit/spectrum regulatory procedures; retrieved from: https://swfound.org/media/205521/matas-attila-en-1-1139-1-1.pdf

Legal Framework for Orbit/Spectrum Access/Use

ITU Constitution – Articles 44 and 45

Objectives:

- *To ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum and satellite-orbit resources*
  in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies, taking into account the special needs of the developing countries and the geographical situation of particular countries

- ***To avoid harmful interference***

- To establish global standards to assure the necessary required performance, interoperability and quality

ITU Spectrum Planning in a Nutshell

The ITU is the oldest, continuously operating inter-governmental organization, operating since 1875.

Now, a specialized agency of the U.N., it seeks to build consensus on spectrum allocations, satellite orbital plane uses, technical standards, and ICT4D.

While some national commitments have treaty-level significance, much of what the ITU does lies in non-binding, but consensus driven recommendations that most nations accept and implement.

Positive network externalities favor shared standards, "uniform rules of the road," and conflict avoidance that support single global product lines, fewer incompatible frequency assignments and tech standards, little, if any, signal interference, and no collisions of spacecraft.

ITU spectrum planning is a time consuming, methodical process involving: 1) development of an agenda of new allocations and reallocations, first subject to study and analysis; 2) opportunities for national delegations to articulate their position; 3) consensus building and development of national commitments, to reduce the number of non-conforming footnotes to specific spectrum allocations by individual nations; 4) formal designation of frequency allocations for one or more specific services by the ITU and individual nations; and 5) the eventual registration of radio spectrum uses and satellite orbital locations by the ITU.

The Rising Risk of Ruin by Space Debris

The primary orbital slots for satellites are limited by physics and mission. Geosynchronous satellites match the earth's orbital speed and operate in a stable, fixed orbit 22,300 above earth. Ideal for point-to-multipoint service, such as broadcast audio and video.

Low earth orbiting ("LEO") satellites operate 200-1200 miles above earth. A large constellation of small satellites necessary for global coverage, because of close proximity to earth; small, moving footprints.

Over 10,000 satellites currently orbit earth.

Individual satellite operators have little incentive to conserve space resources through space debris mitigation, e.g., recycling space launch stages, ejecting end of life satellites outward into deep space, or on a steep earthbound trajectory leading to vaporization.

The Tragedy of the Commons/Kessler Syndrome results when users of a shared and scarce resource incur little, if any consumption costs. They have an individual incentive to overuse, even though collectively such action can generate congestion, radio interference, collisions, and proliferating space debris.

The UN and ITU Lack Authority to Require Space Debris Mitigation by Nation States and Private Ventures

The Space Treaties appeal to the goodwill of nations to promote peaceful uses of Outer Space for the benefit of all.

The Treaties anticipate the potential for actions causing damage, but do not mandate compensation and sanction noncompliance.

The Treaties do not apply to private spacefaring ventures.

Without "skin in the game" (financial incentives or liability for polluting space), Nation States and private ventures have little incentive to conserve space resources and to refrain from actions that create a toxic environment, e.g., failing to remove no longer used space objects and irresponsible testing of ASAT weapons.

Space junk proliferation has a domino effect: More debris triggers the higher likelihood for more collisions of space objects that will cascade into a larger debris field resulting in even more collisions or emergency collision avoidance maneuvers using limited navigation fuel.

Types of Damages in Space and on Earth

Space Debris Collisions with Valuable, Operational Space Objects, e.g., 2009 Russian Cosmos 2251 collision with an Iridium LEO satellite; see https://swfound.org/media/6575/swf_iridium_cosmos_collision_fact_sheet_updated_2012.pdf .

Two valueless space objects collide generating more space debris, e.g., the 1996 collision between the French Cerise military reconnaissance satellite and debris from an Ariane rocket.

Massive space debris proliferation from ASAT testing. Kinetic energy ASATs physically collide with satellites at high speeds, and can include ballistic missiles, drones, and explosives. Non-kinetic ASATs use non-physical methods to disable satellites, such as cyberattacks, jamming, or blinding satellites with lasers. ASAT technology can be earth-based or in-space.

Atmospheric pollution and incomplete vaporization of abandoned space objects, e.g., January 24, 1978, Russian Cosmos 954, with 50 kg of Uranium 235, contaminated 124,000 sq. km of northern Alberta and Saskatchewan. The government of Canada billed the Soviet Union over $6 million for damages caused by the satellite, but only received $3 million in compensation. See https://www.rcinet.ca/en/2017/01/24/canada-history-jan-24-1978-soviet-radiation-across-the-arctic/

Recommendations

The Five Space Treaties need substantial amendment creating enforceable rights and responsibilities for national governments and private ventures. Emphasis on clear and enforceable duties of care.

Few spacefaring stakeholders will agree to a moratorium on space and radio spectrum resource use, pending consensus building on a leisurely schedule like the 4-year cycle for ITU conferences.

If a private venture's owned and operated space object collides with, and damages another space object, the private venture specifically should bear financial responsibility to compensate the harmed public or private entity.

Ideally, public and private ventures owning and operating space objects, such as satellites, should incur the responsibility to eject end of life space objects into deep space or on a downward trajectory with 100% vaporization, or minor residue field at remote ocean locations.

Recommendations (cont.)

Nation States and private ventures should deposit funds into an account that could be tapped to compensate other parties harmed by a collision or impact from space debris abandoned by a known party. Such an escrow account also could provide a bounty for ventures that collect and dispose of space debris.

The UN should reiterate that space cannot be weaponized or colonized. Violators should face sanctions including the loss of privileges and rights conferred by the Space Treaties.

The UN and ITU need to improve coordination of individual and joint responsibilities and more proactively anticipate emerging conflicts. Their registration functions cannot remain passive and perfunctory.