SEMINARARBEIT

SPACE DEBRIS AND SPACE TRAFFIC MANAGEMENT: TWO CONTEMPORARY ISSUES OF SUSTAINABLE SPACE SECURITY

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1. Abbreviations

ASAT	Anti-Satellite Weapon Test
ASI	Agenzia Spaziale Italiana
BNSC	British National Space Centre
CD	United Nations Conference on Disarmament
CNES	Centre national d’études spatiales (France)
CNSA	China National Space Administration
COPUOS	Committee on the Peaceful Uses of Outer Space
CSA	Canadian Space Agency
DISCOS	Database and Information System Characterising Objects in Space
DLR	German Aerospace Center
DoD	Department of Defense (U.S.)
ESA	European Space Agency
EU	European Union
EUCoC	Code of Conduct for Outer Space Activities of the European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FCC	Federal Communications Commission (U.S.)
GEO	Geostationary Earth Orbit
GGE	Group of Governmental Experts
GPS	Global Positioning System (U.S.)
GRAVES	Grande Réseau Adapté à la Veille Spatiale (France)
HEO	High Elliptical Orbit
IAA	International Academy of Astronautics
IADC	Inter-Agency Space Debris Coordination Committee
ILC	International Law Commission
ISRO	Indian Space Research Organisation
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
JSpOC	Joint Space Operations Center (U.S.)
LEO	Low Earth Orbit
LTSSA	Long Term Sustainability of Space Activities
MEO	Medium Earth Orbit
NASA	National Aeronautics and Space Administration (U.S.)
NSAU	National Space Agency of Ukraine
OST	Outer Space Treaty
PAROS	Prevention of an Arms Race in Outer Space
Roscosmos	Russian Federal Space Agency

SSA	Space Situational Awareness
SSN	Space Surveillance Network (U.S.)
SSS	Space Surveillance System (Russia)
STM	Space Traffic Management
STRATCOM	Strategic Command (U.S.)
STSC	Scientific and Technical Subcommittee
TCBM	Transparency and Confidence-Building Measures
TIRA	Tracking and Imaging Radar
UARS	Upper Atmosphere Research Satellite
UNCOPUOS	United Nations Committee on the Peaceful Uses of Outer Space
UNGA	United Nations General Assembly
UNODA	United Nations Office of Disarmament Affairs
USAF	United States Air Force
USSTRATCOM	United States Strategic Command
WG	Working Group
WTO	World Trade Organisation

2. Introduction

In the past years, significant debris-generating events as well as improved tracking abilities have encouraged the recognition of space debris as a significant threat. The impact of space debris on space security is related to a number of key issues, including the amount of space debris in various orbits, space surveillance capabilities that track space debris to enable collision avoidance, as well as policy and technical efforts to reduce new debris and to potentially remove the existing space debris in the future. While the existing international space law is widely considered outdated and insufficient to address the current challenges to space security posed by space debris, governmental and non-governmental agencies, the United Nations and the European Union have adopted, principles, resolutions, confidence-building measures, and voluntary technical regulatory guidelines. This paper outlines the problem of space debris and gives an overview of the current international legal and regulatory framework governing space activities.

3. The Problem of Space Debris

a. Definition and Sources of Space Debris

There is no international agreement on the definition of space debris. According to the 2007 Space Debris Mitigation Guidelines by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), space debris includes "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional."[1] According to the 2006 Space Traffic Management Report (STM) by the International Academy of Astronautics (IAA), space debris is defined as "all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere, that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or other functions for which they are or can be authorized."[2] Four types of space debris can be differentiated: Inactive payloads, operational debris, fragmentation debris, and microparticulate debris.[3] Inactive payloads consist primarily of defunct Earth orbiting satellites. Microparticulate debris includes dust from solid rocket motors and surface degradation products such as paint flecks. Mission-related or operational debris are objects intentionally discarded during satellite delivery or satellite operations, including lens caps, separation and packing devices, spin-up mechanisms, empty

[1] Committee on the Peaceful Uses of Outer Space, Scientific & Technical Subcommittee, Report on its 44th Session, Feb. 12-23 2007, U.N. Doc. A/AC.105/890, Annex 4, [hereinafter UNCOPUOS Space Debris Mitigation Guidelines], available at http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_890E.pdf and http://www. oosa.unvienna.org/pdf/publications/st_space_49E.pdf (last visited on 21 May 2013).
[2] International Academy of Astronautics, Cosmic Study on Space Traffic Management (2006), at 21, sec. 1.3., [hereinafter IAA STM Report], available at http://www.iaaweb.org/iaa/studies/spacetraffic.pdf (last visited on 21 May 2013).
[3] Diaz D. Trashing the final frontier: an examination of space debris from a legal perspective. Tulane Environmental Law Journal 1993;6:369-395, at 372, 737; see also Bird R. Special issue on legal issues affecting international business: procedural challenges to environmental regulation of space debris. American Business Law Journal 2003;40:635-684, at 639 *et seq*.

propellant tanks, and payload shrouds.[4] Today, most missions have very few pieces of this type of debris, and Low Earth Orbit (LEO) objects of this type will re-enter the Earth's atmosphere more rapidly.[5] By far the largest percentage of the catalogued space debris originates from the fragmentation of spacecraft and launch vehicle stages due to energetic events such as explosions or collisions (Figure 1.1).[6] These can be both unintentional as in the case of unused fuel exploding or intentional as in the testing of weapons in space that utilize kinetic energy interceptors. While the cause of over one-in six debris generating fragmentation events is still unknown, the majority of on-orbit fragmentations result from propulsion-related events caused by catastrophic malfunctions during orbital injection or maneuvers and subsequent explosions based on residual propellants.[7] Therefore, the most effective mitigation measure has been the passivation of spacecraft and launch vehicle orbital stages at the end of their mission.[8]

The types of Earth orbits are depicted in Figure 1.2. LEO is the most highly congested area, especially the Sun-synchronous region.[9] Some debris in LEO will re-enter the Earth's atmosphere and disintegrate in a relatively short period of time due to atmospheric drag.[10] At a 600 km altitude, an object will re-enter in fifteen years.[11] At the altitude where most satellites orbit, above 850 km, the re-entry time is usually measured in centuries.[12] Space debris located in Medium Earth Orbit (MEO) and Geostationary Earth Orbit (GEO) can potentially remain there for hundreds of years or indefinitely unless they are purposely decommissioned and decelerated to a lower orbit or transferred to a higher graving orbit where they will not interfere with the orbits of other spacecraft.[13] Because of orbital velocities of up to 7.8 km per second (~30.000 km per hour) in LEO debris as small as 10 cm in diameter carries the kinetic energy of a 35.000 kg truck travelling at up to 190 km per hour and imposes therefore a significant risk of damage from collision with spacecraft and launch vehicle orbital stages (Figure 1.3).[14] Although space objects in GEO have lower relative velocities, debris at this altitude is still moving as fast as a bullet – about 1.800 km per hour.[15] Satellites and spacecraft can

[4] National Aeronautics and Space Administration (NASA)-Handbook for Limiting Orbital Debris, doc. 8719.14, 30 July 2008, sec. 4.2.2.1, at 26, available at http://www.hq.nasa.gov/office/codeq/doctree/NHBK871914.pdf (last visited on 21 May 2013).
[5] Ibid., sec. 4.2.2.1, at 27.
[6] Ibid., sec. 4.2.2.2, at 27.
[7] Ibid., sec. 4.2.4.1, at 31.
[8] Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines (IADC-02-01, rev.1), Sept. 2007, sec. 3.4.1, at 6, available at http://www.iadc-online.org/index.cgi?item=docs_pub (last visited on 21 May 2013) [hereinafter IADC Space Debris Mitigation Guidelines]. Passivation requires the removal of all forms of stored energy, including residual propellants and compressed fluids, and the discharge of electrical storage devices.
[9] Space Security Index 2012, ed. Cesar Jaramillo, Spacesecurity.org, Sept. 2012, at 28, available at http://www.spacesecurity.org/SpaceSecurityReport2012.pdf (last visited on 21 May 2013).
[10] Akers A. The infinity and beyond: orbital space debris and how to clean it up. University of La Verne Law Review 2012;33:285-317, at 291; see also Williamson M. Space: The Fragile Frontier (AIAA 2006), at 73.
[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] Space Security Index 2012, *supra* fn 9, at 27.
[15] Ibid.

be designed to withstand minor impacts from space debris, however, it is considered impractical to shield against objects bigger than a few centimetres.[16]

Orbital debris re-entering the Earth's atmosphere is not uncommon. At least one piece of debris reportedly re-enters the atmosphere each day[17], but large objects re-enter the Earth's atmosphere on average once a year.[18] In 2011, 39 satellites re-entered Earth's atmosphere including NASA's Upper Atmosphere Research Satellite (UARS) and the German X-ray astronomy satellite ROSAT.[19] UARS re-entered the atmosphere and fell to Earth over the middle of the Pacific Ocean on 24 September 2011. ROSAT re-entered the Earth's atmosphere over the Bay of Bengal on 23 October 2011 (it is unclear if any pieces of the satellite reached the Earth's surface). Both uncontrolled satellite re-entries as well as the re-entry of Phobos-Grunt in early 2012[20] received significant mainstream media attention all over the world. An increase in re-entries is expected as a result of a period of high solar activity in 2013.[21] Greater solar activity will expand the atmosphere, causing increased atmospheric density, and thus more drag, to objects below 900 km in altitude. During periods of high solar activity, objects in these lower altitudes are expected to have their altitudes lowered as much as ten times more quickly than during periods of low solar activity.[22]

In order to actively remove space debris, various de-orbiting techniques are currently being researched and being recommended to national and international agencies. Politically, the situation of active debris removal is complex due to liability, safety and security issues surrounding the relocation of the debris. The techniques of satellite disposal in LEO and GEO are different.[23] Removal measures for LEO satellites include direct controlled re-entry into the atmosphere over the ocean (which requires enough fuel reserve to transfer the satellite into a lower orbit to allow controlled disposal), use of a robotic arm mounted on space shuttles to retrieve debris, as well as other proposed solutions such as the attachment of electrodynamic tethers to the satellites before the launch (which increase the atmospheric drag and speed up the atmospheric re-entry) or the use of a powerful ground-based laser (to ablate the front surface off of debris, thereby producing a rocket-like thrust that slows the object;

[16] Ibid., at 28.
[17] Akers A, *supra* fn 10, at 291; see also Greenfieldboyce N. Where falling satellite lands is anyone's guess. NPR Online (21 Sept. 2011), http://www.npr.org/2011/09/21/140641362/where-falling_satellite-lands-is-anyones-guess?sc=emaf and http://m.npr.org/news/Science/140641362 (last visited 22 May 2013).
[18] Ibid.; see also Space Security Index 2012, *supra* fn 9, at 33. Predicting the re-entry of space objects is difficult because the density of the Earth's atmosphere is constantly changing. Greenfieldboyce N, *supra* fn 17.
[19] Space Security Index 2012, ibid., at 34; Data compiled by Nicholas Johnson from the Space Track public satellite catalogue maintained by the U.S. military, available at http://space-track.org.
[20] Ibid., at 35, 53. The Russian Phobos-Grunt spacecraft had been launched on 9 November 2011 from Baikonur. The Phobos-Grunt probe was intended to conduct a scientific research mission of Mars. Because of an onboard system failure, Phobos-Grunt failed to perform two booster ignitions that would have carried it to Mars and stranded in LEO. Russia, working with the United States and the ESA in an international cooperation, tried to regain control of Phobos-Grunt. When this effort failed, they continued to cooperate in tracking the unresponsive spacecraft through its re-entry in the Pacific Ocean off the coast of Chile on 15 January 2012.
[21] Ibid., at 34.
[22] Ibid.; Data compiled by Nicholas Johnson from the Space Track public satellite catalogue maintained by the U.S. military, available at http://space-track.org.
[23] COPUOS Space Debris Mitigation Guidelines, *supra* fn 1, Annex 4 P4, at 3-4; see also Akers A, *supra* fn 10, at 308 *et seq*.

with a continued application the debris will eventually decrease their altitude enough to become subject to atmospheric drag).[24] De-orbiting of GEO satellites is currently not possible because the altitude of GEO is too high to allow re-entry into the Earth's atmosphere. The only existing cost-effective option to prevent interference of decayed GEO satellites with active satellites is to move them to a higher orbit (some 235 km above the GEO orbit).[25]

b. Amount of Space Debris

Between 1961 and 1996, an average of approximately 240 new pieces of debris were catalogued each year (Figure 1.4).[26] This increase in the number of pieces resulted from the fragmentation of existing space debris and from the presence of new satellites in orbit. Between October 1997 and June 2004 only 603 new pieces were recorded. This significant decrease in new space debris was the consequence of increased international debris mitigation efforts in the 1990s, combined with a lower number of launches per year.[27] During the three-year period from 2007 to 2009, three major debris-generating events caused a significant increase in the annual rate of debris production:[28] An intentional collision in January 2007 demonstrated the potential for collisions to significantly pollute the near Earth orbital environment. On 11 January 2007, the People's Republic of China launched an anti-satellite ballistic missile that struck a Chinese meteorological satellite, Fengyun-1C.[29] The resulting debris cloud represents the single worst contamination of LEO during the past 50 years. More than 3,000 fragments have been catalogued by the U.S. Space Surveillance Network (SSN) to date.[30] Extending from 200 km to more than 4000 km in altitude, the debris frequently transit the orbits of hundreds of operational spacecraft, including the human space flight regime, and the majority of the debris were thrown into long-duration orbits, with lifetimes measured in decades and even centuries.[31] In February 2008, the United States used a modified missile as an Anti-Satellite Weapon to destroy the malfunctioning satellite USA-193 (most pieces of the debris resulting from this event were short lived), and in February 2009 the first known collision between two intact satellites – the inactive, defunct Russian communications satellite Cosmos 2251 and the active U.S. satellite Iridium 33 (Iridium-Cosmos collision) – occurred at an altitude of approximately 800 km over Northern Siberia,

[24] Ibid.
[25] Ibid.
[26] Space Security Index 2012, *supra* fn 9, at 29.
[27] Ibid.
[28] Ibid.
[29] Takeuchi Y. Space traffic management as a guiding principle of the international regime of sustainable space activities. Journal of East Asia & International Law 2011;4:319-334, at 320; National Aeronautics and Space Administration (NASA), Chinese Debris Reaches New Milestone, 14 Orbital Debris Quarterly News (Oct. 2010), 3, available at http://www.orbitaldebris.jsc.nasa.gov/newsletter/pdfs/QDQNv14i4.pdf (last visited on 21 May 2013).
[30] Ibid.
[31] Ibid.

immediately creating a cloud of debris of approximately 2000 pieces larger than 10 cm.[32] There were no major debris-generating events between 2010 and 2012.[33]

The U.S. Strategic Command's Joint Space Operations Center (JSpOC) detects, tracks and identifies space objects through an elaborate constellation of twenty-nine ground-based radars and optical sensors located at more than two dozen sites worldwide.[34] The U.S. SSN is the most advanced earth-based space surveillance system. Although technological constraints limit the system to "spot checking" rather than continuous surveillance and the size of currently catalogued objects to those with a radar cross-section of 10 cm or greater in LEO and 1 m or greater in GEO, the U.S. JSpOC using the SSN may track some 22,000 man-made objects in Earth orbit.[35] Only objects that can be identified and attributed to a specific launch and launching state are recorded in the satellite catalogue.[36] These objects include operational (functional) spacecraft, non-operational (inactive or retired) spacecraft and rocket bodies, as well as debris from a variety of sources. Despite the relatively low number of satellite fragmentation in 2011, the U.S. SSN had catalogued 17.147 objects (of which < 5 percent were operational satellites) as of December 2011, representing an increase of 7.8 percent or 1,248 tracked objects larger than 10 cm in diameter since 2010[37] — in contrast to an increase of 5.1 percent or 809 trackable space debris from 2009 to 2010.[38] In the absence of major debris-creating events in 2011, the 7.8 percent increase of space debris since 2010 is most likely due to the addition of tracked, but previously uncatalogued objects to the catalogue or cataloguing already existing debris from past break-ups.[39] It is estimated that the Earth's orbits contain as many as 300,000 objects with a diameter larger than 1 cm and several millions that are smaller.[40] The amount of space debris generally depends on two key factors, the number of objects in orbit and the number of debris-generating launches each year (Figure 1.5).[41] While the overall number of space debris continues to increase exponentially even without additional launches, largely due to inter-debris collisions, more launches (a total of 80) took place in 2011 than in any of the previous years, placing 126 new satellites in orbit (Figure 1.6).[42] As of 31 December 2011, a total of 994 operating satellites orbited Earth (741 active

[32] Space Security Index 2012, *supra* fn 9, at 27.
[33] Ibid., at 29.
[34] Ibid., at 28, 45.
[35] Ibid.
[36] Ibid., at 46.
[37] Ibid., at 31. Data compiled from the Space Track public satellite catalogue maintained by the U.S. military, available at http://space-track.org.
[38] Space Security 2011, ed. Cesar Jaramillo, Spacesecurity.org, August 2011, at 11, available at http://www.spacesecurity.org/space.security.2011.revised.pdf (last visited on 21 May 2013).
[39] Space Security Index 2012, *supra* fn 9, at 31.
[40] Ibid., at 11.
[41] Ibid., at 29.
[42] Ibid., at 31; see Wang Ting, Deployed Satellite, available at http://wangting.org/Database/DeployedSate.php; Nicholas Johnson, USA Space Debris Environment, Operations and Policy Updates, Presentation given to UNCOPUOS Scientific and Technical Committee meeting in Vienna, Austria, 6-17 Feb. 2012, available at http:/unoosa.org/pdf/pres/stsc2012/tech-26E.pdf.

satellites located in LEO and 419 in GSO; 441 satellites of U.S. origin and 101 from Russia).[43] A study conducted by NASA has shown that, in LEO, inter-debris collisions will become the dominant source of debris production within the next 50 years.[44] LEO debris population is expected to increase by an average of 30% in the next 200 years.[45] The population growth is primarily driven by catastrophic collisions between 700 and 1000 km altitudes, and such collisions are likely to occur every 5 to 9 years.[46]

4. The Current Legal Framework – Provisions of International Space Law

International space law comprises five United Nations (UN) treaties and six UN General Assembly (UNGA) resolutions (Figure 2.1). The treaties are the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty), the 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Astronaut Rescue Agreement), the 1972 Convention on International Liability for Damage Caused by Space Objects (Liability Convention), the 1975 Convention on Registration of Objects Launched into Outer Space (Registration Convention), and the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement).[47] These texts have been negotiated in the UNCOPUOS, which therefore can be regarded as the primary forum for the development of space law (Figure 2.2).[48] In the past decade, however, international regulations relevant to space activities have been elaborated increasingly in other international fora (i.e., the International Telecommunication Union [ITU], the World Trade Organisation [WTO], the United Nations Conference on Disarmament

[43] Space Security Index 2012, *supra* fn 9, at 31; Union of Concerned Scientists, UCS Satellite Database, 31 Dec. 2011, http://www.ucsusa.org/nclear_weapons_and_global_security/space_weapons/technical_issues/ucs-satellite-database.html.

[44] Space Security Index 2012, ibid., at 29.

[45] Inter-Agency Space Debris Coordination Committee (IADC), Stability of the Future LEO Environment (IADC-12-08), Jan 2013, sec. 5, at 17, available at http://www.iadc-online.org/index.cgi?item=docs_pub (last visited on 22 May 2013).

[46] Ibid.

[47] U.N. Doc. A/AC.105/C.2/2013/CRP.5 (March 28, 2013), Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan 27, 1967, adopted by the GA in its resolution 2222 (XXI) of 19 Dec 1966, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr 22, 1968, adopted by the GA in its resolution 2345 (XXII) of 19 Dec 1967, 19 U.S.T. 7570, 672 U.N.T.S. 119; Convention on International Liability for Damage Caused by Space Objects, Mar 29, 1972, adopted by the GA in its resolution 2777 (XXVI) of 29 Nov 1971, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention]; Convention on the Registration of Objects Launched into Outer Space, Jan 14, 1975, adopted by the GA in its resolution 3235 (XXIX) of 12 Nov 1974, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention]; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec 18, 1979, adopted by the GA in its resolution 34/68 of 5 Dec 1979, 18 I.L.M. 1434, 1363 U.N.T.S. 3, available at http://www.oosa.unvienna.org/oosa/en/SpaceLaw/treaties.html and http:/www.oosa.unvienna.org/pdf/publications/st_space_61E.pdf (last visited on 22 May 2013).

[48] IAA STM Report (2006), *supra* fn 2, sec. 2.2, at 38.

[CD]).[49] Parallel to these, the development of nonbinding ("soft law") provisions has become an increasingly important factor in the regulation of space activities.[50]

The UN space treaties establish the fundamental right of all states to access space, as well as state responsibility to use space for peaceful purposes. They prohibit national appropriation of space, and restrict certain military activities such as placing nuclear weapons or weapons of mass destruction in outer space.[51] The UNGA resolutions provide for the application of international law and promotion of international cooperation and understanding in space activities, the dissemination and exchange of information through transnational direct television broadcasting via satellites and remote satellite observations of Earth and general standards regulating the safe use of nuclear power sources necessary for the exploration and use of outer space.[52] Despite their non-binding nature, these principles establish a code of conduct reflecting the position of the international community on these issues.

a. The 1967 Outer Space Treaty

The 1967 Outer Space Treaty (OST), the first international agreement concerning space law, contains general principles that govern activities in space.[53] As of 1 January 2013, 102 states had ratified this treaty and 26 others had signed it.[54] The OST establishes the fundamental right of all states to access space as well as the state responsibility to use space for peaceful purposes. Art. I states that the exploration and use of outer space shall be carried out for the benefit, and in the interest, of all countries and shall be the "province of all mankind", and that outer space shall be "free for exploration and use by all States". Although this provision suggests that no one country is allowed to pollute outer space[55], there is no provision in the OST specifically prohibiting the pollution of the space environment[56]. According to Art. VI, the signatories bear international liability for national activities carried out in outer space by governmental agencies or by non-governmental entities, the activities of which have to be authorised and supervised by the state. Art. VII provides generally that a state participating in a launch (which launches or procures the launching of an object into outer space or from whose territory or facility an object is launched) can be held internationally liable if damage is caused to another state (or its natural or juridical persons) by the launched object. Art. VIII provides that the state that registers the object retains jurisdiction and control over it while it is in space. Art. IX imposes a duty to refrain from harmful contamination of the outer space environment and from harmful interference with the activities of other states without first consulting the proper parties that

[49] Ibid.
[50] Ibid.
[51] Ibid., sec. 2.2.1.
[52] Ibid., sec. 2.2.
[53] Outer Space Treaty, *supra* fn 47.
[54] Outer Space Treaty, ibid.; The list of signatories and ratifications is available at http://www.unoosa.org/oosa/en/SpaceLaw/treatystatus/index.html and U.N. Doc. A/AC.105/C.2/2013/CRP.5 (28 Mar 2013) at http://www.unoosa.org/pdf/limited/c2/AC105_C2_2013_CRP05E.pdf (last visited on 21 May 2013).
[55] Diaz D, *supra* fn 3, at 377.
[56] Bressack L. Addressing the problem of orbital pollution: defining a standard of care to hold polluters accountable. George Washington International Law Review 2011;43:741-780, at 754.

may be affected. Because the OST does not define the term "harmful contamination", it is unclear whether and when the generation of space debris rises to the level of "harmful contamination".[57] It has been suggested that "harmful contamination" does not include space debris, but refers only to astronauts and spacecraft or to contaminating resulting from the introduction of extraterrestrial matter.[58] Obviously, however, the generation of debris that ultimately causes damage would be harmful, and because even the smallest microparticles can cause substantial damage in space, seemingly the introduction of any debris in space would constitute "harmful contamination".[59] The OST establishes the general legal basis for the use of the space environment, but has been criticised for its lack of definitional clarity, and there have been repeated calls for an updated space security normative regime.[60] The OST neither defines the term "space object or its component parts" in Art. VII, nor specifies where airspace ends and outer space begins.[61] Although both the Legal and the Scientific and Technical Subcommittees of the UNCOPUOS have considered this issue since 1959, there is still no internationally agreed or legally binding definition of the delimitation between air space and outer space.[62] It is a common view among international agencies and organisations that space begins at 100 km above Earth, but some states have repeatedly disclaimed the need for the establishment of such a boundary.[63] The lack of a legal delimitation of air space from outer space, however, has not had any effect on space activities, since the application of space law has not been questioned in any specific case.[64]

Furthermore, the implications of the OST notion of "peaceful purposes" in Art. IV have been the subject of debate among spacefaring states.[65] While the Soviet Union initially viewed peaceful purposes as wholly non-military, space assets have been developed extensively to support terrestrial military operations, and the view that "peaceful" in the context of the OST means "non-aggressive"

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[57] Diaz D, *supra* fn 3, at 377.

[58] Williams C. Space: the cluttered frontier. Journal of Air Law & Commerce 1995;60:1139, at 1156; Imburgia JS. Space debris and its threat to national security: a proposal for a binding international agreement to clean up the junk. Vanderbilt Journal of Transnational Law 2011;44:589-641, at 615.

[59] Diaz D, *supra* fn 3, at 377.

[60] Space Security 2012, *supra* fn 9, at 56; Akers A, *supra* fn 10, at 101; Pusey N. Note &Comment, The case for preserving nothing: the need for a global response to the space debris problem. Colorado Journal of International Environmental Law & Policy 2010;21:425-450, at 437.

[61] Outer Space Treaty, *supra* fn 47, Art. VII; Space Security Index 2012, *supra* fn 9, at 56.

[62] Space Security Index 2012, ibid., at 56; see Report of the UN Secretariat, Committee on the Peaceful Uses of Outer Space, Historical Summary on the Consideration of the Question on the Definition and Delimitation of Outer Space, UN Doc. A/AC.105/769 of 18 January 2002 (describing decades-long attempts to reach a definition, with no agreement).

[63] Imburgia JS, *supra* fn 58, at 612; Rosenfield SB. Where air space ends and outer space begins. Journal of Space Law 1979;7:137-148, at 137 *et seq.*; Frans von der Dunk. The sky is the limit – but where does it end? Proceedings of the 48th Colloquium on the Law of Outer Space 2006;84-94. The 100 km limit, originally picked by the World Air Sports Federation in the 1950s to keep track of the aeronautical record book, was first introduced by the Soviet Union in 1979 to be use to defined where outer space begins; because of atmospheric friction and gravitational pull, most objects orbiting below this altitude can not sustain orbit.

[64] IAA STM Report, *supra* fn 2, at 39. The missing delimitation, on the other hand, can become a problem, when the re-entry of reusable space vehicles is concerned.

[65] Space Security Index 2012, *supra* fn 9, at 56; Outer Space Treaty, *supra* fn 47, Art. IV.

has been supported by general state practice.[66] The interpretation favoured by some states that all military activities in outer space are permissible, unless specifically prohibited by another treaty or customary international law, has been contested.[67] While there have been no attacks by space actors against the space assets of another nation from Earth, some states (China 2007, United States 2008) have tested ASATs against their own satellites.[68]

b. The 1972 Liability Convention

The 1972 Liability Convention establishes a liability system for activities in outer space which is instrumental when addressing damages caused by man-made space debris and spacecraft.[69] As of 1 January 2013, the Liability Convention had 89 ratifications, including the United States, Russia, China and Iran, and 22 signatures, and three international intergovernmental organisations have declared their acceptance of the rights and obligations provided for in the Convention.[70] Because damages caused by orbital space debris in outer space were considered a rather rare occurrence[71], the main concern of the signatories at the time of drafting was damages caused by space objects when they re-entered the Earth's atmosphere.[72] Nevertheless, the Convention also regulates international liability for damages caused by space objects elsewhere than on the surface of the Earth.

i. Relevant Definitions

"Damage". — The Liability Convention refers only to damage to persons or property, but does not necessarily apply to damage caused to the outer space environment or even to the Earth's environment.[73] Art. I (a) of the Liability Convention defines "damage" to mean "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 organisations." Although Art. IX of the Outer Space Treaty imposes a duty of spacefaring states to refrain from "harmful contamination of the space environment and adverse changes of the Earth resulting from the introduction of extraterrestrial matter", the pollution of the space environment per se has not been recognised as triggering state

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[66] Space Security Index 2012, ibid., at 56 *et seq*; Vlasic IA. The Legal Aspects of Peaceful and Non-Peaceful Uses of Outer Space, in: Bupendra Jasani (ed.), Peaceful and non-Peaceful Uses of Space: Problems of Definition for the Prevention of an Arms Race in Outer Space (London: Taylor and Francis, 1991). The U.S. interpretation of "peaceful" as synonymous with "non-aggressive" was a logical extension of the U.S. effort to gain international recognition of the permissibility of reconnaissance satellites, while simultaneously discouraging military space activities that threatened these assets – two major goals of U.S. policy during the period predating the Outer Space Treaty (1957-1967). See States PB. The Militarization of Space: Z.S. Policy, 1945-84 (Ithaca, NY: Cornell University Press, 1988), 59-71.

[67] Waldrop E. Weaponization of outer space: U.S. national policy. High Frontier 2005, 34-45, at 37, available at http://www.law.umich.edu/curriculum/workshops/governance/WkshpPaper2006_Waldrop.pdf; Jakhu R. Legal issues relating to the global public interest in outer space. Journal of Space Law 2006;32:31-110: at 41.

[68] Space Security Index 2012, *supra* fn 9, at 57.

[69] Liability Convention, *supra* fn 47, Arts. II, III.

[70] Liability Convention, *supra* fn 54.

[71] Akers A, *supra* fn 10, at 303; Baker HA. Space Debris: Legal and Policy Implications (M. Nijhoff Publ. Dordrecht 1989), 175 pp, at 79.

[72] Ibid.

[73] Akers A, ibid., at 304; Bressack L, *supra* fn 56, at 755.

responsibility.[74] The Liability Convention does not mandate the prevention of new space debris or the removal of existing space debris that does not cause physical damage to objects or persons belonging to another state.[75]

"Space object". — Liability under the Liability Convention may arise when the damage is caused by a space object. The Liability Convention does not define the term "space object", but only provides in Art. I (d) that the term "space object" includes "component parts of a space object as well as its launch vehicle and parts thereof". The treaty fails to define what a "component part" of a "space object" is, or whether either term encompasses "space debris". There has been some debate whether particularly smaller pieces of man-made orbital debris would constitute a "space object" for the purposes of establishing liability.[76] Some experts argue that separating orbital debris from the definition of space object would appear "to run counter the intention of the drafters of the Liability Convention" and that the term space objects should include any object launched by humans into space.[77] It has been put forward that because collisions with even a small piece of debris have severe consequences, there should be provisions to hold the state liable for injury caused by such debris.[78] Others suggest that the drafters of the Convention intended for a distinction between "component parts of a space object and parts of its launch vehicle" and that "small pieces and fragments that are not capable of surviving a re-entry into the atmosphere" were not included in the definition of component parts.[79] In the light of this dispute, it should be noted that, with the rise of technology and space commercialisation, particularly in private industry, the entities responsible for the majority of objects launched into space have a monetary interest in keeping the terms purposefully vague to avoid liability for damage caused by their space debris.[80]

"Launching state". — According to Art. VI of the Outer Space Treaty, states are responsible for national activities in outer space independent whether such activities are carried out by governmental agencies or by non-governmental entities (activities of non-governmental entities require authorisation and continuous supervision by the state). It can be followed that state liability applies to damages caused by governmental as well as non-governmental entities, and that the launching state may be responsible for the activities of its nationals in space, even if those nationals are acting in a seemingly private capacity. Art. I (c) of the Liability Convention, which incorporates Art. VII of the Outer Space

[74] Bressack L, ibid.

[75] Imburgia JS, *supra* fn 58, at 617; Jasentuliyana N. Space debris and international law. Journal of Space Law 1998;26:139-162, at 143.

[76] Bressack L, *supra* fn 56, at 756.

[77] Gorove S. Toward a clarification of the term „space object" – an international legal and policy imperative? Journal of Space Law 1993;21:11-26, at 11, 15; Cheng B. Space objects, astronauts and related expressions. Proceedings of the 34th Colloquium on the Law of Outer Space 1992;13, at 17, 24.

[78] Stayduhar M. Flying the friendly skies may not be so friendly in outer space: international and domestic law leaves United States citizen space tourists without a remedy for injury caused by government space debris. University of Pittsburgh Journal of Technology Law & Policy 2006;7:1-23, at 1, 3.

[79] Lee RJ. The Liability Convention and private space launch services – domestic regulatory responses. Annals of Air & Space Law 2006;31, at 351, 362 (citing Wirin WB. Space debris and space objects. Proceedings of the 34th Colloquium on the Law of Outer Space 1992;13, at 45).

[80] Akers A, *supra* fn 10, at 304; Jasentuliyana N, *supra* fn 75, at 143.

Treaty to designate the parties responsible for damage, introduces the concept of the "launching state". The launching state is defined as "(i) a State which launches or procures the launching of a space object; [or] (ii) a State from whose territory or facility a space object is launched."[81] "Procured" in this context means that the state actively requested, initiated, or promoted the launching of the space object. Whereas the broad definition of "launching state" provided for in Art. VII of the Outer Space Treaty and Art. I c of the Liability Convention applies to the concept of strict liability in Art. II of the Liability Convention without any limitation, it has been suggested that the formulation in Art. III of the Liability Convention (language-based interpretation of the word "only") may imply a restriction to this broad definition of "launching states" and limit state liability to activities carried out by government agencies.[82] In case of damage being caused by more than one launching state, Art. V of the Liability Convention provides that the launching states are "jointly and severally liable." This joint liability has been criticised of being unfair because often times the state responsible for the launch is not the same entity that will operate and control the satellite once it has been launched into space.[83] In addition, because of joint liability the launching states may not worry too much about their space objects because the risk is spread among a few states, rather than concentrated on one state.[84] Critics have therefore suggested that the Liability Convention's definition of "launching state" should be limited to include only those states that have actual control over the space object.[85] As the Space Security Report 2012 states, "the growing number of private commercial actors carrying out space launches is blurring the definition of the term "launching state", because a satellite operator may be officially registered in one state, have operations in another, and launch spacecraft from the territory of a third country."[86] Moreover, the Liability Convention operates under the assumption that the launching state of any given object or parts thereof will be easily identifiable (which is "quite clearly not the case"[87]) and provides no specific mechanism for identifying space objects launched into outer space, or associated debris that might be created.[88] Therefore, "liability for damage caused by space debris [may be] difficult to establish as it may be difficult to determine the specific source of a piece of debris, particularly when it is a small piece that has not been catalogued."[89]

In the case of the Iridium-Cosmos collision in 2009 (which was resolved diplomatically without the application of the Liability Convention), Russia was the launching state for

[81] Liability Convention, *supra* fn 47, Art. I (c).
[82] Christol CQ. International liability for damage caused by space objects. American Journal of International Law 1980;74:346-371, at 346 *et seq*.; Cheng B. Convention on International Liability for Damage caused by Space Objects, in: Manual on Space Law, Vol. I (Nandasiri Jasentuliyana and Roy S.K. Lee, eds.), 1979. (In case of space activities carried out by non-governmental entities liability would only attach, if the state negligently violated an obligation to authorise and supervise the activities of the private actors.)
[83] Bressack L, *supra* fn 56, at 766; Lee RJ, *supra* fn 79, at 362.
[84] Ibid.
[85] Bressack L, ibid.
[86] Space Security Index 2012, *supra* fn 9, at 57.
[87] Imburgia JS, *supra* fn 58, at 617; Jasentuliyana N, *supra* fn 75,at 143.
[88] Ibid.
[89] Space Security Index 2012, *supra* fn 9, at 57.

Cosmos because Cosmos was launched from Plesetsk, Russia in 1993, from a Russian territory and facility, and Russia procured the launch.[90] For Iridium, both the United States and Russia could be considered launching states under the broad definition of Art. I (c) of the Liability Convention.[91] The United States procured the launch and was responsible for the damage caused by the private company Iridium Satellite LLC in accordance with Art. VI of the Outer Space Treaty.[92] Russia can be considered a launching state, too, because the Iridium satellite was launched in 1997 from a Russian facility in Baikonur, Kazakhstan.[93]

ii. Liability Standards

The Liability Convention establishes a dual liability system that is dependent on the place where the damage occurred (Art. II – absolute liability, Art. III – fault liability).[94]

Before the Liability Convention entered into force, the liability of the launching state for damage caused by its spacecraft had been established under the Outer Space Treaty. Art. VII of the Outer Space Treaty establishes that the launching state "is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons." According to Art. VII of the Outer Space Treaty the international liability of the launching state is overarching, not dependent on the place where the damage occurred and does not require the existence of "fault" in case of damage caused elsewhere than on the surface of the Earth. The Liability Convention has therefore been criticised of being less efficient and unsatisfactory.[95]

Art. II of the Convention provides that a launching state "is absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft flight." Absolute liability encompasses liability under any circumstances, even in case of *force majeure*.[96] In the event of damage being caused on the Earth or in the atmosphere the victim does not have to prove fault, but only has to establish that the object belonged to the launching state, and that the victim state was injured by the object.[97] "Gross negligence" or "an act or omission done with intent to cause damage in the part of [the] claimant State" is exonerating.[98] No exoneration is granted, when the damage is caused by illegal activities of the launching state, inconsistent with international law, including the

[90] Bressack L, *supra* fn 56, at 765; Jakhu R. Iridium-Cosmos Collision and its Implications for Space Operations, in: Yearbook on Space Policy 2008/2009, Kai-Uwe Schrogl et al. (eds.) 2010, 254 *et seq*.
[91] Ibid.
[92] Ibid.
[93] Bressack L, ibid., at 766; Weeden B. 2009 Iridium-Cosmos Collision Factsheet, Secure World Found., 3, available at http://swfound.org/media/6575/2009iridium-cosmoscollisionfactsheet.pdf (last updated Nov 10, 2010).
[94] Liability Convention, *supra* fn 47, Arts. II, III.
[95] Kerrest A. Liability of Damages Caused by Space Activities, in: Marietta Benkö and Kai-Uwe Schrogl (eds.), Current Problems and Perspectives for Future Regulation (Eleven International Publishing, Utrecht, 2005), at 91,103; see also Kerrest A and Smith LJ. Art. VII, in: Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl (eds.), Cologne Commentary on Space Law, Volume I – Outer Space Treaty (Carl Heymanns Verlag, Köln 2009), at 126, 142.
[96] Diederiks-Verschoor IH and Kopal V. An Introduction to Space Law (3rd ed., Kluwer Law International, Alphen aan den Rijn, 2008), at 37.
[97] Bressack L, *supra* fn 56, at 757.
[98] Liability Convention, *supra* fn 47, Art. VI.

Charter of the United Nations and the Outer Space Treaty.[99] Art. III of the Liability Convention establishes that "in the event of damage being caused elsewhere than on the surface of the Earth 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, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible." When damage is caused to a space object of a launching state by a space object of another launching state, and as a result of that, damage is caused to a third state, the first two states shall be jointly and severally liable to the third state.[100] If the damage has been caused to the third state on the surface of the Earth or to aircraft in flight, the first two states are absolutely liable to the third state; if the damage has been caused to a space object of the third state or to persons or property on board that space object elsewhere than on the surface of the earth (i.e., in outer space), their liability to the third state is based on the fault of either (or both) of the first two states.[101]

The concept of "absolute" liability reflects the generally accepted rule that in case of ultra-hazardous activities uninvolved third parties should be adequately protected against the risks of serious harm that are necessarily involved with such activities.[102] On the other hand, in the event of damage being caused by collisions between spacecrafts parties are more in a position of equality. Consequently, basing liability on fault in this case seems to be the more reasonable solution.[103] In addition, at the time of drafting, the state representatives were more concerned with damage being caused by the re-entry of space debris into the Earth's atmosphere than with damage being caused by collisions of space debris with other objects in outer space.[104] It was generally believed that the possibility of damage in space was remote (big sky theory).[105] Second, the distinction between "fault" liability and "absolute" liability was the result of a political compromise between Russia, which supported the application of the fault standard in outer space, and the United States, which insisted on the application of the strict liability in outer space.[106] The United States seemed to lose that political fight in an effort to finish the long-overdue treaty.

The Liability Convention does not provide a specific standard of care or due diligence for the establishment of "fault" in the context of state liability for damages caused in outer space. According to the Articles of the International Law Commission (ILC) on the Responsibility of States for

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[99] Ibid.

[100] Liability Convention, *supra* fn 47, Art. IV; Bressack L, *supra* fn 56, at 758 *et seq*.

[101] Ibid.

[102] Diederiks-Verschoor IH and Kopal V, *supra* fn 96; see also von Wulf von Kries, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl, Grundzüge des Raumfahrtrechts. Rahmenbestimmungen und Anwendungsgebiete (C.H. Beck, München 2002), at 28.

[103] Diederiks-Verschoor IH and Kopal V, ibid., at 38.

[104] Bressack L, *supra* fn 56, at 758; see also Bornemann L. This Is Ground Control to Major Tom...Your Wife Would Like to Sue but There's Nothing We Can Do...The Unlikelihood that the FTCA Waives Sovereign Immunity for Torts Committed by the United States employees in Outer Space. A Call For Preemptive Legislation. Journal of Air Law & Commerce 1998;63, at 517.

[105] Ibid.; see also Firestone MS, Comment. Problems in the resolution of disputes concerning damage caused in outer space. Tulane Law Review 1985;59, at 761.

[106] Bressack L, *supra* fn 56, at 758; Firestone MS, ibid., at 761.

Internationally Wrongful Acts of 2001, the state's responsibility presupposes an internationally wrongful act which is attributable to that state and represents a violation of an international legally binding obligation of that state.[107] While the criterion of "fault" has been deliberately left out in the ILC Articles, the ILC commentary on the Articles clarifies that the criterion of "fault" still plays a role in the establishment of a state's responsibility if it is part of the "primary" norm of international law which has been violated.[108] Art. III of the Liability Convention represents such a "primary" norm of international law. The establishment of fault of the state or fault of persons for whom it is responsible is therefore essential for triggering the state's responsibility in case of damage occurring in outer space. The term "fault" is not defined in the Liability Convention.[109] It has to be interpreted by use of the rules of treaty interpretation as laid down in Art. 31 of the Vienna Convention on the Law of Treaties, which are generally accepted as reflecting customary international law.[110] According to Art. 31 para. 1 of the Vienna Convention on the Law of Treaties "[a] treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose." The definitions of the legal term "fault" as provided by the Black's Law Dictionary and the Max Planck Encyclopedia of Public International Law give some insight into the concept of fault in the context of liability[111], but represent a rather general statement (Max Planck Encyclopedia of Public International Law) or reflect American and English jurisprudence and are not applicable to other jurisdictions or to liability under public international law (Black's Law Dictionary).[112] An analysis of the context of the term "fault", in particular of the preceding Art. II of the Liability Convention, reveals that "fault" liability is considered to be opposed to "absolute" liability. The context of the treaty term indicates that the criterion of fault "is an autonomous and additional criteria for liability for damage under space treaties."[113] Because the context analysis does not provide sufficient clarity on the meaning of the term "fault" in the context of space activities, the application of other means of treaty interpretation is necessary.[114] According to Art. 31 para. 3 c of the Vienna Convention on the Law of Treaties, also other norms of international law applicable between

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[107] Responsibility of States for Internationally Wrongful Acts, GA Res 56/83 of 12 December 2001, Annex, Art. 2 [hereinafter ILC Articles]; see also the commentary by James Crawford, The International Law Commission's Articles on State Responsibility. Introduction, Text and Commentaries (Cambridge University Press, Cambridge 2002), at 81 *et seq*.
[108] Crawford J, ibid., at 82.
[109] Commentators have seen this as a serious defect of the Convention. See DeSaussure H and Haanappel PPC. A unified, multinational approach to the application of tort and contract principles to outer space. Proceedings of the 21st Colloquium on the Law of Outer Space 1978, at 138; Christol CQ. International liability for damage caused by space objects. American Journal of International Law 1980;74, at,346, 368.
[110] See, for many, Malcolm N. Shaw, International Law (6th ed., Cambridge University Press Cambridge 2008), at 933.
[111] Black's Law Dictionary. Definitions of the Terms and Phrases of American and English Jurisprudence, Ancient and Modern (6th ed., West Publishing, St. Paul Minnesota 1990), 608; Guiseppe Palmisano, Fault, in: Max Planck Encyclopedia of Public International Law, last updated in Sept 2007, at http://www.mpepil.com (last visited on 30 May 2013).
[112] Marboe I. The Importance of Guidelines and Codes of Conduct for Liability of States and Private Actors, in: Irmgard Marboe (ed.), Soft Law in Outer Space, The Function of Non-binding Norms in International Space Law (Böhlau Verlag Wien et al. 2012), at 123 *et seq*.
[113] Ibid., at 125
[114] Ibid.

the parties should be taken into consideration in the interpretation of a treaty term.[115] These other norms include treaty norms, customary international law norms and general principles of law.[116] The general principles of law reflect "general principles of municipal jurisprudence, in particular of private law, in so far as they are applicable to relations of States."[117] They are usually identified through a comparative law analysis. A comprehensive comparative analysis of the most important legal systems (including the national law systems of France, Germany, United Kingdom, and the United States) under consideration of the Principles of European Tort Law evidences that, although the national legal systems are very diverse and include both civil law and common law jurisdictions, there is a common understanding on what represents "negligent" behaviour and thus "fault" in various jurisdictions.[118] Fault is the violation of the required standard of behaviour of a reasonable person in the circumstances.[119] Breach of a legally binding obligation is not a necessary prerequisite for the establishment of fault in the context of liability for damages caused by space activities. If a person, however, violates a mandatory legal rule, this will automatically lead to a finding of negligence.[120] The required standard of care for a reasonable person in the circumstances is assessed on a case by case analysis. A number of criteria have to be considered in order to determine if the standard of care has been violated.[121] These factors include the expertise to be expected of a person undertaking the activity – expertise can be based on technical and professional standards, such as the "state of the art" of the respective industry;[122] the observance of technical norms or administrative prescriptions generally but not necessarily implies a lack of fault, while non-compliance with standards and guidelines usually reflects negligence –, the foreseeability of the damage, and the availability and the costs of precautionary or alternative measures which the actor should have undertaken to avoid damage.[123] Non-binding norms such as professional practices and safety standards may be important for the establishment of fault in the context of liability as they rather precisely describe what is considered to be "reasonable" by profession, the industry, the community, etc.[124] This standard of care is not only important in relation to the liability of private space actors, but as a "general principle of law" has to be considered also in the interpretation of the term "fault" in the context of the liability of states under the Liability Convention.[125]

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[115] See Art. 31 para. 3 of the Vienna Convention on the Law of Treaties: "There shall be taken into account, together with the context: [...] (c) any relevant rules of international law applicable in the relation between the parties."
[116] Marboe I, *supra* fn 112, at 125.
[117] Sir Robert Jennings and Sir Arthur Watts (eds.), Oppenheim's, International Law, Vol I (9th ed., Longman, Essex 1992), at 29.
[118] Irmgard Marboe, *supra* fn 112, at 126-135.
[119] Ibid., at 135.
[120] Ibid.
[121] Ibid.
[122] Bohlmann UM. Connecting the principles of international environmental law to space activities. Proceedings of the 54th Colloquium of Outer Space 2011, at 1 ,9.
[123] Marboe I, *supra* fn 112, at 135.
[124] Ibid.
[125] Ibid.

Other norms of international law applicable between the parties, which according to Art. 31/3/c Vienna Convention on the Law of Treaties should be taken into account in order to interpret a treaty term such as "fault" in Art. III of the Liability Convention, include treaty norms and customary international law norms. In the law of outer space, the Outer Space Treaty, notably its Arts. I ("common benefit clause") and IX, are of particular relevance in identifying the standard of care which is demanded from states undertaking space activities.[126] Art. IX of the Outer Space Treaty can be interpreted as a duty of states to take appropriate measures to prevent other states from significant harm or, at least, to minimise the risk of harm.[127] A "reasonable" government will not use outer space for its own benefit, but will conduct outer space activities with due regard to the interests of other countries and will undertake reasonable efforts to avoid harm to other countries or their citizens. A violation of that duty may be an indicator of "negligent" behaviour in the context of fault liability.[128] As regards customary international law, the standard of "due diligence" may be relevant for states engaging in space activities.[129] In the area of the treatment of "aliens", are required to protect foreign nationals in the same way as they protect their own citizens.[130] In the area of environmental protection, states have the duty to take appropriate measures to prevent other states and areas beyond their national jurisdiction from harm or, at least, to minimise the risk of harm.[131] The commentary on the Draft Articles of the ILC on the "Prevention of Transboundary Harm from Hazardous Activities of 2001, clarifies that the required standard of due diligence is compared to what a "reasonable" or "good" government would do.[132] This standard of care or due diligence can be laid down in various international documents including non-binding guidelines such as the UNCOPUOS Space Debris Mitigation Guidelines (see below).

While the violation of binding international norms ("hard law") entails state responsibility (irrespective of the occurrence of any damage), the violation of non-binding international norms ("soft law") does not.[133] However, non-binding international norms may be relevant for the evaluation of a

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[126] Ibid., at 136 *et seq*.

[127] Ibid.; see also Hobe S and Mey JH. UN Space Debris Mitigation Guidelines. Zeitschrift für Luft- und Weltraumrecht 2009;58, at 388, 398. Art. IX of the Outer Space Treaty reiterates the „interests of others"-formula of Art. I and provides that "[i]n the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, *with due regard to the corresponding interests of all other States Parties to the Treaty*. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as *to avoid their harmful contamination* (emphasis added)."

[128] Marboe I, ibid., at 137.

[129] Ibid.

[130] See, for instance, Malcolm N. Shaw, *supra* fn 110, at 824 *et seq*.

[131] Bohlmann UM, *supra* fn 122.

[132] Draft Articles on the Prevention of Transboundary Harm from Hazardous Activities, with Commentaries, Yearbook of the International Law Commission, 2001, vol. II, Part Two, 149 *et seq*., available at http://untreaty.un.org/ilc/texts/instruments/english/commentaries/9_7_2001.pdf (last visited on 30 May 2013); Commentary to Art. 3, para. 17, Draft Articles on Prevention; in general see, for instance, Johan G. Lammers, Prevention of transboundary harm from hazardous activities – The ILC draft articles, 14 Hague Yearbook of International Law (2001), at 3.

[133] Marboe I, *supra* fn 112, at 119 *et seq*.

due standard of care or diligence in the context of liability for damages caused to another party.[134] Non-binding international guidelines, such as the UNCOPUOS Space Debris Mitigation Guidelines (see below), may provide an indicator what is considered to be reasonable efforts to prevent other countries from harm. The violation of these guidelines may therefore indicate the existence of fault, which in case of damage caused entails liability.[135]

The Liability Convention has been used in only one settlement: In 1979, Canada sought damages against the Soviet Union following an incident in January 1978 in which a Soviet satellite (Cosmos-954) re-entered the atmosphere and spread radioactive debris across western Canada.[136] The satellite was a nuclear reactor satellite containing uranium-235 and Canada spent $ 14 million (CAD) for cleanup of the radioactive debris.[137] In its Art. II claim under the Liability Convention, Canada sought $ 6 million (CAD) in damages from the Soviet Union. Ultimately, the states settled for $ 3 million (CAD) in 1981.[138] The Soviet Union never admitted liability and the legal procedures established in Arts. VIII-XX of the Liability Convention were not used to resolve the dispute.[139] The Liability Convention was not applied to the Iridium-Cosmos incident 2009. The states ultimately handled the collision diplomatically and absorbed their own loses.[140] This case shows that states do not want to adjudicate their claims under the Liability Convention because there are so many uncertainties involved with proving fault in space.[141] Second, it demonstrates that states have little to no incentive to monitor their debris, and have more motivation to monitor their functional satellites. Consequently, when a collision involves debris or defunct satellites that are well past their useful lives, states may not have an incentive to establish fault through a Claims Commission because their direct damages are so minimal.[142]

[134] Ibid.
[135] Ibid.
[136] Space Security Index 2012, *supra* fn 9, at 57; see also Akers A, *supra* fn 10, at 304 *et seq*; Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954, 18 I.L.M. 899, 902 (1979). The majority fragments discovered by the Canadian government were radioactive, with some fragments containing lethal levels of radioactivity.
[137] Ibid.; Baker HA, *supra* fn 71, at 66. The majority of fragments discovered by the Canadian government were radioactive, with some fragments containing lethal levels of radioactivity.
[138] Ibid.
[139] Baker HA, ibid., at 66. First, the claim must be presented formally by the government of the victim through diplomatic channels to the allegedly liable launching state. Second, if the states are unable to reach an agreement by negotiations, a three-member Claims Commission can be appointed to make a determination. The decision of the Claims Commission is not final and not binding unless the parties have so agreed. See Liability Convention, *supra* fn 47, Arts. VIII-XX. There was also some dispute about the applicability of the Liability Convention because the Soviet Union had not yet ratified the convention at the time of the Cosmos re-entry.
[140] Bressack L, *supra* fn 56, at 763.
[141] Ibid.
[142] Ibid.; At the time of the Iridium-Cosmos collision, Cosmos did not have any station keeping or maneuvering capability; it was debris. Iridium was a normal operational satellite, providing telecommunication services and it was equipped with maneuvering capability. However, the Iridium satellite was aging and on its way to becoming non-operational debris. Thus, the United States did not suffer a lot of damages. Nor did Russia suffer damages, given that its satellite was already defunct.

c. The 1975 Registration Convention

The 1975 Registration Convention requires states to maintain national registries of objects launched into space and to provide information about their launches to the Secretary-General of the UN;[143] the UN then merges all the national registries into a publicly accessible international registry (Convention Register), which facilitates effective management of space traffic, enforcement of safety standards and attribution of liability for damage.[144] As of 1 January 2013, 60 states (latest depositary notification: accession by Lithuania to the Registration on 8 March 2013) have ratified, 4 have signed and two international intergovernmental organisations (European Space Agency and European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)) have declared their acceptance of the rights and obligations provided for in the Registration Convention.[145] The UN also maintains a separate register with information provided by states not party to the Convention (The Resolution Register), based on UNGA Resolution 1721B of 20 December 1961.[146] The following information must be made available by the state members: the name of the launching state, an appropriate designator of the space object or its registration number, date and territory or location of the launch, basic orbital parameters, including nodal period (=the time between two successive northbound crossings of the equator, usually in minutes), inclination of the orbit (polar orbit is 90 degrees and equator orbit is 0 degrees), apogee (=highest altitude above the Earth's surface, in kilometres), and perigee (=lowest altitude above the Earth's surface, in kilometres), as well as the general function of the space object.[147] The main defects of the Registration Convention are the following:[148]

1) The Registration Convention only requires states to provide the most basic information about the launched object. More useful information such as satellite orbital positions, notifications of orbit changes, and notifications of break-ups as well as information on appropriate identification markings for spacecraft and component parts are not required. [149] States may provide this information at their discretion.

2) The Convention does not require states to continuously update the information about launched space objects to the international registry.[150] Similarly, information, once registered, cannot be changed.

3) The Registration Convention does not require pre-launch notification (which would be relevant for an effective space traffic management system) but only requires registration following the

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[143] Registration Convention, *supra* fn 47, Arts. II, IV.

[144] Ibid., Art. III; see Index of Notifications by Member States and Organisations by Year of Issue, United Nations Office for Outer Affairs, at http://www.oosa.unvienna.org/oosa/en/SORegister/docsyoiidx.html (last visited on 22 May 2013); see also Online Index of Objects Launched into Outer Space, at http://www.oosa.unvienna.org/oosa/en/osoindex.html.

[145] Registration Convention, *supra* fn 54.

[146] Space Security Index 2012, *supra* fn 9, at 58.

[147] Registration Convention, *supra* fn 47, Art. IV.

[148] Akers A, *supra* fn 10, at 305-307; Space Security Index 2012, *supra* fn 9, at 58.

[149]. Akers A, ibid., at 305 *et seq*; Space Security Index 2012, *supra* fn 9, at 58.

[150] Akers A, ibid., at 306; Taylor MW. Trashing the solar system one planet at a time: Earth's orbital debris problem. George Washington International Environmental Law Review 2007;20, at 45.

launching.[151] The Convention also fails to provide a specific deadline for when the space object must be registered.[152] Information is to be provided "as soon as practicable",[153] it might not be provided for weeks or months, if at all. The registration of the space objects has actually declined (from 1980 to June 2006, at least 225 objects were launched into space but never registered),[154] and because no satellite in the UN registry is recorded to have a military purpose, there is speculation among analysts that military-related launches may go unregistered.[155] From January 2012 to December 2012, information on 139 launched space objects from 17 different states and EUMETSAT was received by the UN Secretary-General in accordance with the Registration Convention.[156]

4) The Convention fails to provide enforcement mechanisms to ensure (timely) registration of the launched space objects by the states and it does not provide a penalty regime in case of failures to register.[157]

5. Other Laws and Regimes

While states have been rather reluctant to deal with the legal aspects of space debris, the issue of space debris for the international community has so far merely appeared as a "technical" concern.[158] Several national and international organisations of the spacefaring nations, including China, Japan, Russia and the United States, as well as the European Union (EU) have engaged in developing technically feasible and practical ways and means of decreasing or avoiding space debris.[159] NASA was the first space agency to issue a comprehensive set of orbital debris mitigation guidelines in the August 1995 NASA Safety Standard 1740.[160] In December 2000 the U.S. government issued formal orbital debris mitigation standards for space operators developed by the DoD and NASA (United States Government Orbital Debris Mitigation Standard Practices).[161] The U.S. Federal Communications Commission (FCC) rules 2004 required satellite operators to move geostationary satellites at the end of their lifetime into graveyard orbits 200 to 300 km above GEO, and new rules in 2005 required satellite system operators to submit orbital debris mitigation plans.[162] In 2008 NASA published the first edition of the Handbook for Limiting Orbital Debris, which contained the scientific background to NASA's

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[151] IAA STM Report 2002, *supra* fn 2, at 39.
[152] Akers A, *supra* fn 10, at 306.
[153] Registration Convention, *supra* fn 47, Art. IV.
[154] Akers A, *supra* fn 10, at 306; Space Security 2007, Spacesecurity.org, 50, available at http://www.spacesecurity.org/SSI2007.pdf.
[155] Ibid.; Space Security 2011, *supra* fn 38, at 49.
[156] Data compiled by the author from the Index of Notifications by Year, United Nations Office for Outer Affairs, available at http://www.oosa.unvienna.org/oosa/en/SORegister/docsyoiidx.html (last visited on 20 May 2013).
[157] Akers A, *supra* fn 10, at 307.
[158] Marboe I, *supra* fn 112, at 139.
[159] Space Security Index 2012, *supra* fn 9, at 32.
[160] Ibid.
[161] Ibid.; United States Government Orbital Debris Mitigation Standard Practices, available at http://www.nesdis.noaa.gov/CRSRA/files/USG_Orbital%20Debris_Standard_Practices.pdf (last visited on 4 Junde 2013).
[162] Ibid.; Peter B. de Selding, FCC Enter Orbital Debris Debate, Space New, 28 June 2004.

Orbital Debris Program for debris mitigation procedures.[163] This Handbook is consistent with the objectives of the U.S. National Space Policy (August 2006), the U.S. Government Orbital Debris Mitigation Standard Practices (February 2001), the IADC Space Debris Mitigation Guidelines (October 2002), and the space debris mitigation guidelines of the STSC of the UNCOPUOS.[164] The European Space Agency (ESA) initiated a space debris mitigation effort in 1998, published the ESA Space Debris Mitigation Handbook in 1999 and revised it in 2002.[165] In 2002 ESA also issued the European Space Debris Safety and Mitigation Standard and adopted new debris mitigation guidelines in 2003.[166] In 2000, Russia put into force a "General Requirements for Mitigation of Space Debris Population".[167] The requirements in this standard are consistent with those of other agencies within the IADC. Russia has in place a Space Debris Mitigation Standard, which again follows the IADC guidelines.[168] The National Space Development Agency (NASDA [one of three agencies that later became JAXA]) of Japan first adopted a Space Debris Mitigation Standard in March 1996, becoming one of the first agencies to do so.[169] The Standard addressed all of the pertinent debris issues, such as collisions, released debris, and maintenance of the GEO belt. The Standard was updated in 2003 to align more closely with the IADC standard.[170]

The contents of the above-mentioned Standards and Handbooks may be slightly different from each other but their fundamental principles are the same: (1) Preventing on-orbit break-ups, (2) removing spacecraft and orbital stages that have reached the end of their mission operations from the useful densely populated orbit regions, and (3) limiting the objects released during normal operations.[171] Most states require that residual propellants, batteries, flywheels, pressure vessels, and other instruments be depleted or passivated at the end of their operational lifetimes.[172] All major national debris mitigation guidelines address the disposal of GEO satellites, typically in graveyard orbits 235 km above the GEO orbit; most seek the removal of defunct spacecraft from LEO within 25 years.[173] However, these guidelines are not universally or regularly followed; inconsistent compliance with debris mitigation guidelines continues to be a critical problem for outer space security.[174]

[163] NASA Handbook for Limiting Orbital Debris, doc. 8719.14, *supra* fn 4.
[164] Ibid., at 5.
[165] Space Security Index 2012, *supra* fn 9, at 32.
[166] Ibid.
[167] NASA Handbook for Limiting Orbital Debris, 8719, *supra* fn 4, at 155.
[168] Ibid.
[169] Ibid., at 156.
[170] Ibid.
[171] Space Security Index 2012, *supra* fn 9, at 33.
[172] Ibid.; Passivation is the elimination of all stored energy on a spacecraft or orbital stages to reduce the chance of break-up. Typical passivation measures include venting or burning excess propellant, discharging batteries and relieving pressure vessels.
[173] Ibid.
[174] Ibid.

a. The IADC Guidelines

The IADC was formed in 1993 as an international forum to harmonise the efforts of various space agencies to address the problem caused by orbital debris.[175] As of 2013, the IADC comprised ASI (Agenzia Spaziale Italiana [Italy], the British National Space Centre (BNSC), CNES (Centre national d'études spatiales [France]), CNSA (China National Space Administration), CSA (Canadian Space Agency), DLR (German Aerospace Center), ESA, ISRO (Indian Space Research Organisation), JAXA (Japan Aerospace Exploration Agency), NASA, NSAU (National Space Agency of Ukraine), and Roscosmos (Russian Federal Space Agency). A Steering Group and four specified Working Groups covering measurements (WG1), environment and database (WG2), protection (WG3) and mitigation (WG4) make up the IADC.[176] In 2002, after a multi-year effort, the IADC adopted a consensus set of guidelines designed to mitigate the growth of the orbital debris population.[177] These guidelines were submitted to the STSC of COPUOS on 18 November 2002 and formally presented to the STSC of COPUOS at its 40th session in February 2003.[178] The IADC Guidelines is a document of a technical nature and is proposed to be applicable to earth orbiting vehicles addressing mission planning, design and operation (launch, mission, disposal).[179] The IADC Guidelines identify four basic practices to limit space debris: (1) limitation of debris released during normal operations (by designing systems to avoid the release of debris), (2) minimisation of the potential for on-orbit break-ups (by continuously monitoring spacecraft and taking action when necessary to avoid break-up), (3) Post-mission disposal (disposal of spacecraft after the mission by moving spacecraft into less congested orbits), and (4) prevention of on-orbit collisions (by maneuvering spacecraft to avoid collisions when necessary).[180] In order to minimise the potential for accidental post mission break-ups resulting from stored energy, all on-board sources of stored energy of a space asset, such as residual propellants and other fluids, such as pressurant, should be depleted, either by depletion burns or venting, to prevent accidental break-ups by over-pressurisation or chemical reaction; battery charging lines should be de-activated, high-pressure vessels should be vented, and power to flywheels or momentum wheels should be terminated during the disposal phase; depletion should be accomplished as soon as this operation does not pose an unacceptable risk to the payload.[181] In order to minimise the potential for break-ups during operational phases, spacecrafts and orbital stages should be designed so as to exclude probable failure modes leading to accidental break-ups. They should be periodically monitored to detect malfunctions leading to break-up or loss of control function, and in the case of a malfunction should be adequately

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[175] Ibid.

[176] Inter-Agency Space Debris Coordination Committee (IADC), http://www.iadc-online.org/ (last visited on 4 June 2013).

[177] IADC Space Debris Mitigation Guidelines (2002), *supra* fn 8.

[178] Report of the IADC Activities on Space Debris Mitigation Guidelines, Presentation to the Scientific and Technical Subcommittee of the United Nations on the Peaceful Uses of Outer Space, 40th Session of the UNCOPUOS Scientific and Technical Subcommittee of February 2003, available at http://www.iadc-online.org/index.cgi?item=docs_pub (last visited on 4 June 2013).

[179] Ibid.

[180] IADC Space Debris Mitigation Guidelines (2002), *supra* fn 8, P 1, at 5.

[181] Ibid., sec. 5.2.1., at 8.

recovered or passivated.[182] Intentional destruction of a spacecraft or orbital (stages) and other harmful activities that may significantly increase the collision risks to other spacecraft and orbital stages should be avoided (i.e., intentional break-ups should be conducted at sufficiently low altitudes so that orbital fragments are short-lived).[183] The IADC Guidelines specifically recommend post-mission disposal of spacecraft and orbital stages from GEO into higher orbits (minimum increase of perigee altitude 235 km) and de-orbiting of spacecraft and orbital space from LEO within 25 years.[184] A Support Document to the IADC Space Debris Mitigation Guidelines provides rationale for the Guidelines and technical information for the implementation of the Guidelines. The IADC Guidelines are regarded as an important evolution in the orbital debris problem because they brought the discussion of space debris mitigation into the international community and served as the impetus for the COPUOS to approve their own guidelines.[185] Both the IADC and the COPUOS guidelines are legally nonbinding, but declare that all states should voluntarily apply the debris mitigation measures. In January 2013, the IADC-WG2 presented the outcomes of its AI 27.1 investigation on the Stability of the Future LEO Environment.[186] Each of the six participating member agencies (ASI, ESA, ISRO, JAXA, NASA, and UKSA [UK Space Agency, former BNSC]) used their own models to simulate the future environment, assuming nominal launches and a 90% compliance of the commonly–adopted mitigation measures (this compliance assumption is certainly higher than the current reality), through year 2209.[187] Even with a 90% implementation of the commonly-adopted mitigation measures, based on the ESA provided initial population of 2009, the LEO debris population is expected to increase by an average of 30% in the next 200 years.[188] The population growth is primarily driven by catastrophic collisions between 700 and 1000 km altitudes and such collisions are likely to occur every 5 to 9 years.[189] The AI 27.1 study results confirm the instability of the current LEO debris population.[190] In order to stabilise the LEO environment, two key elements are considered essential for the long-term sustainability of the future LEO environment: full compliance of the mitigation measures, such as the 25-year rule, and more aggressive measures such as active debris removal.[191] Remediation of the environment after 50 years of space activities is complex and requires a tremendous amount of resources and international cooperation to investigate the benefits of environment remediation, explore various options and support the development of the most cost-effective technologies.[192]

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[182] Ibid., sec. 5.2.2., at 8 *et seq*.
[183] Ibid., sec. 5.2.3., at 9.
[184] Ibid., sec. 5.3., at 9 *et seq*. (De-orbiting is defined as intentional changing of orbit for re-entry of a spacecraft or orbital stages into the Earth's atmosphere by applying a retarding force usually via a propulsion system.)
[185] Bressack L, *supra* fn 56, at 753.
[186] IADC Report on the Stability of the Future LEO Environment (IADC-12-08), *supra* fn 45.
[187] Ibid., sec. 5, at 17.
[188] Ibid.
[189] Ibid. (A catastrophic collision occurs when the ratio of impact energy to target mass exceeds 40J/g. The outcome of a catastrophic collision is the total break-up of the target, whereas a non-catastrophic collision only results in damage to the target and generates a small amount of debris.)
[190] Ibid.
[191] Ibid.
[192] Ibid., sec. 5, at 17,18.

b. The COPUOS Space Debris Mitigation Guidelines

In 1959, the UN General Assembly established the Committee on the Peaceful Uses of Outer Space (COPUOS) (UNGA resolution 1472 (XIV)) as a permanent body to maintain close contact with governmental and non-governmental organisations concerned with outer space matters, to provide for the exchange of such information relating to outer space activities as supplied by the states on a voluntary basis, and to assist in the study of measures for the promotion of international cooperation in outer space activities. Today, COPUOS has 74 members – one of the largest Committees in the UN – and, in addition to states, a number of international organisations, including both inter- and non-governmental organisations, have observer status with COPUOS.[193] The Committee has two standing Subcommittees, the Scientific and Technical Subcommittee (STSC) and the Legal Subcommittee. The Committee and the Subcommittees meet annually to consider questions put before them by the GA, reports submitted to them and issues raised by the member states, and, working on the basis of consensus, make recommendations to the GA.[194] In UNCOPUOS, space debris has been dealt with primarily in the STSC until today. The STSC began discussions on space debris in 1994. At the thirty-first session of STSC in 1994, the matter of space debris was included as an item on the agenda.[195] In accordance with the agreement of the Committee, the STSC considered under that item scientific research relating to space debris, including debris measurement techniques, mathematical modelling of the debris environment, characterisation of the space debris environment, and measures to mitigate the risks of space debris.[196] The STSC decided about a multi-year workplan for the period from 1996 to 1998 and adopted the "Technical Report on Space Debris" in 1999.[197] In 2001 COPUOS asked IADC to develop a set of international debris mitigation guidelines. After the publication of the IADC Space Debris Mitigation Guidelines, the STSC agreed on two further multi-year workplans for the periods between 2002 and 2005 and between 2005 and 2007 with the goal of expediting an international adoption of voluntary debris mitigation measures.[198] In June 2005, representatives from over a dozen member states of COPUOS and ESA (which holds an official Observer status) participated in a session to begin drafting a set of space debris mitigation guidelines. As a result of this 4-day meeting, a consolidated set of draft space debris mitigation guidelines were produced. On 1 March 2006, the Space Debris Working Group formally presented the Subcommittee with a draft document entitled

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[193] Committee on the Peaceful Uses of Outer Space, United Nations Office for Outer Space Affairs, available at http://www.oosa.unvienna.org/oosa/COPUOS/copuos.html (last visited on 22 May 2013).
[194] Ibid.
[195] COPUOS Space Debris Mitigation Guidelines, *supra* fn 1, preface.
[196] Ibid.
[197] Report adopted by the Scientific and Technical Subcommittee in 1999, UN Doc. A/AC.105/720, available at http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_720E.pdf (last visited 30 May 2013).
[198] Report of the Scientific and Technical Subcommittee of its 38th Session from 12 to 23 February 2011, UN Doc. A/AC.105/761, para. 128 *et seq*., Report of the Scientific and Technical Subcommittee of its 42nd Session from 21 February to 4 March 2005, UN Doc. A/AC.105/848, para. 95 and annex II.

"U.N. COPUOS STSC Space Debris Mitigation Guidelines".[199] After a full year of review in 2006, the guidelines were adopted by the Subcommittee at its 44th meeting in February 2007 (A/AC.105/890, para. 99) and endorsed by the Committee at its 50th session in 2007 (A/62/20, paras. 118-119). In its resolution 62/217 of 22 December 2007, the UNGA endorsed the Space Debris Mitigation guidelines of the UNCOPUOS and agreed that the voluntary guidelines for the mitigation of space debris reflected the existing practice as developed by a number of national and international organisations, and invited member states to implement those guidelines through relevant national mechanisms.[200] The UNCOPUOS Space Debris Mitigation Guidelines are published in Annex 4 of the Report of the STSC of UNCOPUOS on its 44th Session (U.N. Doc. A/AC.105/890, Feb. 12-23 2007).[201] Although the IADC and the UNCOPUOS Guidelines are merely non-binding technical guidelines, they (a) can develop into a professional standard if they are widely implemented and respected by the relevant industry, (b) can be regarded as safety standards, and (c) contain elements that may play a role in the assessment of the duties of care and due diligence in liability cases against states and space operators.[202]

Guideline 1: Limit debris released during normal operations

While in the early decades of space missions the release of mission-related objects into Earth orbit such as sensor covers, separation mechanisms and deployment articles was permitted, "recognition of the threat posed by such objects" now encourages to use specially designed space systems in an effort to reduce this source of space debris or, if this is not feasible, to minimise the effect of any release of space debris on the space environment. The "recognition" of the threat may be an important element in the evaluation of the space activities of private and public space actors.[203]

Guideline 2: Minimise the potential for break-ups during operational phases

Guideline 2 instructs to minimise the potential for accidental break-ups during operational phases. These catastrophic events should be avoided by designing spacecraft to avoid failure modes and incorporating potential break-up scenarios. Guideline 2 refers to some break-ups which occurred in the past due to system malfunction such as failures of propulsion and power systems. The occurrence of such catastrophic events in the past relates to the "foreseeability" of the damage and thus influences the assessment of the standard of care which is demanded from actors carrying out new space operations.[204]

Guideline 3: Limit the probability of accidental collision in orbit

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[199] UNCOPUOS Space Debris Mitigation Guidelines, supra fn 1, annex to UN Doc. A/AC.105/C./L.260; see also Report of the Committee on the Peaceful Uses of Outer Space of its 62nd Session from 6 to 15 June 2007; available at http://www.oosa.unvienna.org/pdf/publications/st_space_49E.pdf (last visited on 30 May 2013).

[200] Imburgia JS, *supra* fn 58, at 624; UN GA Resolution 62/217 of 1 February 2008, available at http://www.oosa.unvienna.org/pdf/gares/ARES_62_217E.pdf (last visited on 25 May 2013).

[201] Ibid.

[202] Marboe I, *supra* fn 112, at 141 *et seq*.

[203] Ibid., at 141.

[204] Ibid.

Guideline 3 asks to limit the probability of accidental collisions in orbit. The Guidelines point out that some member states and international organisations have already adopted collision avoidance procedures. This has an influence on the evaluation of the required standard of care as the respective states may represent the relevant "group" [205] whose behaviour is a determinative factor in the evaluation of the standard of care for the actor in the same field. Implementation of collision avoidance procedures can also be considered as a "professional standard of care"[206] to be expected of a person carrying out the activity.

Guideline 4: Avoid intentional destruction and other harmful activities

Guideline 4 instructs to avoid intentional destruction of on-orbit spacecraft and other harmful activities that create long-lived space debris. The Guideline establishes that, if intentional break-ups (which are not totally banned) are necessary, they shall be conducted at sufficiently low altitudes to create only short-lived fragments. An action which is carried out in contradiction to the Guideline may be regarded as being incompatible with the required standard of care.[207]

Guideline 5: Minimise potential for post-mission break-ups resulting from stored energy

Guideline 5 explains in detail the threats caused by unintentional post-mission break-ups. The Guideline outlines the importance of passivation of space objects at the end of their mission. The removal of all forms of stored energy, including residual propellants and compressed fluids, and the discharge of electrical storage devices, may reflect the required "state of the art" (if not so yet, perhaps in the future).[208]

Guideline 6: Limit the long-term presence of space objects in the LEO region after the end of their mission

Guideline 6 provides that space objects in LEO should be removed from orbit after the end of their mission or, if this is not possible, be disposed of in higher orbits. This Guideline is less specific than the IADC Guidelines[209] and does not introduce the 25-year limit for non-maneuverable space objects. Because of its vagueness, Guideline 6 cannot easily be regarded as an established state of the art. Violation of the Guideline does not automatically entail liability for damage caused to another spacecraft, but liability in this context has to be evaluated on the basis of other determinative factors relating to the due standard of care such as collision avoidance procedures.[210]

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[205] Ibid., at 142; The reference to a "group" of comparable actors is of particular importance under German law. See German Civil Code in the version promulgated on 2 January 2001; official translation by the German Ministry of Justice at http://www.gesetze-im-internet.de/englisch_bgb/englisch_bgb.html#p3312.

[206] Marboe I, ibid.; This criterion can be found in civil law and common law jurisdictions as well as in the Principles of European Tort Law. See European Group on Tort Law, Principles of European tort law: text and commentary (Springer Verlag Wien et al. 2005).

[207] Marboe I, ibid.

[208] Ibid.

[209] IADC Space Debris Mitigation Guidelines (2002), *supra* fn 8, sec. 5.3. ("Objects Passing Through the LEO Region"), at 9 *et seq*. "This IADC and some other studies and a number of existing national guidelines have found 25 years to be a reasonable and appropriate lifetime limit."

[210] Marboe I, *supra* fn 112, at 142.

Guideline 7: Limit the long-term interference of space objects with the GEO region after the end of their mission

Guideline 7 provides for a removal of space objects from GEO to avoid long-term interference with the GEO region. In contrast to the IADC Space Debris Mitigation Guidelines,[211] this provision does not specifically require disposal at a perigee altitude of 235 km above the GEO orbit. This Guideline can be regarded as "implementation of the obligation of international cooperation and paying due regard to the interest of other States in Arts. I and IX of the Outer Space Treaty and, in particular, of the non-appropriation principle in Art. II."[212] Also, because the removal of GEO satellites has been increasingly deployed in recent years, this provision may develop into general practice and become an established state of the art.[213]

In conclusion, the UNCOPUOS Space Debris Mitigation Guidelines contain a number of elements of the required standard of care essential for the establishment of fault liability. In case of damage being caused to a third party, the violation of these guidelines may indicate fault in the context of liability.[214]

The above-mentioned international soft law instruments cannot be considered subject to the law of treaties and its fundamental principle of *pacta sunt servanda*.[215] However, soft law instruments may "codify pre-existing customary international law, helping to provide greater precision through the written text, or precede and help form new customary international law."[216] In order to assess whether soft law agreements may qualify for the creation of customary international law or if they contain some of its elements, the basic criteria established by the International Court of Justice in several

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[211] IADC Space Debris Mitigation Guidelines (2002), *supra* fn 8, sec. 5.3. ("Geosynchronous Region"), at 9. "The IADC and other studies have found that fulfilling the two following conditions at the end of the disposal phase would give an orbit that remains above the GEO protected region: 1. A minimum increase in perigee altitude of 235 km […] 2. An eccentricity less than or equal to 0.003." Other options enabling spacecraft to fulfil this guideline to remain above the GEO protected region are described in the "Support to the IADC Space Debris Mitigation Guidelines" document.

[212] Marboe I, *supra* fn 112, at 143.

[213] Ibid.; Currently, about 1/3 of inactive satellites are removed from the GEO region to a disposal orbit at least 250 km above the GEO, 1/3 to a lower orbit, still presenting a danger for future interferences with functional GEO satellites, and 1/3 are left in the GEO orbit. The removal of GEO satellites has not yet become a standardised practice, see Viikari L, The environmental element in space law: assessing the present and charting the future (Martinus Nijhoff Publishers, Leiden et al. 2008), at 115 with further references.

[214] Marboe I, *supra* fn 112, at 144.

[215] Ferrazzani M. Soft Law in Space Activities – An Updated View, in: Irmgard Marboe (ed.), Soft Law in Outer Space, The Function of Non-binding Norms in International Space Law (Böhlau Verlag Wien et al. 2012), at 111.

[216] Ibid., at 111 *et seq.*; citing Dinah L. Shelton, Soft Law, Handbook of International Law (Routledge Press 2008), GWU Legal Studies Research Paper No. 322, at 8: "A non-binding normative instrument may do one or more of the following: 1) codify pre-existing customary international law, helping to provide greater precision through the written text; 2) crystallise a trend towards a particular norm, overriding the views of dissenters and persuading those who have little or nor relevant state practice to acquiesce in the development of the norm; 3) precede and help form new customary international law; 4) consolidate political opinion around the need for action on a new problem, fostering consensus that may lead to treaty negotiations or further soft law; 5) fill in gaps in existing treaties in force; 6) form part of the subsequent state practice that can be utilised to interpret treaties; 7) provide guidance or a model for domestic laws, without international obligation, and 8) substitute for legal obligation when on-going relations make formal treaties too costly and time-consuming or otherwise unnecessary or politically unacceptable."

cases and in the literature should be applied.[217] According to these criteria, two fundamental elements are necessary to be present to establish customary practice a source of law: State practice (*diuturnitas*) and *opinio iuris*. In the area of space law, the special nature of space activities (vast and continuous growth of space activities) is recognised to be a factor accelerating the formation of custom.[218] Therefore an activity, relatively concentrated in time, may qualify as fulfilling the requirement of *diuturnitas*, if it is uniform, extensive and consistent enough to demonstrate its legal validity. The institutions based on soft law instruments such as the IADC are often brought into existence by government representatives. The declared objectives are then implemented through a continuous and uniform behaviour: delegations representing public institutions meet regularly, they convene with the declared intention to formulate and subsequently to follow the ground rules established between themselves, to exchange internal information and consult on the results of their activities.[219] Because of the expected benefits of this cooperation, the actors wish to play along. This consistent behaviour reflects the *opinio iuris* of the involved entities.[220] The UNCOPUOS Space Debris Mitigation Guidelines may be considered as reflecting the *opinio iuris* of the leading spacefaring states "since they were adopted by consensus of the UNGA, and reflect the uniform opinion of the twenty-six space nations with regard to space debris mitigation practices.[221] At the time of the adoption, the respective states were expressing their individual perception that the Guidelines were lawful and in accordance with international law."

The above-mentioned soft law agreements resulting from international cooperation in the area of space activities may thus form a basis for the development of new customary law. However, some authors deny the existence of an extensive, uniform and consistent state practice with regard to space debris mitigation as well as the existence of *opinio iuris*. They argue that it is the prevailing but not a uniform state practice among the specifically affected states to limit the generation of new space debris when it is cost-effective and can be achieved without negative mission impact.[222] In addition, they refer to the ASATs carried out by China and the United States as evidence for the lack of a consistent state practice of space debris mitigation.[223] With regard to the *opinio iuris*, some authors note that the entities performing a continuous and uniform state practice are convinced that they are accomplishing an international duty because they "at least consider their domestic requirements as

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[217] Ibid., at 113 *et seq.*; see North Sea Continental Shelf (Federal Republic of Germany/Netherlands and Denmark), Judgment of the International Court of Justice of 20 February 1969, ICJ Reports 1969, 3; see also Akehurst M. Custom as a source of international law. British Yearbook of International Law (1974-1975);47, at 1.

[218] Cheng B. United Nations resolutions on outer space: „instant" international customary law? Indian Journal of International Law 1965, at 23; Guzman AT. Saving customary international law. Michigan Journal of International Law 2005;27, at 115; Lepard BD. Customary international law: a new theory with practical applications (Cambridge University Press, Cambridge 2010), at 98.

[219] Ferrazzani M, *supra* fn 215, at 114.

[220] Ibid., at 115; Hilgenberg H. A fresh look at soft law. European Journal of International Law 1999;10, at 514.

[221] Ferrazzani M, ibid.; Welly ND. Enlightened state-interest – a legal framework for protecting the "common interest of all mankind" from Hardinian tragedy, Journal of Space Law (2010);36,273-313, at 311.

[222] Imburgia JS, *supra* fn 58, at 625; Taylor MW, *supra* fn 150, at 28.

[223] Ibid.

national mechanisms governing space debris mitigation to implement the IADC Space Debris Mitigation Guidelines and the UNCOPUOS Space Debris Mitigation Guidelines."[224] Other authors exclude the possibility of creating binding international law by these guidelines due to the lack of *opinio iuris*.[225] They argue that the guidelines require member states and international organisations to "voluntarily take measures, through national mechanisms or through their own applicable mechanisms, to ensure that [the space debris mitigation] guidelines are implemented" but this requirement applies only to "the greatest extent feasible".[226] Therefore, they deny the existence of *opinio iuris* as "there is no legal obligation to follow the guidelines."[227]

c. Basic Concepts of Space Traffic Management - The IAA Space Traffic Management Report

The 1967 OST contains a set of principles, a number of which are of direct relevance to space traffic.[228] Nevertheless, international space law lacks numerous provisions which are essential for a comprehensive space traffic management regime.[229] The Report of Cosmic Study on Space Traffic Management (STM Report) was drafted by the International Academy of Astronautics (IAA) study group in 2006. Principles of the STM concept have been widely discussed among the international community as an implied manner through the Code of Conduct for Outer Space Activities of the European Union (EUCoC) and the Long Term Sustainability of Space Activities (LTSSA).[230] The IAA STM Report presents a model for a comprehensive STM regime up until the year 2020.[231] The model regime consists of three parts: Part 1 defines necessary data for safe space operations, and proposes establishing a database and distribution mechanisms for data.[232] Part 2 of the model regime proposes a notification system (pre-launch notification with more precise information than currently provided by the Registration Convention, information on the end of active/operational lifetime of space objects, and pre-notification of orbital maneuvers and active de-orbiting).[233] Part 3 provides a set of necessary rules for traffic management as well as clarification of "fault" in case of damage caused in outer space

224 Takeuchi Y, *supra* fn 29, at 332.
225 Imburgia JS, *supra* fn 58, at 625; Taylor MW, *supra* fn 150, at 29.
226 UNCOPUOS Space Debris Mitigation Guidelines, *supra* fn 1, Annex 4 P3.
227 Imburgia JS, *supra* fn 58, at 625.
228 Outer Space Treaty, *supra* fn 47 (i.e., the principle of utilisation of outer space for the benefit of, and in the interests of all countries; the principle of outer space being the "province of mankind", the principle of freedom of exploration and use of outer space, the principle that the state retains jurisdiction and control over its space object, whether it is in outer space or on Earth for as long as it is registered with/by the state, the principle of non-appropriation of outer space, including the Moon and other celestial bodies, the principle of use of outer space for peaceful purposes, and the interdiction of weapons of mass destruction).
229 IAA STM Report (2006), *supra* fn 2, at 39 *et seq*, sec. 2.2.2. (i.e., lack of a legal delimitation of air space from outer space, lack of a pre-launch notification requirement, no prioritization of certain space activities, no "right-of-way-rules", no prioritization of maneuvres, no traffic separation ["one-way-traffic"], no "zoning" rules [restriction of certain activities in certain areas], no communication rules [advance notification and communication if orbits of other operators are passed], no legally binding rules with regard to the mitigation of space debris and the disposal of spent space objects as well as the prevention of pollution of the atmosphere, lack of enforcement mechanisms).
230 Takeuchi Y, *supra* fn 29, at 329.
231 IAA STM Report (2006), *supra* fn 2, sec. 4.2, at 91 *et seq*,
232 Ibid., sec. 4.2. P1, at 91.
233 Ibid., sec. 4.2. P2, at 91.

with regard to the implications of traffic rules.[234] The 2006 STM Report recommends the endorsement of the IADC Space Debris Mitigation Guidelines by the UNCOPUOS, improvement and enhanced international cooperation on space surveillance and collision avoidance, and the implementation of enforcement mechanisms.[235]

d. The Draft International Code of Conduct for Outer Space Activities of the European Union

The EU initiative for an International Code of Conduct (CoC) for Outer Space Activities was launched at the end of 2008 as a means to achieve enhanced safety and security in outer space through the development and implementation of transparency and confidence-building measures.[236] In 2008 the EU presented to the international community a preliminary draft CoC for Outer Space Activities.[237] After consultations with spacefaring nations, the draft CoC 2008 was revised in 2010, and the revised draft CoC for Outer Space Activities was adopted by the Council of the EU on 27 September 2010.[238] This new proposal for an International CoC for Outer Space Activities was presented to the international community in October 2010.[239] The EU intended to pursue "consultations with third countries that have an interest in outer space activities, with the aim of establishing a text that is acceptable to the greatest number of countries and of adopting the Code of Conduct at an ad-hoc diplomatic conference."[240] While the majority of spacefaring countries, including Australia, Canada, and Japan, endorsed the EU code, other spacefaring nations such as Russia, India and China have indicated that they might not sign the EU code because they were insufficiently consulted in its development.[241] Because the code is voluntary, concern was expressed that it would prevent the global community from moving toward a legally binding rule in the future.[242] Critics also said that the code did not include effective verification and monitoring mechanisms, and India and other Asian countries

[234] Ibid., *et seq*, sec. 4.2. P3, at 91.
[235] Ibid., sec. 4.2, at 92.
[236] European Union External Action, Foreign Policy, Non Proliferation And Disarmament, Outer Space Activities, available at http://eeas.europa.eu/non-proliferation-and-disarmament/outer-space-activities /index_en.htm (last visited on 23 May 2013); see also Council conclusions and draft Code of Conduct for outer space activities, doc. 17175/08 (PESC 1697, CODUN 61), 8 Dec 2008, available at http://register.consilium.europa.eu/pdf/en/08/st17175.en08.pdf.
[237] Ibid.
[238] The Revised Draft Code of Conduct for Outer Space Activities (14455/10), Council Conclusions concerning the revised draft Code of Conduct for Outer Space Activities, 11 Oct 2010, Council of the European Union, doc. 14455/10, Annex, available at http://www.consilium.europa.eu/uedocs/cmsUpload/st14455.en10.pdf (last visited on 23 May 2013).
[239] Ibid.
[240] Ibid., at 2.
[241] Space Security Index 2012, *supra* fn 9, at 62; Observer Research Foundation, Code of Conduct in Space: India Should Lead The way, 31 May 2011, available at http://www.observerindia.com/cms/sites /orfonline/modules/report/ReportDetail.html?cmaid=23591&mmacmaid=23592. China's reluctance to support the code has been attributed to its purported view that the issue of orbital space debris should no be included in the Code, as well as an objection to the code's insistence that states that adopt the code share information on their domestic national space policies, including security objectives and defense-related activities.
[242] Space Security Index 2012, ibid., at 62.

believed hat they were not sufficiently consulted during its drafting.[243] The United States and the EU also engaged in consultations. The U.S. administration debated for two years whether to endorse the EU code, pending a Pentagon assessment as to whether it would have an operational impact on the military's use of space.[244] While statements from various administration officials during 2011 seemed to indicate that the United States might endorse the code in its current form or with minor modifications, on 17 January 2012 U.S. Secretary of State Clinton instead stated that "the United States has decided to join with the European Union and other nations to develop an International Code of Conduct for Outer Space Activities."[245] On 6 June 2012, the EU proposed a revised version of its draft Code, based on comments received in bilateral meetings with various partners, and officially launched the multilateral diplomatic process to discuss and negotiate its initiative for an International CoC for Outer Space Activities.[246] Substantial negotiations on the basis of the revised draft code began at the Multilateral Experts Meeting of October 2012 in New York, with a view to adopt the Code in 2013.[247]

e. The Long Term Sustainability of Space Activities

The long-term sustainability of space activities topic has been discussed within the UNCOPUOS framework since 2004.[248] In 2009, the UNCOPUOS decided to add a sustainability item to its agenda. This led to the establishment of an official Working Group (WG) under the chairmanship of South African Peter Martinez on 18 February 2010.[249] The LTSSA WG is an initiative under the STSC of UNCOPUOS tasked with producing a consensus report outlining voluntary best practice guidelines for all space actors to ensure the long-term sustainable use of outer space. A working paper containing the

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[243] Ibid.; Observer Research Foundation, Code of Conduct in Space: India Should Lead The way, 31 May 2011, available at http://www.observerindia.com/cms/sites/orfonline/modules/report/ReportDetail.html?cmaid=23591 &mmacmaid=23592.

[244] Lake E. Republicans Wary of EU Code for Space Activity, Washington Times, 3 Feb 2011, available at http://www.washingtontimes.com/news/2011/feb/3/republicans-wary-of-eu-code-for-space-activity.

[245] Abramson J and Gebben N. US Moves Forward on Space Policy, Arms Control Association, March 2011, available at http://www.armscontrol.org/aet/2011_03/space; Hillary R. Clinton, International Code of Conduct for Outer Space Activities, Press Statement by Hillary R. Clinton, Secretary of State, 17 Jan 2012, available at http://www.state.gov/secretary/rm/2012/01/180969.htm.

[246] European Union, Working Document, Revised Draft International Code of Conduct for Outer Space Activities, 5 June 2012, available at http://www.consilium.europa.eu/media/1696642/12_06_05_coc_space_eu_ revised_draft_working_document.pdf. (last visited on 23 May 2013) [hereinafter EuCoC 2012]. Although the document retains much of the language from the 2010 draft, one major addition to the text is an explicit statement that the code is not legally binding, a key point emphasised by U.S. officials supportive of the code in the face of criticism. See Farnsworth T. Issue Briefs, New Draft of Space Code Released, Arms Control Association, Washington, available at http://www.armscontrol.org/2012_07-08/New_Draft_of_Space_Code_ Released (last visited on 23 May 2013).

[247] Ibid.

[248] Chow T. UNCOPUOS Long-Term Sustainability of Space Activities Working Group. Fact Sheet. [Website article, updated June 2013, at 1]. Secure World Foundation, www.swfound.org. Available at http://swfound.org/media/109514/SWF_UNCOPUOS_LTSSA_Fact_Sheet_June_2013.pdf (last visited 25 July 2013).

[249] Ibid.

WG terms of reference, method of work, and work plan was presented to the Subcommittee in 2011.[250] In the same year, the four expert groups were formed to examine specific topics relevant to long-term space sustainability: A – Sustainable space utilisation supporting sustainable development on Earth (co-chaired by Portugal and Mexico); B – Space debris, space operations, and tools to support space situational awareness sharing (co-chaired by Italy and the United States); C – Space weather (co-chaired by Japan and Canada); and D – Regulatory regimes and guidance for new space actors (co-chaired by Australia ad Italy).[251] State delegations or intergovernmental bodies with permanent observer status at COPUOS can nominate non-governmental experts to these groups as a part of their official delegation. According to the terms of reference[252], which define objectives, scope and organisation, the LTSSA WG aims to identify areas of concern to space sustainability, examine and propose measures to ensure the safe and sustainable use of outer space for peaceful purposes, and prepare a report containing a consolidated set of best practices that could be applied on a voluntary basis by states, international organisations, national non-governmental organisations and the private sector. The LTSSA WG has a multi-year work plan for the period 2011-2014. Each expert group met in 2012 to determine scope of work, develop outlines and define writing assignments. In 2013, the expert groups prepared draft reports with the goal of submitting a consolidated report to the STSC in 2014 (Figure 2.3).[253] The current schedule calls for the STSC to review and finalise the report during its 51st session in 2014 with the intent of presenting to the full Committee the following June. Currently, the LTSSA WG is progressing, but it is likely that the WG will require an additional year to complete its report.[254] While there was first disagreement over the extent to which private sector and non-governmental entities should be involved in the process, a compromise was finally reached that these entities could participate indirectly through a member state delegation.[255] A second issue of concern surrounding the LTSSA WG is the debate over what constitutes "best practices". While some participants feel that only existing space activities should be considered, others would like to examine potential future challenges. There has also been discussion about whether a best practice is a goal to be achieved or a preferred was of accomplishing a goal.[256] The four expert Groups have made substantive progress on draft best practice guidelines, which the Chair has compiled into one document

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[250] COPUOS, Terms of Reference and Methods of Work of the Working Group on the Long Term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee, U.N. Doc. A/AC.105/C.1/L.307/Rev.1, 28 Feb 2011, available at http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_L307Rev1E.pdf (last visited on 23 May 2013). See also Report from the 54th session of UNCOPUOS to the 66th session of the UNGA, Supplement No. 20 (A/66/20), 2011, pp. 51-57.
[251] Ibid.
[252] COPUOS, Terms of Reference and Methods of Work of the Working Group on the Long Term Sustainability of Outer Space Activities of the Scientific and Technical Subcommittee, *supra* fn 250. See also Report from the 54th session of UNCOPUOS to the 66th session of the UNGA, *supra* fn 250.
[253] Chow T. UNCOPUOS Long-Term Sustainability of Space Activities Working Group. Fact Sheet. [Website article, updated June 2013], *supra* fn 248, at 2.
[254] Ibid.
[255] Ibid.
[256] Ibid.

(A/AC.105/C.1/2013/CRP.23).[257] A third issue is how the LTSSA WG should interface with other international initiatives or bodies also working on space sustainability, notably the Conference on Disarmament (CD), the ITU and the UNGA Group of Governmental Experts (GGE) on Transparency and Confidence-building Measures (TCBMs) for Space Activities. As part of the effort to facilitate harmonisation among these complementary initiatives, the Chair of the GGE presented at the third meeting of the LTSSA WG, providing an update of the work taking place in the GGE. Also, the terms of reference state that the WG "should avoid duplicating the work being done within these international entities and should intensify areas of concern relating to the long-term sustainability of outer space activities that are not being covered by them."[258]

Differences and similarities between the revised draft International CoC for Outer Space Activities 2012 and the draft best practice guidelines of the LTSSA.WG — The International CoC of the European Union was adopted by the third preliminary draft on 6 June 2012; the EU intended to consult with other states and conclude the agreement with their signature in a few years, while the LTSSA has agreed to start its discussions in the WG in mid-2011 and its conclusions are expected to be published in 2014 (or 2015).The revised draft International CoC for Outer Space Activities is being discussed through diplomatic channels, while the LTSSA is being discussed within the COPUOS/STSC.[259] The draft International CoC sets up a series of legally nonbinding norms and principles with the main purpose to "enhance the security, safety and sustainability of all space activities".[260] The LTSSA would be a set of voluntary recommended guidelines of technical practice to operators of spacecraft.[261] Two significant differences between the CoC and the LTSSA include national security and consultation measures.[262] The CoC aims to achieve a code of conduct among the governments and, therefore, includes national security issues.[263] According to Art. 2 of the CoC, the subscribing states keep "the inherent right of individual or collective self-defense in accordance with the UN Charter."[264] The states resolve to "take all appropriate measures to prevent outer space from becoming an arena of conflict."[265] Because the LTSSA remains a series of best practice guidelines of the space operators, it does not mention the relationship to national security.[266] In contrast to the draft best practice guidelines of the LTSSA WG, the draft International CoC introduces consultation

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[257] Available at http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_2013_CRP23E.pdf (last visited 25 July 2013).
[258] Report from the 54th session of UNCOPUOS to the 66th session of the UNGA, *supra* fn 250, at 55. See also Chow T. UNCOPUOS Long-Term Sustainability of Space Activities Working Group. Fact Sheet. [Website article, updated June 2013], *supra* fn 248, at 2
[259] Takeuchi Y, *supra* fn 29, at 326.
[260] Ibid.; EuCoC 2012, *supra* fn 246, Art. 1.1.
[261] Takeuchi Y, *supra* fn 29, at 326.
[262] Ibid., at 327.
[263] Ibid.
[264] EuCoC 2012, *supra* fn 246, Art. 2.
[265] Ibid.
[266] Takeuchi Y, *supra* fn 29, at 326.

mechanisms in order to promote discussions when problems occur.[267] While space weather issues were only included in the LTSSA and not in the International CoC, both documents recognise space debris mitigation and collision avoidance as the main priority issues to be resolved.[268] The measures to be taken to secure these issues are in both documents notification among operators and information sharing.[269]

Space situational awareness sharing. — In the absence of an international space surveillance system, countries are establishing national space surveillance systems, with a limited degree of information exchange, to reduce their reliance on the information released by other space actors such as the United States.[270] The absence of an operational global system for space surveillance is in part due to the sensitive nature of surveillance data. In addition, technical and policy challenges put constraints on data sharing, although some select space actors show efforts to overcome these challenges, as exemplified by the expansion of the U.S. Space Situational Awareness (SSA) Sharing Program.[271] Because of Cold War security concerns, the United States and the Soviet Union were pioneers in the development of space surveillance capabilities. Russia has a dedicated space surveillance system, the Space Surveillance System (SSS), which, however, is not as advanced as the U.S. SSN.[272] The SSS has catalogued approximately 5,000 objects, mostly in LEO.[273] Due to a limited geographic distribution, it cannot track satellites at very low inclination or in the Western hemisphere, and operation of Russian surveillance sensors is reportedly erratic.[274] The U.S. SSN, the most advanced and comprehensive space surveillance system, is capable of tracking as many as 22,000 man-made objects in Earth orbit.[275] The U.S. government shares SSA data through the SSA Sharing Program, headed by the U.S. Strategic Command (USSTRATCOM).[276] Three types of data are shared: Basic, Advanced, and Emergency.[277] Basic services are obtained online in a public and free database known as Space Track and include historical and current satellite data, decay and re-entry data, and Orbital

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[267] EuCoC 2012, *supra* fn 246, Art. 9.

[268] EuCoc 2012, ibid., Art. 4 (The draft International CoC for Outer Space Activities calls on signatories to reaffirm their commitments to the UNCOPUOS Space Debris Mitigation Guidelines.); LTSSA, *supra* fn 250, O.C. (Operative Clause) 16(b).

[269] EuCoc 2012, ibid., Arts. 6, 8; LTSSA, O.C. 16(b),(d).

[270] Space Security Index 2012, *supra* fn 9, at 14, 47.

[271] Ibid.

[272] Ibid., at 47.

[273] Ibid.

[274] Ibid.

[275] Ibid., at 31, 46.

[276] Ibid., at 46.

[277] Ibid., at 53; McLeod CB. Space Situational Awareness (SSA) Sharing, Presentation given to UNCOPUOS Scientific and Technical Committee meeting in Vienna, Austria, 6-17 Feb 2012, available at http://www.unoosa.org/pdf/pres/stsc2012/tech-40E.pdf. While some operators would like direct access to orbital data, there is some reluctance to release it widely. For instance, regulations for the Sharing Program restrict the sharing of surveillance information with a non-U.S. government entity to agreements in which "providing such data analysis to that entity is in the national security interest of the United States." Lt Col Maloney D. Public Law 108-136, Section 913, 10 U.S.C. §2274 (i)-Data Support, Space Surveillance Support to Commercial and Foreign Entities (CFE) Pilot Program, 20 Oct 2004, available at http://celestrak.com/NORAD/elements/notices/Space_Surveillance_Support_to_CFE_Pilot_Program_V07.pdf; Space Security Index 2012, *supra* fn 9, at 46.

Data Request forms.[278] The publicly available data at the Space Track website is a low accuracy version of the U.S. SSN catalogue and not sufficiently precise to adequately support collision avoidance.[279] Advanced Services require an official agreement between the U.S. government and the recipient. They enable two information exchange and the provision of conjunction assessment, launch support, and other more precise data and analysis.[280] The conjunction assessment criteria used in the SSA Sharing Program include notification to the owners/operators of any active satellite above LEO of predictions that their satellite will approach within 5 km of another orbiting object in the next 72 hours as well as notification to the owners/operators of any active satellite in LEO of predictions that their satellite will approach within 1 km of another orbiting object and within 200 m in the radial direction in the next 72 hours.[281] The USSTRATCOM has signed more than 30 such agreements with non-governmental entities since September 2010.[282] As of November 2011, USSTRATCOM is authorised to sign these partnerships agreements with other governments.[283] Emergency services provide notifications of close approaches, regardless of prenegotiated agreements.[284] As part of the SSA Sharing Program, JSpOC provides 20 to 30 close approach warnings per day and conjunction assessment to private sector companies and foreign actors.[285] France and Germany also use national space surveillance capabilities to monitor debris.[286] ESA maintains its own Database and Information System Characterising Objects in Space (DISCOS), which also takes inputs from the U.S. public catalogue, the Tracking and Imaging Radar (TIRA), and ESA's Space Debris Telescope in Tenerife, Spain.[287] Because active debris removal remains difficult, notification about the maneuvers of satellites to the other operators and information sharing among governmental and non-governmental space actors have been recognised to be the most effective ways in order to avoid collisions and new debris generation. More bilateral agreements and international cooperation on SSA and data sharing create a very positive impact on space security and sustainability.[288]

f. The Group of Governmental Experts of the UN

The Group of Governmental Experts (GGE) on Transparency and Confidence-building Measures (TCBMs) in Outer Space Activities is a UN initiative. The GGE originated from the UN First Committee on Disarmament and International Security and was established in 2011 by UNGA

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[278] Space Security Index 2012, *supra* fn 9, at 53; McLeod CB, *supra* fn 277; see http://www.space-track.org.
[279] Ibid.; Space Security Index 2012, at 46.
[280] Ibid.
[281] Space Security Index 2012, ibid., at 52.
[282] Ibid., at 53; Ferster W. Stratcom Could Negotiate Data Sharing Agreements, Space News, 19 July 2011, www.space.news.com/military/110719-stratcom-international-data-sharing.html; McLeod CB, *supra* fn 277.
[283] Space Security Index 2012, ibid., at 53; McLeod CB, ibid.
[284] Ibid.
[285] Ibid.
[286] Space Security Index 2012, ibid., at 50, 52. France maintains a satellite catalogue, which contains 2,700 objects observed using the Grande Réseau Adapté à la Veille Spatiale (GRAVES) space surveillance system. Germany contributes data from its Tracking and Imaging Radar (TIRA) to the European SSA Programme.
[287] Space Security Index 2012, ibid., at 48.
[288] Ibid., at 44, 51.

resolution 65/68 of 13 January 2011. UNGA resolution 65/68, which was adopted with a vote of 183 states in favor and none opposed (the United States abstained from voting on the resolution, objecting to its mention of the Chinese-Russian draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Object [PPWT], however, has since publicly declared its support for the process[289]), requested that the Secretary General establish, on the basis of equitable geographic distribution, a group of governmental experts to conduct a study commencing in 2012, and to report to UNGA in 2013.[290] The GGE consists of 15 international experts. Five of these are nominated by the permanent five of the UN Security Council, and the remaining expert spots are filled by ten other countries, selected by the UN based on state applications and fair geographic representation (Brazil, Chile, Italy, Kazakhstan, Nigeria, Romania, South Africa, South Korea, Sri Lanka, and Ukraine. The GGE met for the first time in New York, July 23-25, 2012; for a second time in Geneva, April 1-5, 2013; and for the third and last time in New York, July 8-12, 2013. The GGE's objectives are to examine and report on methods for improving international cooperation and reducing the risks of misunderstanding and miscommunication in space activities. The ultimate aim is to produce a consensus report that outlines conclusions and recommendations on transparency and confidence-building measures that can help ensure strategic stability in the space domain. The GGE is expected to submit its report to the UNGA at its 68th session commencing September 2013.[291] The GGE will not only examine the existing international law regarding space, but also consider the proposed International CoC, the work of the LTSSA WG of UNCOPUOS, and existing bilateral TCBMs. Topics reviewed include different categories of TCBMs, and a proposed central point of contact for all space TCBMs. From the discussions so far it has emerged that it is widely agreed that TCBMs are strictly voluntary in nature, that the UN Office of Disarmament Affairs (UNODA) could be a good central point of contact, that states and other relevant entities outside GGE should be consulted, and that different categories of TCBMs already exist (e.g., information exchanges, visits, notifications, and consultations).[292] The report will likely include an overview of the current dynamic in space, the general nature and characteristics of TCBMs, an emphasis on practicable and implementable TCBMs, and references to or elements of other ongoing international initiatives. While the Conference on Disarmament (CD), the international negotiating body responsible for space security issues, tasked with prevention of an arms race in outer space (PAROS), has been deadlocked for the last 15 years, the GGE is seen as a promising development that may advance important and necessary confidence-building measures related to peaceful space operations and move forward international dialogue on space security issues.[293]

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[289] Chow T. Group of Governmental Experts on TCBMs in Outer Space Activities. Fact Sheet. [Website article, updated June 2013, at 1]. Secure World Foundation, www.swfound.org. Available at http://swfound.org/media/109311/SWF%20-%20GGE%20Fact%20Sheet%20-%20June%202013.pdf (last visited 25 July 2013).

[290] Space Security Index 2012, *supra* fn 9, at 69.

[291] Chow T, *supra* fn 289, at 1.

[292] Ibid., at 2.

[293] Ibid., at 1; Space Security Index 2012, *supra* fn 9, at 16, 69 *et seq*.

6. Conclusion

A growing awareness of the impact of space debris on the security of space assets has encouraged space actors to take efforts to decrease the production of new space debris through the development and implementation of national and international debris mitigation guidelines. In the absence of legally binding regulatory mechanisms governing the complex issue of space debris and space traffic management, compliance with voluntary mitigation guidelines among space actors is still inconsistent. However, non-binding international norms such as guidelines and codes of conducts may play an important role for the establishment of liability of the launching states and of private actors for damages caused by space objects in outer space. More bilateral agreements and international cooperation on SSA and data sharing as well as exchange of knowledge base among space actors are essential for mitigation strategies and remediation measures.

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Treaties, Guidelines, and Codes of Conduct

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8. Annex

a. Figures

Figure 1.1. Top 10 breakups of on-orbit objects[294]

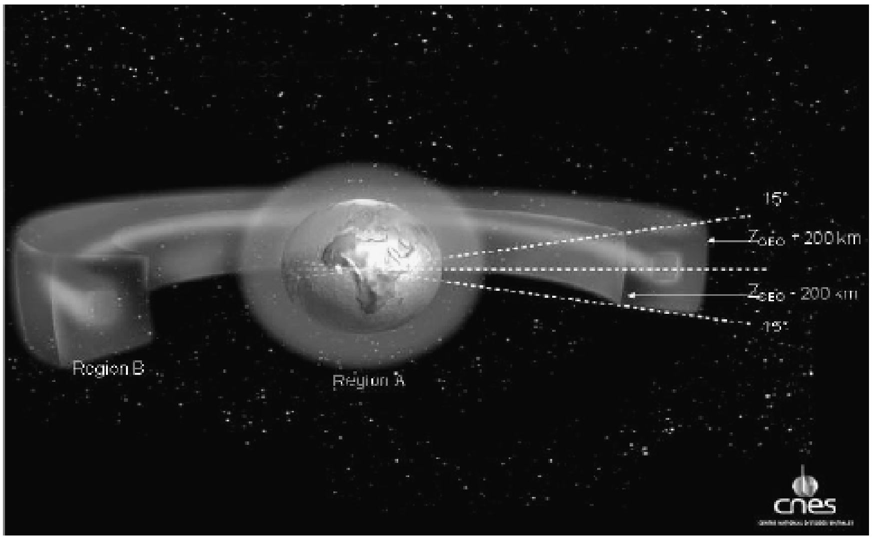
Common name	Launching state	Year of breakup	Altitude of breakup (km)	Total cataloged pieces of debris*	Pieces of debris still in orbit*	Cause of breakup
Fengyun-1C	China	2007	850	3,218	3,012	Intentional Collision
Cosmos 2251	Russia	2009	790	1,541	1,375	Accidental Collision
STEP 2 Rocket Body	United States	1996	625	713	63	Accidental Explosion
Iridium 33	United States	2009	790	567	493	Accidental Collision
Cosmos 2421	Russia	2008	410	509	18	Unknown
SPOT 1 Rocket Body	France	1986	805	492	33	Accidental Explosion
OV 2-1 / LCS-2 Rocket Body	United States	1965	740	473	36	Accidental Explosion
Nimbus 4 Rocket Body	United States	1970	1,075	374	248	Accidental Explosion
TES Rocket Body	India	2001	670	370	116	Accidental Explosion
CBERS 1 Rocket Body	China	2000	740	343	189	Accidental Explosion
			Total:	**7,903**	**5,172**	

*These totals only include trackable debris (generally >10 cm)

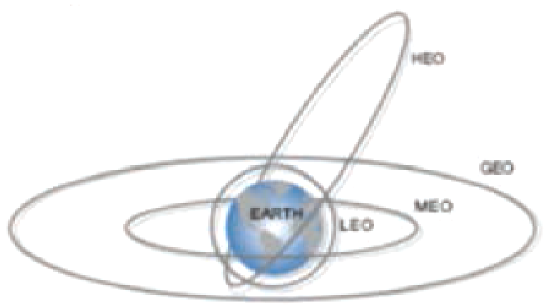
Break-up = any event that generates fragments, which are released into Earth orbit. This includes (1) an explosion caused by the chemical or thermal energy from propellants, pyrotechnics etc., (2) a rupture caused by an increase in internal pressure, and (3) a break-up caused by energy from collision with other objects.

[294] Space Security Index 2012, *supra* fn 9, at 31; Data compiled from the Space Track public satellite catalogue maintained by the U.S. military, online: http://space-track.org; Nicholas Johnson, USA Space Debris Environment, Operations and Policy Updates, Presentation given to the UNCOPUOS Scientific and Technical Committee meeting in Vienna, Austria, 6-17 Feb 2012, at http://unoosa.org/pdf/pres/stsc2012/tech-26E.pdf.

Figure 1.2. Types of Orbits[295]
a.



b.



Today's satellites operate mainly in three basic orbital regions: LEO, MEO and GEO. As of 1 April 2012 there are approximately 999 operating satellites, of which 470 are in LEO, 69 in MEO, 424 in GEO, and 36 in HEO.

(1) Region A, Low Earth Orbit (LEO) Region is the spherical region that extends from the Earth's surface up to an altitude of 2,000 km. LEO is often used for remote sensing and earth observation. LEO satellites can circle the Earth quickly, usually in about 90-100 minutes. This frequency allows imaging satellites to gather information on specific phenomena (i.e., Earth resources, weather) in specific areas several times a day.

(2) Region B, Geostationary Orbit (GEO) Region is a region in which the satellite orbits at approximately 36,000 km above the Earth's equator. The geosynchronous region is a segment of the spherical shell defined by a lower altitude (=geostationary altitude) minus 200 km, upper altitude (=geostationary altitude) plus 200 km, -15 degrees ≤ latitude ≤ + 15 degrees, and a geostationary altitude of 35, 786 km. Geostationary orbit has a period equal to the period of rotation of the Earth. By orbiting at the same rate, in the same direction as the Earth, the satellite appears stationary relative to the surface of the Earth. Communications satellites are the most common geosynchronous satellites. GEO satellites provide a "big picture" view of the Earth and are also used for coverage of weather events.

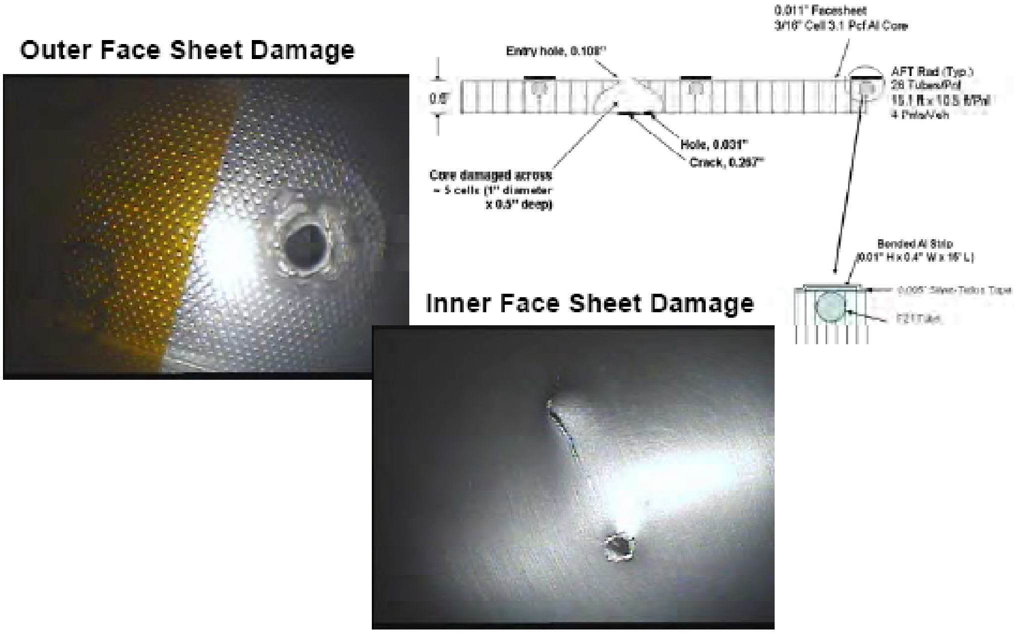
[295] A: Report of the IADC Activities on IADC Space Debris Mitigation Guidelines and Supporting Document, Presentation given to the UNCOPUOS Scientific and Technical Committee, 42th Session. B: Space Security Index 2012, *supra* fn 9, at 28, 151; From the Space Foundation, The Space Report 2008 (Colorado Springs: Space Foundation 2008), at 52.

(3) Medium Earth Orbit (MEO) is the region of space around the Earth above LEO (2,000 km) and below GEO (36,000 km). Orbital period of MEO satellites ranges from two to 12 hours. MEO satellites are most commonly used for navigation such as the U.S. Global Positioning System (GPS).

(4) High Elliptical Orbits (HEO) are characterised by a relatively low altitude perigee and an extremely high altitude apogee (perigee = the closest distance from the Earth to the satellite; apogee = the furthest distance from the Earth to the satellite). These extremely elongated orbits have the advantage of long dwell times at a point in the sky and are increasingly being used for specific applications such as early warning satellites and polar communications coverage.

Figure 1.3. [296]

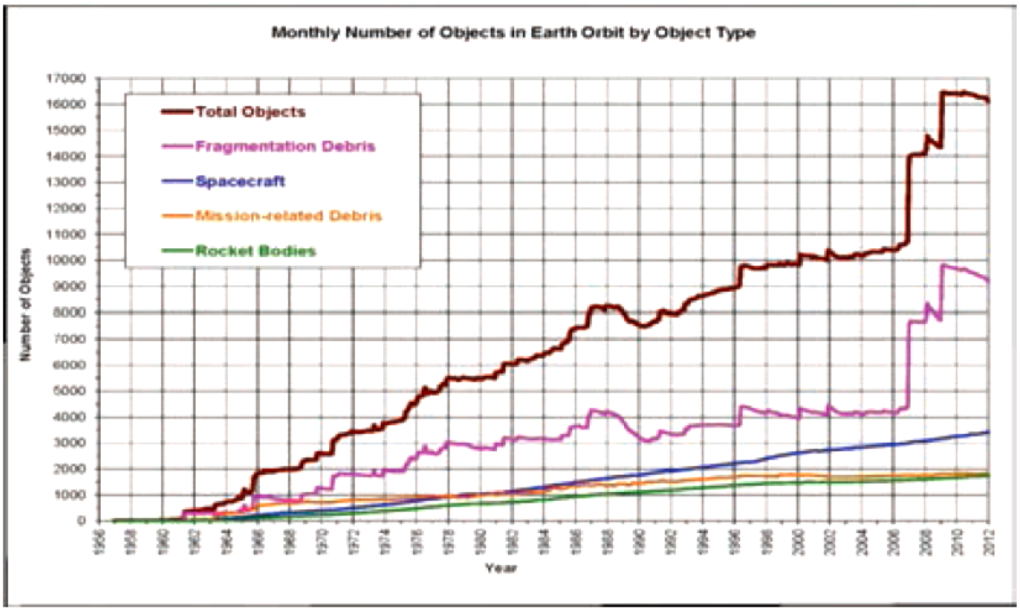
a. Radiator damage on STS-115 caused by a small piece of circuit board material.



b. Debris hole in a panel of the SMM Satellite

[296] NASA Handbook for Limiting Orbital Debris (2008), doc. 8719.14, *supra* fn 4, at 24.

Figure 1.4. Growth in on-orbit population by category[297]



Total Objects

Fragmentation Debris

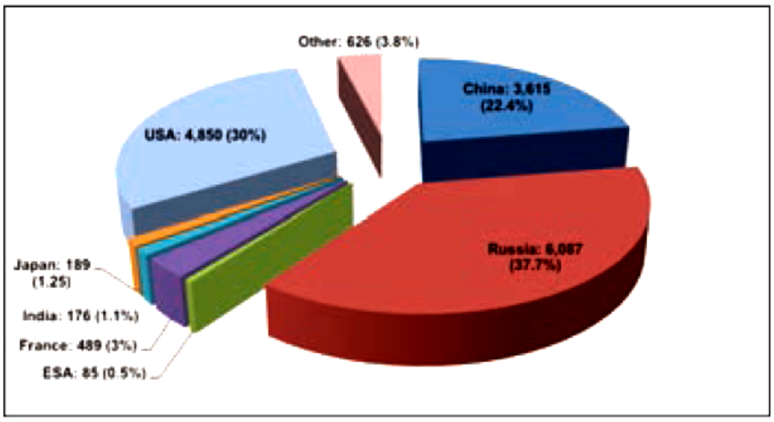
Spacecraft

Mission-related Debris

& Rocket Bodies

Note: This graph depicts the number of objects entering Earth's orbit in a given year.

Figure 1.5. Total catalogued on-orbit population by launching state by the end of 2011[298]

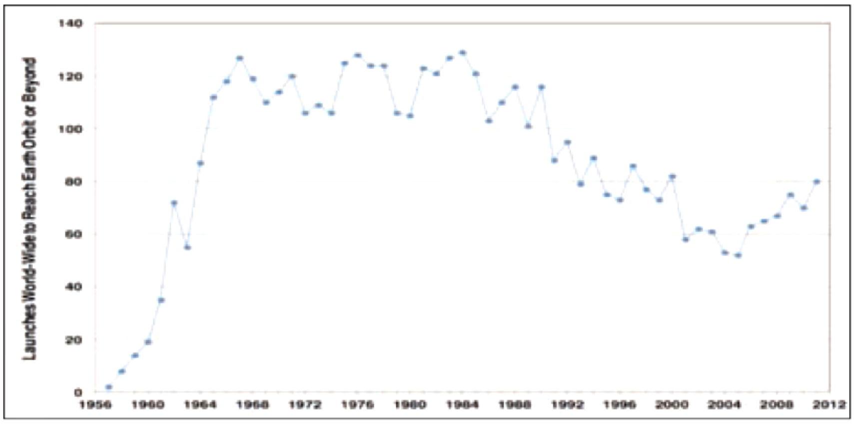


[297] Space Security Index 2012, *supra* fn 9, at 29; Singer J. Space-based missile interceptors could pose debris threat. Space News (13 Sept. 2004), at 8.

[298] Space Security Index 2012, *supra* fn 9, at 30; Data compiled from NASA's Orbital Debris Quarterly News, Jan 2012, at http://www.orbitaldebris.jsc.nasa.gov/newsletter.html.

Figure 1.6.

a. Number of launches by year[299]



b. Countries with independent orbital launch capability[300]

*Dark grey indicates an independent orbital launch capability and dots indicate launch sites.

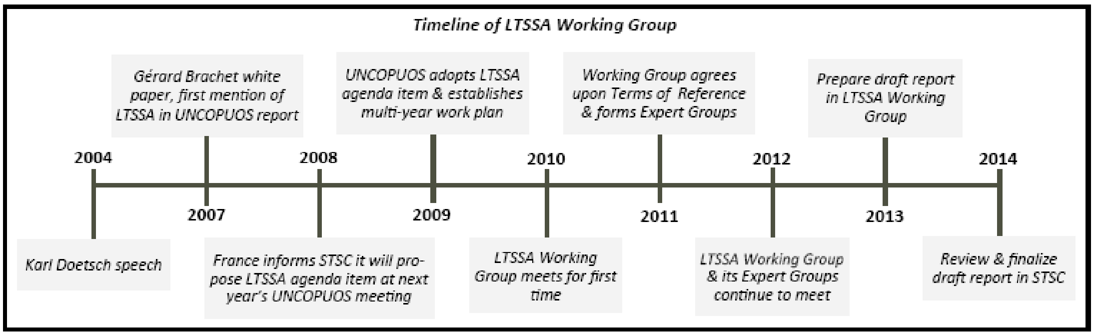
[299] Space Security Index 2012, supra fn 9, at 32; Nicholas Johnson, *supra* fn 280.
[300] Space Security Index 2012, *supra* fn 9, at 77.

Figure 2.1. Key UN space principles[301]

Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space (1963)
Space exploration should be carried out for the benefit of all countries.
Outer space and celestial bodies are free for exploration and use by all states and are not subject to national appropriation by claim of sovereignty or by any other means.
States are liable for damage caused by spacecraft and bear international responsibility for national and nongovernmental activities in outer space.
Principles on Direct Broadcasting by Satellite (1982)
All states have the right to carry out direct television broadcasting and to access its technology, but states must take responsibility for the signals broadcasted by them or actors under their jurisdiction.
Principles on Remote Sensing (1986)
Remote sensing should be carried out for the benefit of all states, and remote sensing data should not be used against the legitimate rights and interests of the sensed state, which shall have access to the data and the analysed information concerning its territory on a non-discriminatory basis and on reasonable cost terms.
Principles on Nuclear Power Sources (1992)
Nuclear power may be necessary for certain space missions, but safety and liability guidelines apply to its use.
Declaration on Outer Space Benefits (1996)
International cooperation in space should be carried out for the benefit and in the interest of all states, with particular attention to the needs of developing states.
UN Space Debris Mitigation Guidelines (2007)
These are voluntary guidelines for mission-planning, design, manufacture, and operational phases of spacecraft and launch vehicle orbital stages to minimize the amount of debris created.

Figure 2.2. UN-related institutions relevant to international space security[302]

Figure 2.3. Timeline of LTSSA Working Group[303]



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301 Space Security Index 2012, *supra* fn 9, at 59.
302 Ibid., at 68.
303 Chow T. UNCOPUOS Long-Term Sustainability of Space Activities Working Group. Fact Sheet. [Website article, updated June 2013], *supra* note 248, at 1.

b. The COPUOS Space Debris Mitigation Guidelines

UNITED NATIONS
OFFICE FOR OUTER SPACE AFFAIRS

Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space

UNITED NATIONS
Vienna, 2010

Preface

The Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space are the result of many years of work by the Committee and its Scientific and Technical Subcommittee.

At its thirty-first session, in 1994, the Subcommittee considered for the first time, on a priority basis, matters associated with space debris under a new item of its agenda (A/AC.105/571, paras. 63-74). In accordance with the agreement of the Committee, the Subcommittee considered under that item scientific research relating to space debris, including relevant studies, mathematical modelling and other analytical work on the characterization of the space debris environment (A/48/20, para. 87).

In addressing the problem of space debris in its work, the Subcommittee at its thirty-second session, in 1995, agreed to focus on understanding aspects of research related to space debris, including debris measurement techniques; mathematical modelling of the debris environment; characterizing of the space debris environment; and measures to mitigate the risks of space debris, including spacecraft design measures to protect against space debris. Accordingly, the Subcommittee adopted a multi-year workplan for specific topics to be covered from 1996 to 1998. The Subcommittee agreed that at each session it should review the current operational debris mitigation practices and consider future mitigation methods with regard to cost efficiency (A/AC.105/605, para. 83).

At its thirty-third session, in 1996, the Subcommittee agreed to prepare a technical report on space debris that would be structured according to the specific topics addressed by the workplan during the period 1996-1998 and that the report would be carried forward and updated each year, leading to an accumulation of advice and guidance, in order to establish a common understanding that could serve as the basis for further deliberations of the Committee on that important matter (A/AC.105/637 and Corr. 1, para. 96).

At its thirty-sixth session, in 1999, the Subcommittee adopted the technical report on space debris (A/AC.105/720) and agreed to have it widely distributed, including by making it available to the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), the Legal Subcommittee at its thirty-ninth session, in 2000, international organizations and other scientific meetings (A/AC.105/736, para. 39).

At its thirty-eighth session, in 2001, the Subcommittee agreed to establish a workplan for the period from 2002 to 2005 (A/AC.105/761, para. 130) with the goal of expediting international adoption of voluntary debris mitigation measures. In addition to the plan to address debris mitigation measures, it was envisaged that member States and international organizations would continue to report on research and other relevant aspects of space debris.

In accordance with that workplan, at the fortieth session of the Subcommittee, in 2003, the Inter-Agency Space Debris Coordination Committee (IADC) presented its proposals on debris mitigation, based on consensus among the IADC members. At the same session, the Subcommittee began its review of the proposals and discussed means of endorsing their utilization.

At its forty-first session, in 2004, the Subcommittee established a working group to consider comments from member States on the above-mentioned proposals of IADC on debris mitigation. The Working Group recommended that interested member States, observers to the Subcommittee and members of IADC become involved in updating the IADC proposals on space debris mitigation for the Working Group's consideration at the next session of the Subcommittee.

During the forty-second session of the Subcommittee, in 2005, the Working Group agreed on a set of considerations for space debris mitigation guidelines and prepared a new workplan for the period from 2005 to 2007, which was subsequently adopted by the Subcommittee. The Working Group also agreed on the text of the revised draft space debris mitigation guidelines (A/AC.105/848, annex II, paras. 5-6), submitted the text to the Subcommittee for its consideration and recommended that the revised draft space debris mitigation guidelines be circulated at the national level to secure consent for adoption of the guidelines by the Subcommittee at its forty-fourth session, in 2007.

At its forty-fourth session, in 2007, the Subcommittee adopted the space debris mitigation guidelines (A/AC.105/890, para. 99).

At its fiftieth session, in 2007, the Committee endorsed the space debris mitigation guidelines and agreed that its approval of those voluntary guidelines would increase mutual understanding on acceptable activities in space and thus enhance stability in space-related matters and decrease the likelihood of friction and conflict (A/62/20, paras. 118-119).

In its resolution 62/217 of 22 December 2007, the General Assembly endorsed the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space and agreed that the voluntary guidelines for the mitigation of space debris reflected the existing practices as developed by a number of national and international organizations, and invited Member States to implement those guidelines through relevant national mechanisms.

Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space

1. Background

Since the Committee on the Peaceful Uses of Outer Space published its Technical Report on Space Debris in 1999,[1] it has been a common understanding that the current space debris environment poses a risk to spacecraft in Earth orbit. For the purpose of this document, space debris is defined as all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional. As the population of debris continues to grow, the probability of collisions that could lead to potential damage will consequently increase. In addition, there is also the risk of damage on the ground, if debris survives Earth's atmospheric re-entry. The prompt implementation of appropriate debris mitigation measures is therefore considered a prudent and necessary step towards preserving the outer space environment for future generations.

Historically, the primary sources of space debris in Earth orbits have been (*a*) accidental and intentional break-ups which produce long-lived debris and (*b*) debris released intentionally during the operation of launch vehicle orbital stages and spacecraft. In the future, fragments generated by collisions are expected to be a significant source of space debris.

Space debris mitigation measures can be divided into two broad categories: those that curtail the generation of potentially harmful space debris in the near term and those that limit their generation over the longer term. The former involves the curtailment of the production of mission-related space debris and the avoidance of break-ups. The latter concerns end-of-life procedures that remove decommissioned spacecraft and launch vehicle orbital stages from regions populated by operational spacecraft.

2. Rationale

The implementation of space debris mitigation measures is recommended since some space debris has the potential to damage spacecraft, leading to loss of mission, or loss of life in the case of manned spacecraft. For manned flight orbits, space debris mitigation measures are highly relevant due to crew safety implications.

A set of mitigation guidelines has been developed by the Inter-Agency Space Debris Coordination Committee (IADC), reflecting the fundamental mitigation elements of a series of existing practices, standards, codes and handbooks developed by a number of national and international organizations. The Committee on the Peaceful Uses of Outer

[1] United Nations publication, Sales No. E.99.I.17.

Space acknowledges the benefit of a set of high-level qualitative guidelines, having wider acceptance among the global space community. The Working Group on Space Debris was therefore established (by the Scientific and Technical Subcommittee of the Committee) to develop a set of recommended guidelines based on the technical content and the basic definitions of the IADC space debris mitigation guidelines, and taking into consideration the United Nations treaties and principles on outer space.

3. Application

Member States and international organizations should voluntarily take measures, through national mechanisms or through their own applicable mechanisms, to ensure that these guidelines are implemented, to the greatest extent feasible, through space debris mitigation practices and procedures.

These guidelines are applicable to mission planning and the operation of newly designed spacecraft and orbital stages and, if possible, to existing ones. They are not legally binding under international law.

It is also recognized that exceptions to the implementation of individual guidelines or elements thereof may be justified, for example, by the provisions of the United Nations treaties and principles on outer space.

4. Space debris mitigation guidelines

The following guidelines should be considered for the mission planning, design, manufacture and operational (launch, mission and disposal) phases of spacecraft and launch vehicle orbital stages:

Guideline 1: Limit debris released during normal operations

Space systems should be designed not to release debris during normal operations. If this is not feasible, the effect of any release of debris on the outer space environment should be minimized.

During the early decades of the space age, launch vehicle and spacecraft designers permitted the intentional release of numerous mission-related objects into Earth orbit, including, among other things, sensor covers, separation mechanisms and deployment articles. Dedicated design efforts, prompted by the recognition of the threat posed by such objects, have proved effective in reducing this source of space debris.

Guideline 2: Minimize the potential for break-ups during operational phases

Spacecraft and launch vehicle orbital stages should be designed to avoid failure modes which may lead to accidental break-ups. In cases where a condition leading to such a failure is detected, disposal and passivation measures should be planned and executed to avoid break-ups.

Historically, some break-ups have been caused by space system malfunctions, such as catastrophic failures of propulsion and power systems. By incorporating potential break-up scenarios in failure mode analysis, the probability of these catastrophic events can be reduced.

Guideline 3: Limit the probability of accidental collision in orbit

In developing the design and mission profile of spacecraft and launch vehicle stages, the probability of accidental collision with known objects during the system's launch phase and orbital lifetime should be estimated and limited. If available orbital data indicate a potential collision, adjustment of the launch time or an on-orbit avoidance manoeuvre should be considered.

Some accidental collisions have already been identified. Numerous studies indicate that, as the number and mass of space debris increase, the primary source of new space debris is likely to be from collisions. Collision avoidance procedures have already been adopted by some member States and international organizations.

Guideline 4: Avoid intentional destruction and other harmful activities

Recognizing that an increased risk of collision could pose a threat to space operations, the intentional destruction of any on-orbit spacecraft and launch vehicle orbital stages or other harmful activities that generate long-lived debris should be avoided. When intentional break-ups are necessary, they should be conducted at sufficiently low altitudes to limit the orbital lifetime of resulting fragments.

Guideline 5: Minimize potential for post-mission break-ups resulting from stored energy

In order to limit the risk to other spacecraft and launch vehicle orbital stages from accidental break-ups, all on-board sources of stored energy should be depleted or made safe when they are no longer required for mission operations or post-mission disposal.

By far the largest percentage of the catalogued space debris population originated from the fragmentation of spacecraft and launch vehicle orbital stages. The majority of those break-ups were unintentional, many arising from the abandonment of spacecraft and launch vehicle orbital stages with significant amounts of stored energy. The most effective mitigation measures have been the passivation of spacecraft and launch vehicle orbital stages at the end of their mission. Passivation requires the removal of all forms of stored energy, including residual propellants and compressed fluids and the discharge of electrical storage devices.

Guideline 6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission

Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the LEO region should be removed from orbit in a controlled fashion. If this is not possible, they should be disposed of in orbits that avoid their long-term presence in the LEO region.

When making determinations regarding potential solutions for removing objects from LEO, due consideration should be given to ensuring that debris that survives to reach the surface of the Earth does not pose an undue risk to people or property, including through environmental pollution caused by hazardous substances.

Guideline 7: Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission

Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the GEO region should be left in orbits that avoid their long-term interference with the GEO region.

For space objects in or near the GEO region, the potential for future collisions can be reduced by leaving objects at the end of their mission in an orbit above the GEO region such that they will not interfere with, or return to, the GEO region.

5. Updates

Research by Member States and international organizations in the area of space debris should continue in a spirit of international cooperation to maximize the benefits of space debris mitigation initiatives. This document will be reviewed and may be revised, as warranted, in the light of new findings.

6. Reference

The reference version of the IADC space debris mitigation guidelines at the time of the publication of this document is contained in the annex to document A/AC.105/C.1/L.260.

For more in-depth descriptions and recommendations pertaining to space debris mitigation measures, Member States and international organizations may refer to the latest version of the IADC space debris mitigation guidelines and other supporting documents, which can be found on the IADC website (www.iadc-online.org).

c. The Draft International Code of Conduct for Outer Space Activities of the European Union 2012

European Union - 5 June 2012

WORKING DOCUMENT

REVISED DRAFT

INTERNATIONAL CODE OF CONDUCT FOR OUTER SPACE ACTIVITIES

Preamble

The Subscribing States

Considering that the activities of exploration and use of outer space for peaceful purposes play a growing role in the economic, social, and cultural development of nations, in the management of global issues such as the preservation of the environment, disaster management, the strengthening of national security, and in sustaining international peace;

Noting that all States should actively contribute to the promotion and strengthening of international cooperation relating to these activities;

Recognising the need for the widest possible adherence to relevant existing international instruments that promote the peaceful uses of outer space, in order to meet existing and emerging new challenges;

Further recognising that space capabilities - including associated ground and space segments and supporting links - are vital to national security and to the maintenance of international peace and security;

Recalling the initiatives aiming at promoting a peaceful, safe, and secure outer space environment, through international cooperation;

Recalling the importance of developing transparency and confidence-building measures for activities in outer space;

Considering the importance of the sustainable use of outer space for future generations;

Taking into account that space debris affects the sustainable use of outer space, constitutes a hazard to outer space activities and potentially limits the effective deployment and utilisation of associated outer space capabilities;

Stressing that the growing use of outer space increases the need for greater transparency and better information exchange among all actors conducting outer space activities;

Convinced that the formation of a set of best practices aimed at ensuring security in outer space could become a useful complement to international law as it applies to outer space;

Reaffirming their commitment to resolve any dispute concerning another State's actions in outer space by peaceful means;

Recognising that a comprehensive approach to safety and security in outer space should be guided by the following principles: (i) freedom of access to space for peaceful purposes; (ii) preservation of the security and integrity of space objects in orbit; and (iii) due consideration for the legitimate defence interests of States;

Conscious that a comprehensive code, including transparency and confidence-building measures could contribute to promoting mutual understandings;

Without prejudice to future work in other appropriate international *fora* such as the Conference on Disarmament and the United Nations Committee on the Peaceful Uses of Outer Space;

Adhere to the following Code of Conduct for Outer Space Activities (hereinafter referred to as the "Code").

I. Purpose, Scope and General Principles

1. Purpose and Scope

1.1. The purpose of this Code is to enhance the security, safety and sustainability of all outer space activities.

1.2. This Code addresses all outer space activities conducted by a Subscribing State or jointly with other States or by non-governmental entities under the jurisdiction of a Subscribing State, including those activities conducted within the framework of international intergovernmental organisations.

1.3. This Code, in endorsing best practices, contributes to transparency and confidence-building measures and is complementary to the normative framework regulating outer space activities.

1.4. This Code is not legally binding. Adherence to this Code and to the measures contained in it is voluntary and open to all States.

2. General Principles

The Subscribing States decide to abide by the following principles:

- the freedom for all States, in accordance with international law, to access, to explore, and to use outer space for peaceful purposes without interference, fully respecting the security, safety and integrity of space objects and consistent with internationally accepted practices, operating procedures, technical standards and policies associated with the long-term sustainability of outer space activities, including, *inter alia*, the safe conduct of outer space activities;

- the inherent right of individual or collective self-defence as recognised in the United Nations Charter;

- the responsibility of States to take all appropriate measures and cooperate in good faith to prevent harmful interference in outer space activities; and

- the responsibility of States, in the conduct of scientific, civil, commercial and military activities, to promote the peaceful exploration and use of outer space and to take all appropriate measures to prevent outer space from becoming an arena of conflict.

3. Compliance with and Promotion of Treaties, Conventions and Other Commitments Relating to Outer Space Activities

The Subscribing States reaffirm their commitment to the existing legal framework relating to outer space activities. They reiterate their support to encouraging efforts in order to promote universal adoption, implementation, and full adherence to the instruments to which they are parties or subscribe to:

(a) existing international legal instruments regulating outer space activities, including:

- the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967);
- the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968);
- the Convention on International Liability for Damage Caused by Space Objects (1972);
- the Convention on Registration of Objects Launched into Outer Space (1975);
- the Constitution and Convention of the International Telecommunication Union and its Radio Regulations, as amended;
- the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water (1963) and the Comprehensive Nuclear Test Ban Treaty (1996).

(b) declarations, principles and recommendations, including:

- International Co-operation in the Peaceful Uses of Outer Space adopted by the United Nations General Assembly's (UNGA) Resolution 1721 (December 1961);
- the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space as adopted in UNGA Resolution 1962 (XVIII) (1963);
- the Principles Relevant to the Use of Nuclear Power Sources in Outer Space as adopted by UNGA Resolution 47/68 (1992);
- the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries as adopted by UNGA Resolution 51/122 (1996);

- the International Code of Conduct against Ballistic Missile Proliferation (2002), as endorsed in UNGA Resolutions 59/91 (2004), 60/62 (2005), 63/64 (2008), and 65/73 (2010);
- the Recommendations on Enhancing the Practice of States and International Intergovernmental Organisations in Registering Space Objects as endorsed in UNGA Resolution 62/101 (2007);
- the Space Debris Mitigation Guidelines of the United Nations Committee for the Peaceful Uses of Outer Space, as endorsed in UNGA Resolution 62/217 (2007).

II. Safety, Security and Sustainability of Outer Space Activities

4. Measures on Space Operations and Mitigation of Space Debris

4.1. The Subscribing States commit to establish and implement policies and procedures to minimise the possibility of accidents in space, collisions between space objects or any form of harmful interference with another State's peaceful exploration, and use, of outer space.

4.2. The Subscribing States commit, in conducting outer space activities, to:

- refrain from any action which brings about, directly or indirectly, damage, or destruction, of space objects unless such action is conducted to reduce the creation of outer space debris or is justified by the inherent right of individual or collective self-defence as recognised in the United Nations Charter or by imperative safety considerations, and where such exceptional action is necessary, that it be undertaken in a manner so as to minimise, to the greatest extent possible, the creation of space debris and, in particular, the creation of long-lived space debris;
- take appropriate measures to minimize the risk of collision; and
- make progress towards adherence to, and implementation of International Telecommunication Union regulations on allocation of radio spectra and orbital assignments.

4.3 In order to minimise the creation of outer space debris and to mitigate its impact in outer space, the Subscribing States commit to avoid, to the greatest extent possible, any activities which may generate long-lived space debris. To that purpose, they commit to adopt and implement, in accordance with their own internal processes, the appropriate policies and procedures or other effective measures in order to implement the Space Debris Mitigation Guidelines of the United Nations Committee for the Peaceful Uses of Outer Space as endorsed by UNGA Resolution 62/217 (2007).

4.4. When executing manoeuvres of space objects, for example, to supply space stations, repair space objects, mitigate debris, or reposition space objects, the Subscribing States commit to take all reasonable measures to minimise the risks of collision.

5. Promotion of Relevant Measures in other Fora

The Subscribing States commit to promote the development of guidelines for outer space operations within the appropriate international *fora*, such as the Conference on Disarmament and the United Nations Committee on the Peaceful Uses of Outer Space, for the purpose of protecting the safety and security of outer space operations and the long-term sustainability of outer space activities.

III. Cooperation Mechanisms

6. Notification of Outer Space Activities

6.1. The Subscribing States commit to notify, in a timely manner, to the greatest extent possible and practicable, all potentially affected Subscribing States on the outer space activities conducted which are relevant for the purposes of this Code, including:

- scheduled manoeuvres which may result in dangerous proximity to the space objects of both Subscribing and non-Subscribing States;
- pre-notification of launch of space objects;
- collisions, break-ups in orbit, and any other destruction of a space object(s) which have taken place generating measurable orbital debris;
- predicted high-risk re-entry events in which the re-entering space object or residual material from the re-entering space object would likely cause potential significant damage or radioactive contamination;
- malfunctioning of space objects which could result in a significantly increased probability of a high risk re-entry event or a collision between space objects.

6.2. The Subscribing States commit to provide the notifications described above to all potentially affected States, including non-Subscribing States where appropriate, through diplomatic channels, or by any other method as may be mutually agreed, or through the Central Point of Contact to be established under section 11. In notifying the Central Point of Contact, the Subscribing States should identify, if applicable, the potentially affected States. The Central Point of Contact should ensure the timely distribution of the notifications to all Subscribing States.

7. Registration of Space Objects

The Subscribing States commit to register, in a timely manner, space objects in accordance with the Convention on Registration of Objects Launched into Outer Space and to provide the United Nations Secretary-General with the relevant data as set forth in this Convention and in the Recommendations on Enhancing the Practice of States and International Intergovernmental Organisations in Registering Space Objects, as endorsed by UNGA Resolution 62/101 (2007).

8. Information on Outer Space Activities

8.1. The Subscribing States commit to share, on an annual basis, where available and appropriate, information on:

- their space policies and strategies;
- their space policies and procedures to prevent and minimise the possibility of accidents, collisions or other forms of harmful interference and the creation of space debris; and
- efforts taken in order to promote universal adoption and adherence to legal and political regulatory instruments concerning outer space activities.

8.2. The Subscribing States may also consider providing timely information on outer space environmental conditions and forecasts to the governmental agencies and the relevant non-governmental entities of all space faring nations, collected through their space situational awareness capabilities.

9. Consultation Mechanism

9.1. Without prejudice to existing consultation mechanisms provided for in Article IX of the Outer Space Treaty of 1967 and in Article 56 of the ITU Constitution, the Subscribing States have decided on the creation of the following consultation mechanism:

- A Subscribing State or States that may be directly affected by certain outer space activities conducted by a Subscribing State or States and has reason to believe that those activities are, or may be contrary to the commitments made under this Code may request consultations with a view to achieving mutually acceptable solutions regarding measures to be adopted in order to prevent or minimise the potential risks of damage to persons or property, or of potentially harmful interference to a Subscribing State's outer space activities.

- The Subscribing States involved in a consultation process commit to:
  - consult through diplomatic channels or by other methods as may be mutually determined; and
  - work jointly and cooperatively in a timeframe sufficiently urgent to mitigate or eliminate the identified risk initially triggering the consultations.
- Any other Subscribing State or States which has reason to believe that its outer space activities would be directly affected by the identified risk may take part in the consultations if it requests so, with the consent of the Subscribing State or States which requested consultations and the Subscribing State or States which received the request.
- The Subscribing States participating in the consultations will seek mutually acceptable solutions in accordance with international law.

9.2. In addition, the Subscribing States may propose to create, on a case-by-case basis, independent, *ad hoc* fact-finding missions to investigate specific incidents affecting space objects and to collect reliable and objective information facilitating their assessment. These fact-finding missions, to be established by the Meeting of the Subscribing States, should utilise information provided on a voluntary basis by the Subscribing States, subject to national laws and regulations, and a roster of internationally recognised experts to undertake an investigation. The findings and any recommendations of these experts will be advisory, and will not be binding upon the Subscribing States involved in the incident that is the subject of the investigation.

IV. Organisational Aspects

10. Meeting of Subscribing States

10.1. The Subscribing States decide to hold meetings biennially or as otherwise decided by the Subscribing States, to define, review and further develop this Code and ensure its effective implementation. The agenda for such meetings could include: (i) review of the implementation of the Code, (ii) evolution of the Code, and (iii) discussion of additional measures which may be necessary, including those due to advances in the development of space technologies and their application.

10.2. The decisions at such meetings, both substantive and procedural, are to be taken by consensus of the Subscribing States present.

10.3. Any Subscribing State may propose modifications to this Code. Modifications apply to Subscribing States upon acceptance by all Subscribing States.

10.4. The results of the Meeting of Subscribing States are to be brought in an appropriate manner to the attention of relevant international fora including the United Nations Committee on Peaceful Uses of Outer Space (COPUOS) and the Conference on Disarmament (CD).

11. Central Point of Contact

A Central Point of Contact to be established by Subscribing States will:

- receive and announce the subscription of additional States;
- maintain an electronic database and communications system;
- serve as secretariat at the Meetings of Subscribing States; and
- carry out other tasks as determined by the Subscribing States.

12. Outer Space Activities Database

12.1. The Subscribing States commit to creating an electronic database and communications system, which should be used exclusively for their benefit in order to:

- collect and disseminate notifications and information submitted in accordance with the provisions of this Code; and
- serve as a mechanism to channel requests for consultations.

12.2. Funding the development and maintenance of the Outer Space Activities Database will be agreed by the Meeting of Subscribing States.

13. Participation by Regional Integration Organisations and International Intergovernmental Organisations

In this Code, references to Subscribing States are intended to apply, upon their acceptance:

- To any regional integration organisation which has competences over matters covered by this Code, without prejudice to the competences of its member States.

- With the exception of sections 10 to 12 inclusive: To any international intergovernmental organisation which conducts outer space activities if a majority of the States members of the organisation are Subscribing States to this Code.
