4.A.1. Orbital debris: definition issues

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1. Introduction: the importance of a precise yet comprehensive definition

The terms 'space debris' and 'orbital debris' have not been used, let alone defined, anywhere in the major UN space treaties, most notably the Outer Space Treaty[1]. The Partial Test Ban Treaty, which included outer space as one of the major domains of application of its partial ban on nuclear testing, came closest when referring to "radioactive debris (…) present outside the territorial limits of the state under whose jurisdiction or control [the underlying] explosion is conducted"[2], but fails to offer any further definition or guidance on what constitutes 'radioactive debris'. Obviously, moreover, it does not address any other kind of debris.

Only recently, most notably in the context of the IADC Guidelines[3] and the ensuing COPUOS Guidelines[4] as these have very much focused on the issue, have these terms been introduced into documents of major international legal relevance (even if not legally binding *per* se) and been defined at least for the – somewhat confined – context of those documents.

The importance of defining 'orbital debris' lies in the need to determine precisely to what extent existing law (international as well as national) currently addresses the issue (and does so satisfactorily), respectively how to properly develop (recommendations for) future law on the issue as appropriate.

For instance, the applicability of the Liability Convention[5] hinges on damage being caused by a 'space object'[6]. Whether that notion encompasses all, part or none of existing or future orbital debris will thus determine the extent to which a 'launching State'[7] of what at some point has turned out to be orbital debris may be held liable for damage caused by such debris.

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1 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereafter Outer Space Treaty), London/Moscow/Washington, done 27 January 1967, entered into force 10 October 1967; 610 UNTS 205; TIAS 6347; 18 UST 2410; UKTS 1968 No. 10; Cmnd. 3198; ATS 1967 No. 24; 6 ILM 386 (1967). As of 1 January 2014 the Outer Space Treaty has 103 states parties, including all major space-faring nations, and 25 more signatories (see http://www.unoosa.org/pdf/limited/c2/AC105_C2_2014_CRP07E.pdf; last visited 11 February 2015). Art. IX, widely seen as the first legal provision in international space law addressing the problem of 'space debris', only refers to "harmful contamination" and "harmful interference".

2 Art. I(1)(b), Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (hereafter Partial Test Ban Treaty), Moscow, done 5 August 1963, entered into force 10 October 1963; 480 UNTS 43; TIAS No. 5433; 14 UST 1313; UKTS 1964 No. 3; ATS 1963 No. 26.

3 IADC Space Debris Mitigation Guidelines (hereafter IADC Guidelines); A/AC.105/C.1/L.260.

4 Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (hereafter COPUOS Guidelines), UN OOSA (2010), ST/SPACE/49.

5 Convention on International Liability for Damage Caused by Space Objects (hereafter Liability Convention), London/Moscow/Washington, done 29 March 1972, entered into force 1 September 1972; 961 UNTS 187; TIAS 7762; 24 UST 2389; UKTS 1974 No. 16; Cmnd. 5068; ATS 1975 No. 5; 10 ILM 965 (1971).

6 *Cf.* Arts. II, III, Liability Convention (*supra*, n. 5).

7 See Arts. I(c), II, III, Liability Convention (*supra*, n. 5).

Similarly, because the ownership of a state over its space object is not limited in time, space law currently does not seem to accommodate the concept of 'abandonment' which might allow any state (or possibly even any private space operator) to 'take' a defunct space object 'out of the way' if it happens to orbit in an area presenting a danger to its legitimate space activities. The extent to which 'orbital debris' would currently coincide with the concept of 'space object' would therefore also clarify to which extent similar legal hurdles would stand in the way of potential space operations intended to remove orbital debris.
In the last resort, therefore, if an effort should be made to establish legal duties to no longer intentionally create orbital debris, beyond the current IADC and COPUOS Guidelines documents, and/or legal rights to remove orbital debris, it should be beyond doubt what that term refers to.

2. General definition of 'debris', 'space debris' and 'orbital debris'
In the absence of an undisputed definition of 'space debris' or 'orbital debris' in the main space treaties of more or less global application, it is appropriate to start with a brief general analysis of what the word 'debris', in its manifestation of 'space debris' and 'orbital debris', is generally considered to mean.[8]
Thus, the term 'debris' has been defined as "[t]he remains of anything broken down or destroyed"[9], "1: the remains of something broken down or destroyed; 2: an accumulation of fragments of rock; 3: something discarded; RUBBISH"[10], or more specifically in a geological context as "[l]arge fragments arising from disintegration of rocks and strata"[11]. None of those definitions combine the term 'debris' with 'space' or 'orbital' however.[12]
'Orbital' in itself has been defined as "pertaining to, or of the nature of an orbit, esp. that of a celestial object; moving or taking place in an orbit or circular path"[13]. 'Space', in its meaning of 'outer space' or 'cosmic space', is determined to refer to "the region beyond the earth's atmosphere"[14]; "the part of the universe lying outside the limits of the earth's atmosphere"[15] and "[t]he immense expanse of the universe beyond the earth's atmosphere"[16]. In the latter context, of course note should be taken of the long-standing discussion also on the legal realm of defining (and delimitating) '(outer) space'.[17]

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8 It should be noted in this respect that Art. 31(1), Vienna Convention on the Law of Treaties, Vienna, done 23 May 1969, entered into force 27 January 1980; 1155 UNTS 331; UKTS 1980 No. 58; Cmnd. 4818; ATS 1974 No. 2; 8 ILM 679 (1969), states as the primary rule for interpreting treaty clauses that "[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".
9 *The New Shorter Oxford English Dictionary* (Ed. L. Brown)(1993), 604.
10 *Merriam-Webster's Collegiate Dictionary*, 11th ed. (2011), 320.
11 *McGraw-Hill Dictionary of Scientific and Technical Terms*, 5th ed. (Ed. S.B. Parker)(1994), 524.
12 While for example the *McGraw-Hill Dictionary of Scientific and Technical Terms* (*supra*, n. 11) has no less then 22 lemma's starting with 'orbital' (at 1405), these do not include 'orbital debris'; likewise the dozens of lemma's starting with 'space' (at 1873-5) do not include 'space debris'.
13 *The New Shorter Oxford English Dictionary* (*supra* n. 9), 2014. See also the definitions of 'orbit' in *Merriam-Webster's Collegiate Dictionary* (*supra*, n. 10), 872; *McGraw-Hill Dictionary of Scientific and Technical Terms* (*supra*, n. 11), 1405.
14 *Merriam-Webster's Collegiate Dictionary* (*supra*, n. 10), 1194.
15 *McGraw-Hill Dictionary of Scientific and Technical Terms* (*supra*, n. 11), 1873.
16 *The New Shorter Oxford English Dictionary* (*supra*, n. 9), 2961.
17 See *e.g.* F.G. von der Dunk, International space law, in *Handbook of Space Law* (Ed. F.G. von der Dunk) (2015), 60-72; M. Benkö & E. Plescher, *Space Law – Reconsidering the Definition/Delimitation Question and the Passage of Spacecraft through Foreign Airspace* (2013), 3-48; B. Cheng, *Studies in International*

Since 'debris' in outer space would not necessarily always perform true orbits – as depending upon the impact of gravitational forces of large celestial bodies sufficiently close – it would seem in any event that the word 'space debris' would be preferable as more comprehensive and straightforward than 'orbital debris', even as in practice most debris of immediate concern for the present cosmic study would actually be orbiting the earth. For instance, sounding rockets would not (even be intended to) complete an orbit before re-potentially re-entering, yet might well become relevant debris prior or during their re-entry. ***Therefore, in the remainder of this analysis the term 'space debris' will henceforth be used in this analysis, and it is proposed that this term for precisely those reasons should also be used in any legal documents to be developed in the future on the issue.***
Clearly furthermore, in plain language the word 'space debris' would refer to something physically broken or fragmented, and would normally be assumed to refer to natural celestial bodies broken or fragmented. At the same time, no inherent obstacles would preclude application of the term also to 'man-made' space debris – the type of debris of immediate concern for the present cosmic study.

3. The reference to / definition of 'space debris' in the context of space (law) documents
The aforementioned IADC Guidelines use the term 'space debris' already in the full title of the document, and define it as "all man made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional".[18] The COPUOS Guidelines likewise refers to 'space debris, not 'orbital debris', and defines it exactly similar as "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional".[19]
The reference to 'objects' means that only tangible and visible phenomena, remainders of a particular space activity undertaken by man, are concerned. Radiation, electricity or radio-magnetic consequences of such activity by contrast should not be seen to be included: even as the latter might well cause (potentially harmful) pollution or interference, they are not 'space debris'.
These identical definitions, from the two most authoritative international – yet strictly speaking non-binding – documents addressing the issue of 'space debris' in a coherent and comprehensive manner, also confirm the focus on debris remaining from man-made objects as opposed to debris remaining from natural celestial bodies, as this latter represented the core of the common-language definitions. At the same time an additional element of the definition – the reference to 'non-functional' – extends the scope thereof to objects that may not, strictly speaking, be 'broken' or 'fragmented', but are simply without any use and thus for all practical purposes to be equated to broken and fragmented parts of man-made objects. Other definitions, though usually more extended, confirm this conclusion.[20]

Space Law (1997), 425-56.
18 § 3.1, IADC Guidelines (*supra*, n. 3).
19 § 1, COPUOS Guidelines (*supra*, n. 4).
20 *Cf. e.g.* IAA Position Paper on Orbital Debris (2001), at 3: "any man-made Earth-orbiting object which is non-functional with no reasonable expectation of assuming or resuming its intended function (…) including fragments and parts thereof"; ESA Position Paper Space Debris Mitigation (2005), SP-1301, at 7: "man made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional (…). It includes fragments and parts of man-made Earth-orbiting objects, such as fragments generated by satellite and upper stage break-up due to explosions and collisions"; Art. I(c), ILA Draft Convention on Space Debris (1994): "man-made objects in outer space, other than active or

Increasingly, on the national level states are implementing the international space debris mitigation guidelines (whether IADC or COPUOS) as part of their national process for licensing space operators, requiring license applicants to provide satisfactory details on their approach to mitigation of the risk of creating space debris. Thereby they also effectively transform the, as such non-legally-binding, guidelines into pieces of binding regulation at least vis-à-vis the licensees concerned.

In this context, in the United States the FAA's Office for Commercial Space Transportation, under the Commercial Space Launch Act, licenses launches which only addresses the debris issue as for the launch vehicle itself (without however defining it).[21] More importantly, as for payloads – read the satellites which usually are to be orbited – it is by contrast the FCC which takes care of the possibilities that such satellites may cause the generation of debris. The FCC defines 'orbital debris' as "artificial objects orbiting the Earth that are not functional spacecraft", adding that "[i]t consists of a wide range of non-functioning man-made objects that have been placed into the Earth's orbit, both accidentally and on purpose".[22]

In the case of the United Kingdom, which under its Outer Space Act also has to license space activities undertaken by UK nationals,[23] the Parliamentary Office of Science and Technology has defined 'space debris' as "consist[ing] of millions of pieces of man-made material orbiting the Earth", adding that it "generally refers to man-made material in orbit that no longer serves a useful purpose".[24]

The French space agency CNES, in charge *inter alia* of licensing French space operators as per the French Law on Space Operations including the imposition of requirements intended to mitigate the generation of space debris,[25] has defined 'space debris' as "all man-made objects, including their fragments or parts, other than active space vehicles (or susceptible of use), larger than 10 microns and orbiting the Earth in outer space".[26]

On the website of the European Space Agency, combining the space know-how and resources of nowadays twenty member states including major ones such as France, Germany, the United Kingdom and Italy, "[s]pace debris is defined as all non-functional, man-made objects, including fragments and elements thereof, in Earth orbit or re-entering into Earth atmosphere."[27]

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otherwise useful satellites, when no change can reasonably be expected in these conditions in the foreseeable future"; further also § 6, Technical Report on Space Debris (1999), COPUOS STSC.

21 See 51 U.S.C. Chapter 509. The Act itself does not even refer to the issue of 'debris'; the implementing regulations however do; *cf. e.g.* 14 C.F.R. §§ 417.129(b), 417.211 (requiring "Debris analysis"), but the FAA generally only applies payload reviews when the FCC is already undertaking them; see § 415.53.

22 Second Report and Order, FCC 04-130, of 9 June 2004, at 3.

23 Outer Space Act (hereafter UK Outer Space Act), 18 July 1986, 1986 Chapter 38; *National Space Legislation of the World*, Vol. I (2001), at 293; *Space Law – Basic Legal Documents*, E.I; 36 *Zeitschrift für Luft- und Weltraumrecht* (1987), 12; *cf.* esp. Secs. 1, 2, 3.

24 Postnote, Parliamentary Office of Science and Technology, March 2010, Number 355, at 1.

25 Law on Space Operations (*Loi relative aux opérations spatiales*; hereafter French Law on Space Operations); *Loi n° 2008-518 du 3 juin 2008*; unofficial English version 34 *Journal of Space Law* (2008), 453; *cf.* Artt. 2, 4, (esp.) 5.

26 Definition of space debris; see http://debris-spatiaux.cnes.fr/english/definition_debris_eng.html; last accessed 14 February 2015.

27 Q1, Frequently Asked Questions, Space debris; see http://www.esa.int/Our_Activities/Operations/Space_Debris/FAQ_Frequently_asked_questions; last accessed 14 February 2015.

Including non-orbiting debris as long as clearly resulting from man-made objects as well as limiting the scope to non-functional tangible objects, the IADC and COPUOS Guidelines therefore indeed would offer the most coherent and concise definition also for legal purposes. Thus, also statutes such as the Austrian Outer Space Act[28] refer back to this definition in addressing the issue of space debris mitigation domestically.

4. Expert authors on the definition of 'space debris'

Much has been written about 'space debris' and its legal ramifications especially over the last few decades. Among the earlier authors to substantially do so was Carl Christol, who linked the issue of 'debris' to the broader issues of pollution, contamination and the potential for harmful interference, without however becoming more precise on the term than equating it with "space-junk" and the suggestion "that [debris] possesses tangible, physical characteristics" and thus risks to result in "physical harm of the kind resulting from the collision of space objects or return of fragments to Earth".[29] Likewise, two leading Soviet space lawyers Gennady Zhukov and Yuri Kolosov referred to "dead objects", as "space objects that continue to revolve around the Earth once they have lost their scientific or practical value", as also presenting a problem mainly from the perspective of "littering of outer space" and the "risk of collision".[30]

Then, Steven Gorove loosely defined, in his chapter on "Space debris and international space law", that term as "inactive man-made space objects circling the earth at various altitudes", adding a list of the items to be unequivocally considered to be subsumed by that category, namely "defunct satellites, burnt-out motors, mission-related objects, shrouds, clamps, nuts and bolts, separation and explosion devices and even paint flecks".[31] Juan Manuel de Faramiñán Gilbert, in his chapter on "Space debris: Technical and legal aspects" dwelt at some length on the issues, also highlighting the risk of collisions coming from "inactive" space objects, concluding approvingly by quoting the ILA Draft Convention on Space Debris's definition.[32]

Strictly speaking avoiding defining the term, Francis Lyall and Paul Larsen state that satellites and other space objects do not become 'debris' solely for reason of completion of their operational phase, further indicating that 'space debris' "is not always readily identifiable", as being for the most part "*ex natura* (…) fragmentary".[33] Bernhard Schmidt-Tedd and Stephan Mick also address in some detail the relationship between the notions of 'space object' and 'space debris', referring both to the latter being essentially "non-functional" and to the fragmentation often involved.[34]

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28 Austrian Federal Law on the Authorisation of Space Activities and the Establishment of a National Space Registry (*Bundesgesetz über die Genehmigung von Weltraumaktivitäten und die Einrichtung eines Weltraumregisters (Weltraumgesetz)*; hereafter Austrian Outer Space Act), as adopted by Parliament on 6 December 2011; Federal Law Gazette of 27 December 2011; 61 *Zeitschrift für Luft- und Weltraumrecht* (2012), 37-42, 56-61; see Sec. 5.

29 C.Q. Christol, *The Modern International Law of Outer Space* (1984), 130.

30 G. Zhukov & Y. Kolosov, *International Space Law* (1984), 70.

31 S. Gorove, *Developments in Space Law – Issues and Policies* (1991), 163.

32 J.M. de Faramiñán Gilbert, Space debris: Technical and legal aspects, in *Outlook on Space Law over the Next 30 Years* (Eds. G. Lafferranderie & D. Crowther)(1997), 305, also 309; for the ILA Draft Convention on Space Debris, see *supra*, n. 20.

33 F. Lyall & P.B. Larsen, *Space Law – A Treatise* (2009), 304.

34 B. Schmidt-Tedd & S. Mick, Article VIII, in *Cologne Commentary on Space Law* (Eds. S. Hobe, B. Schmidt-Tedd & K.U. Schrogl), Vol. I (2009), 154.

Similarly, Kai-Uwe Schrogl confirms that there is no legally binding definition, merely pointing out that it comprises "everything from small paint flakes to "dead" satellites".[35] At the same time, together with Marietta Benkö Schrogl acknowledged that such a definition should include "a space object regardless, whether it still exists as a whole or whether it is fragmented to any size, in the event that such an object is non-functional and there is no reasonable expectation of it assuming or resuming its function".[36]

This reference to 'non-functionality' present or future, originally came from of the most published authors on issues of space debris in a legal or meta-legal context, Lubos Perek, who continued to define 'space debris' in that sense, for example in 2005 as "space objects which terminated their functions or fragmented from their parent bodies".[37]

Most succinct probably is the definition by Armel Kerrest de Rozavel, stating that 'space debris' refers to "a useless man-launched object in outer space".[38] Similarly outspoken and straightforward – as well as reflecting to the largest extent the definition of the international documents – is Lotta Viikari, who defines 'space debris' as "a general term referring to all tangible man-made materials in space which do not serve a useful purpose",[39] alternatively "a general term referring to all tangible man-made materials in space other than functional space objects" before listing in considerable detail the various elements included in that definition, from major objects "which no longer serve a useful purpose" up to "leaking fuel and coolant droplets" and "garbage dumped in outer space".[40]

In an effort to be very complete and precise at the same time, Michael Listner proposed that

> "Space debris" is:
> - a space object as defined by Article I(d) of the Liability Convention and Article I(b) of the Registration Convention;
> - that no longer performs its original function or has no tangible function or whose function is no longer required;
> - that either re-enters the atmosphere, remains in Earth orbit, in outer space, or on the Moon or another celestial body,
> - is either created intentionally or through the actions or inactions of a launching state;
> - may have economic value to a launching state;
> - may have historical value to a launching state;
> - and/or may have continued national security value to a launching state.[41]

35 K.U. Schrogl, Space and its sustainable uses, in *Outer Space in Society, Politics and Law* (Eds. C. Brünner & A. Soucek)(2011), 605.

36 M. Benkö & K.U. Schrogl, Space debris in the United Nations: Aspects of Law and Policy, in *Proceedings of the 2nd European Conference on Space Debris* (1997), 752.

37 L. Perek, Ex Facto Sequitur Lex: Facts Which Merit Reflection in Space Law in Particular with Regard to Registration and Space debris Mitigation, in *Space Law: Current Problems and Perspectives for Future Regulation* (Eds. M. Benkö & K.U. Schrogl)(2005), 41.

38 A. Kerrest de Rozavel, Space debris, remarks on current legal issues, in *Proceedings of the 3rd European Conference on Space Debris* (2001), 870.

39 L. Viikari, Environmental aspects of space activities, in *Handbook of Space Law* (Ed. F.G. von der Dunk)(2015), 719.

40 L. Viikari, *The Environmental Element in Space Law* (2008), 31.

41 At http://www.thespacereview.com/article/2187/1; last accessed 14 February 2015.

Finally, many authors, such as Sergio Marchisio[42] and Alessandro Rossi[43] come back to the IADC and COPUOS Guidelines' definition as the most authoritative one, that is that "space debris are all man made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional".

5. Summarizing: the preferred definition of 'space debris'

On the basis of the above analysis it is now possible to arrive at a preferred definition of 'space debris', a term in itself deemed preferable over 'orbital debris' for reasons of being more comprehensive, for the purpose of further legal analysis and any future initiatives to develop further international or national law and regulation on the matter.

Trying to keep the definition as succinct yet as comprehensive as possible, whilst not in itself listing or enumerating – even if non-exhaustively – the various items to be considered as falling within the definition, further to the definition offered by the IADC and COPUOS Guidelines the following definition is proposed, as reflecting the largest measure of consensus amongst existing international documents, national regulations and legal experts: "***all man-made objects and fragments thereof in outer space that are, and are expected to remain, non-functional***".

All other elements of the definitions quoted and discussed above should ultimately be deemed either superfluous, or detracting from the comprehensiveness, or risking confusion, or not meeting with general consensus; by way of further explanation, the above definition of 'space debris' can then also be clarified to mean:[44]

- That 'space debris' only concerns debris resulting from objects somehow introduced into outer space by humans, excluding natural debris constituting or resulting from celestial bodies, large or small.
- That the reference to "in Earth orbit or re-entering the atmosphere" has been made even more succinct by replaced it with "in outer space', which more closely resembles the terminology of the Outer Space Treaty and the other space treaties in addition to constituting a more precise term as it includes also relevant objects beyond earth orbit and not re-entering the atmosphere.
- That the reference to "non-functional" encompasses objects not only presently without any function, but also unlikely ever to have a function – whereby 'function' does not necessarily refer to the object being active, as also completely passive objects may still have a function for example for studying certain orbital parameters.
- That 'space debris' only includes true objects, which are tangible and visible; any other remainders of space activities are not considered included, even as they might pose (risks of) harmful pollution or interference with (other) space activities.
- That 'space debris' indeed is a subset of 'space objects', namely all those which are 'non-functional'.

6. Related concepts: 'space object' and 'component parts'

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42 Slide 2, http://www.unoosa.org/pdf/bst/ALC2010/13_Marchisio_Space_debris_mitigation_and_space_law_Mombasa_September_2011.pdf; last accessed 14 February 2015.

43 At http://www.scholarpedia.org/article/Space_debris; last accessed 14 February 2015. Rossi italicizes the last four words, so as to stress the 'non-functionality' aspect.

44 *Cf.* also further *infra*, § 7.

A major reason for the attention which has been paid to defining the concept of 'space debris' relates to the aforementioned clauses of the Liability Convention which refer to the key notion of 'space object' for the purpose of allocating liability.[45] The Liability Convention, however, does only provide a partial and partially circular 'definition' of 'space object', as it states: "The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof."[46]

In the absence of a treaty- or other authoritative international definition, on the one hand since many years efforts have been made in the literature to define the concept of 'space object' in more precise and useful terms.[47] From these efforts a more or less general understanding arose that "a space object concerns any man-made object which is at least attempted to be physically brought into outer space".[48]

On the other hand, as of more recently, also national space laws have begun to address this issue, largely along the same lines. Thus, the Dutch Space Law defines a 'space object' as "any object launched or destined to be launched into outer space".[49] The Austrian Outer Space Act here replaces "destined" with "intended",[50] and so does the Belgian Space Law.[51] The Korean Space Act takes a slightly different tack, but essentially amounts to the same: a space object is "an object designed and manufactured for use in outer space".[52]

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45 See *supra*, at n. 5.

46 Art. I(d), Liability Convention (*supra*, n. 5). Art. I(b), Convention on Registration of Objects Launched into Outer Space (hereafter Registration Convention), New York, done 14 January 1975, entered into force 15 September 1976; 1023 UNTS 15; TIAS 8480; 28 UST 695; UKTS 1978 No. 70; Cmnd. 6256; ATS 1986 No. 5; 14 ILM 43 (1975), provides for an identical 'definition' of 'space object' for the purpose of registration. For example the UK Outer Space Act (*supra*, n. 23) echoes this 'definition'; see Sec. 13(1).

47 See, from amongst a wealth of writings, M. Lachs, *The Law of Outer Space* (reprint 2010), 65-7; L.J. Smith & A. Kerrest de Rozavel, The 1972 Convention on International Liability for Damage Caused by Space Objects, in *Cologne Commentary on Space Law* (Eds. S. Hobe, B. Schmidt-Tedd & K.U. Schrogl), Vol. II (2013), 114-5; M. Chatzipanagiotis, *The Legal Status of Space Tourists in the Framework of Commercial Suborbital Flights* (2011), 20-1; B.A. Hurwitz, *State Liability for Outer Space Activities in Accordance with the 1972 Convention on International Liability for Damage caused by Space Objects* (1992), 23-6; B. Cheng, *Studies in International Space Law* (1997), 324-6, 493-507; Zhukov & Kolosov (*supra*, n. 30), 85 ff.; S. Hobe, Legal Aspects of Space Tourism, in 86 *Nebraska Law Review* (2007), 443-4; V. Kayser, *Launching Space Objects: Issues of Liability and Future Prospects* (2001), 44-5; S. Gorove, Issues Pertaining to the Legal Definition 'Space Object', 2 *Telecommunications and Space Journal* (1995), 136-45; V. Kopal, The 1975 Convention on Registration of Objects Launched into Outer Space in View of the Growth of Commercial Space Activities, in *Air and Space Law in the 21th Century* (Eds. M. Benkö & W. Kröll) (2001), 377.

48 Von der Dunk (*supra*, n. 17), 87.

49 Sec. 1(c), Law Incorporating Rules Concerning Space Activities and the Establishment of a Registry of Space Objects (hereafter Dutch Space Law), 24 January 2007; 80 *Staatsblad* (2007), at 1; *Nationales Weltraumrecht/ National Space Law* (2008), at 201. Cf. also Art. 1(12), Law of the Republic of Kazakhstan on Space Activities, of 6 January 2012, 2012 No. 528-IV; http://www.oosa.unvienna.org/pdf/spacelaw/national/kazakhstan/528-IV_2012-01-06E.pdf; last accessed 14 February 2015.

50 § 2(2), Austrian Outer Space Act (*supra*, n. 28); adding furthermore "including its components".

51 Art. 3(1), Law on the Activities of Launching, Flight Operations or Guidance of Space Objects (hereafter Belgian Space Law), 17 September 2005, adopted 28 June 2005; *Nationales Weltraumrecht / National Space Law* (2008), at 183; adding furthermore "including the material elements composing that object".

52 Art. 2(c), Space Development Promotion Act (hereafter Korean Space Act), Law No. 7538, of 31 May 2005, entered into force 1 December 2005; unofficial translation 33 *Journal of Space Law* (2007), 175.

The Australian Space Activities Act is considerably more detailed, but again essentially boils down to the same general definition:

> [A] ***space object*** means a thing consisting of:
> (a) a launch vehicle; and
> (b) a payload (if any) that the launch vehicle is to carry into or back from an area beyond the distance of 100 km above mean sea level;
> or any part of such a thing, even if:
> (c) the part is to go only some of the way towards or back from an area beyond the distance of 100 km above mean sea level; or
> (d) the part results from the separation of a payload or payloads from a launch vehicle after launch.[53]

Other national acts either refer to 'spacecraft' or similar, more specific notions,[54] or to "objects launched into outer space".[55]

Through the inclusion of 'component parts' in the 'definition' of 'space object' in the Liability Convention, as well as the teleological argument that if damage caused by a space object after disintegration of such space object would to a large extent deny the Convention its intended effect of offering a generous third-party liability regime to potential victims of space activities,[56] the general consensus is that 'space debris', at least to the extent that physical debris (as opposed to radiation or other 'non-physical' pollution) is at issue, is to be considered included in the notion of 'space object' and its 'component parts'.

As a consequence of that consensus, also, many of the aforementioned definitions of 'space debris' include the concept of 'space object', effectively then subdividing the latter into functional space objects and space objects without a 'function' (present or future), the latter being subsumed under the heading of 'space debris'. Similarly, pollution of outer space can be caused by either such non-functional space objects called 'space debris' or by non-tangible phenomena not qualifying as either 'space object' or 'space debris'.

7. The definition of 'space debris' in the broader context of 'space object' and pollution

Further to the definition of 'space debris' provided earlier, it is now possible also to logically, comprehensively and yet in a fairly straightforward manner place this concept for the purposes of legal analysis in a broader setting of 'space objects', pollution and other interference threats, and other 'non-space-objects', as per the following diagram:

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53 Sec. 8, 35th bullet, An act about space activities, and for related purposes (hereafter Australian Space Activities Act), No. 123 of 1998, assented to 21 December 1998; *National Space Legislation of the World*, Vol. I (2001), at 197.

54 *Cf. e.g.*, for South Africa, Sec. 1, 22nd bullet, Space Affairs Act (hereafter South African Space Affairs Act), 6 September 1993, assented to on 23 June 1993, No. 84 of 1993; Statutes of the Republic of South Africa – Trade and Industry, Issue No. 27, 21-44; *National Space Legislation of the World*, Vol. I (2001), at 413 – defining 'spacecraft' as "any object launched with the purpose of being put and operated in outer space".

55 So *e.g.*, for Sweden, Sec. 1, Act on Space Activities (hereafter Swedish Act on Space Activities), 1982: 963, 18 November 1982; *National Space Legislation of the World*, Vol. I (2001), at 398; *Space Law – Basic Legal Documents*, E.II.1; 36 *Zeitschrift für Luft- und Weltraumrecht* (1987), 11.

56 See for this argument *e.g.* Viikari (*supra*, n. 40), 66-7.

	Man-made/-originating phenomena			Natural phenomena
	Space law applies comprehensively		Space law would not apply in principle	Space law would not apply at all
	Tangible = space object	Non-tangible		
Functional	Functional space object[57]	Non-tangible useful phenomena[58]	Objects / non-tangible phenomena not in outer space[59]	N/A
Non-functional	Non-functional space object = **Space debris**[60]	Non-tangible phenomena causing pollution / interference[61]	Debris / non-tangible phenomena not in outer space[62]	N/A

8. Introducing the concepts of 'abandonment' and 'salvage'?

Whilst the consensus on inclusion of 'space debris' in the concept of 'space object' had the beneficial and intended effect that damage caused by space debris would under the Liability Convention (still) give rise to liability of the launching state(s) of the space object(s) from which the space debris originated, it also had another (unintended) effect which came to pose a legal problem, once the possibilities of active debris removal were becoming obvious – and such removal feasible.

Under Article VIII of the Outer Space Treaty in conjunction with relevant provisions of the Registration Convention namely, the state of registration of a space object (by definition the launching state if only one state qualified as such; one of the launching states if there were two or more states qualifying as such[63]) would "retain jurisdiction and control over such object".[64] Such jurisdiction was without end-date, so continued essentially in perpetuity – and at any rate would in principle also include space objects determined to constitute 'space debris'.

Thus, different from for example the law of the sea, concepts such as 'abandonment' and 'salvage' could not be transported without further ado to the space law-context, nor could consequently any right of other states to take space debris out of harm's way be simply

57 Space law would basically apply comprehensively.

58 *E.g.*, the use of radio-frequencies as coordinated by the ITU regime.

59 With the exception of such parts of space law as apply on a functionalist basis, *e.g.* the provisions of the Liability Convention (*supra*, n. 5) apply to damage caused by space objects wherever they are and wherever that damage is caused.

60 Following the lack of binding force of the IADC and COPUOS Guidelines, applicable parts of existing space law as of yet remain largely confined to general duties of 'good behaviour' as per the Outer Space Treaty (*supra*, n. 1), the applicability of the Liability Convention (*supra*, n. 5) and a few national licensing regimes, as discussed before.

61 The main example of existing applicable law concerns that addressing, as per the ITU regime, interference caused by radio-frequencies.

62 With the exception of such parts of space law as apply on a functionalist basis, *e.g.* the provisions of the Liability Convention (*supra*, n. 5) apply to damage caused by space objects wherever they are and wherever that damage is caused.

63 See Art. II, Registration Convention (*supra*, n. 45).

64 Art. VIII, Outer Space Treaty (*supra*, n. 1).

presumed.[65] As these two legal concepts nevertheless have been referred to as, at least in theory, opening the door to beneficial clean-up operations, at this point in the definitional analysis it is appropriate to briefly assess their meaning and content.

'Abandonment' has been generally defined as "[t]he relinquishing of a right or interest with the intention of never reclaiming it",[66] or, somewhat more precisely, "[t]he relinquishment of an interest in property or of a claim".[67] In the context of the law of the sea, the need – often arising – to remove shipwrecks from a location where they might present major risks to other ships (for example when having sunk in an international strait) and where the owner might not be interested anymore in putting up the effort and the resources to do so, such abandonment would then automatically give rise to a right for anyone – not just the owner – to remove the wreck out of harm's way. Thus, the 1982 United Nations Convention on the Law of the Sea even states that "[a]ny installations or structures which are abandoned or disused *shall* be removed to ensure safety of navigation".[68]

In the absence of (acceptance of) any such concept of 'abandonment' in space law, regardless of risks posed by non-functioning space objects to other, still-functioning ones, no one except (with explicit agreement from) the state exercising jurisdiction is entitled to remove such space debris out of harm's way.

A related development, as far as international maritime operations were concerned, in that it addressed the potential harm to other activities in the same geographical area caused by the presence of a shipwreck – presently the closest analogy to 'space debris' under international law – built upon the fact that sometimes such removed shipwrecks could still represent a considerable residual value, at least part of which was then supposed to be legitimately accruing to the one removing the wreck. This principle became subsumed under the concept of 'salvage',[69] which usually required the consent of the owner – as opposed to 'abandonment', which would essentially give rise to applicability of a 'law of finds'.

In addition, the special concept of 'liability salvage' arose, where the 'value' in salvaging the object at issue was not to be found in the residual value of the object itself, but in the reduction or elimination of the risk that that object might otherwise continue to present to other operators in the area potentially resulting in liability for the owner of the object.[70] Although only partially recognized today in the law of the sea,[71] this might well be the type

65 *Cf. e.g.* Lyall & Larsen (*supra*, n. 33), 309-10.

66 *Black's Law Dictionary*, 10th ed. (Ed. B.A. Garner)(2014), 2.

67 *The New Shorter Oxford English Dictionary* (*supra*, n. 9), 2.

68 Art. 60(3), United Nations Convention on the Law of the Sea, Montego Bay, done 10 December 1982, entered into force 16 November 1994; 1833 UNTS 3 & 1835 UNTS 261; UKTS 1999 No. 81; Cmnd. 8941; ATS 1994 No. 31; 21 ILM 1261 (1982); S. Treaty Doc. No. 103-39; emphasis added. While the clause then adds "taking into account any generally accepted international standards established in this regard by the competent international organization", the existence of an underlying concept of 'abandonment' nevertheless gives other states a basic right to enhance the safety of operation in the relevant area by taking the abandoned installation out of harm's way.

69 'Salvage' was defined as "the rescue of a sea-going ship and its cargo from distress at sea"; R. Garabello, Salvage, in *The Max Planck Encyclopedia of Public International Law* (Ed. W.R. Wolfrum), Vol. VIII (2012), 1121; see more generally 1120-5.

70 See on this *e.g.* M.P. Schaefer, Analogues between Space Law and Law of the Sea/International Maritime Law: Can Space Law Usefully Borrow or Adapt Rules from These Other Areas of Public International Law?, in *Proceedings of the International Institute of Space Law 2012* (2013), 326-30.

71 *E.g.*, Art. 13, International Convention on Salvage, London, done 28 April 1989, entered into force 14 July 1996; ATS 1998 No. 2, only provides for such a right of salvage concerning damage to the environment as such.

of salvage most interesting for space law to develop in view of the fact that the residual value of space debris would usually be non-existent or negligible.

9. Concluding remarks

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