TO INFINITY AND BEYOND—ORBITAL SPACE DEBRIS AND HOW TO CLEAN IT UP

COMMENT

Agatha Akers*

I. INTRODUCTION

> *Out in the depths of space the great celestial cities, the galaxies, cluttered with the memorabilia of ages, are slowly dying. Tens of billions of years pass in the growing darkness. . . . of a universe destined to become a galactic graveyard.*
> – *Edward Robert Harrison*[1]

Since the dawn of space exploration in 1957,[2] humans have been polluting the once-pristine universe.[3] Society today relies on orbits to house satellites needed to provide services for communication, information gathering, and military purposes to most of the world. Current international space law is inadequate to address the growing problem of orbital space debris. This Comment advocates modification of current international policy both to mitigate damage caused by objects yet to be launched into space and to develop the technology necessary to clean up existing debris.[4] Part II provides information about society's growing reliance on private industry satellites. Part III discusses the inadequacy of current space law, and Part IV suggests how existing law might be amended to establish a fund to finance and develop a feasible cleanup method.

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* Juris Doctor candidate, University of La Verne College of Law, 2013. Agatha Akers is a third year law student at the University of La Verne College of Law, where she serves as Editor-in-Chief of the Law Review. Agatha earned a B.A. in English Literature from Northwestern University in Evanston, IL, spent six years in the United States Army as an Arabic Linguist with the rank of Staff Sergeant, and served in two combat deployments to Iraq. Agatha currently works as a law clerk at Crandall, Wade, and Lowe in Rancho Cucamonga, CA. The author thanks Professors Charles Doskow and Almas Khan for their invaluable assistance and feedback during the writing process. The author also thanks her husband, Daniel Akers, who has been incredibly supportive throughout law school.

[1] EDWARD HARRISON, COSMOLOGY: THE SCIENCE OF THE UNIVERSE 526 (2d ed. 2000).

[2] MARK WILLIAMSON, SPACE: THE FRAGILE FRONTIER 8 tbl.1 (2006).

[3] An extended version of this Comment can be found at 33 U. LA VERNE L. REV. 285 (2012). The extended version contains a brief explanation of the technological aspects of orbital space debris and an overview of the emerging space tourism industry.

[4] On October 4, 1957, the USSR launched the first satellite into space: Sputnik 1. WILLIAMSON, *supra* note 2, at 8 tbl. 1.

II. SOCIETY'S RELIANCE ON PRIVATE INDUSTRY SATELLITES

Private sector satellite information providers launch many of the satellites people use on a daily basis. For example, many Americans use satellite providers for their television viewing content. In the United States, DISH Network and DIRECTV are the largest providers of these services. As of November 7, 2011, DISH Network claimed to have nearly 14 million subscribers.[5] The company reported a 12 percent increase in revenue over the same period in 2010 and posted a net income of $319 million for the third quarter of 2011.[6] DISH Network provides several packages whereby customers can subscribe to a selection of television channels priced approximately at $20–$70 per month.[7] In the past, the company owned the technological aspect of the business, but in 2008, EchoStar broke off from DISH Network to develop the technological aspect of the satellite business while DISH Network focused on the entertainment aspect.[8] Today, EchoStar still provides the technological needs for the entertainment programming and the two companies share the same chairman.[9]

EchoStar claims to have nine operational satellites in its "satellite fleet."[10] Three of these satellites are available for leasing, whereas the remaining six satellites are in an active lease with DISH Network.[11] The average service life of the EchoStar satellite fleet is fifteen years.[12] Although the company boasts expertise in spacecraft command and control, the company

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[5] Press Release, DISH Network, DISH Network Announces Third Quarter 2011 Financial Results, Nov. 7, 2011, *available at* http://press.dishnetwork.com/press-releases/dish-network-announces-third-quarter-2011-financia-nasdaq-dish-0818204.

[6] *Id.*

[7] *See generally* DISH NETWORK, http://www.dishnetwork.com/packages/programming/default.aspx (last visited Nov. 10, 2011) (containing pricing information for various DISH Network packages).

[8] *Company Overview*, DISH NETWORK, http://press.dishnetwork.com/Corporate-Info/Company-Overview (last visited Nov. 10, 2011).

[9] *Id.*

[10] *See generally Satellite Fleet*, ECHOSTAR SATELLITE SERVICES, http://www.echostarsatelliteservices.com/SatelliteFleet/SatelliteFleet.aspx (last visited Nov. 10, 2011).

[11] *Id.*

[12] *Id.*

website fails to address the status of defunct satellites and fails to address plans for removal of non-operational satellites in the future.[13]

DIRECTV is the largest provider of satellite television services in the United States. The company claims over 30 million customers throughout the Americas, with over 19 million customers in the United States and over 11 million throughout Latin America.[14] The company boasted an all-time record in the number of subscribers and posted a 14 percent revenue growth of $6.84 billion for the third quarter of 2011.[15] Most recently in 2009, DIRECTV launched the DIRECTV 12 satellite, which was the eleventh satellite in the company's fleet.[16] All of the satellites in DIRECTV's fleet are owned and operated by the company.[17] The company does not publicize what happens to the satellites after they are no longer operational.[18]

According to Federal Communications Commission (FCC) regulations, any satellite in Geosynchronous Earth Orbit[19] (GEO) must be moved into a graveyard orbit, approximately 300 kilometers farther away from Earth.[20] Dozens of GEO satellites become non-operational every year, and NASA scientists estimate that several hundred now reside in this dead orbit in order to ensure that they do not interfere with the active satellites at the lower altitudes.[21] Many other private commercial industries also use satellites to generate revenue. The intricacies of these industries are beyond the scope of this Comment, but those industries include areas such as

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[13] *See generally* ECHOSTAR SATELLITE SERVICES, http://www.echostarsatelliteservices.com/ (last visited Nov. 10, 2011) (focusing on current operations and future technological advances but failing to address space debris mitigation or removal).

[14] Press Release, DIRECTV, DIRECTV Announces Third Quarter 2011 Results, Nov. 3, 2011, *available at* http://investor.directv.com/releasedetail.cfm?ReleaseID=620542.

[15] *Id.*

[16] *DIRECTV HD & Movie Choices Get a Lift With Successful Satellite Launch*, DIRECTV, Dec. 29, 2009, http://news.directv.com/2009/12/29/directv-hd-movie-choices-get-a-lift-with-successful-satellite-launch/.

[17] *Id.*

[18] *See generally* DIRECTV, http://www.directv.com/DTVAPP/index.jsp (last visited Nov. 10, 2011) (failing to specify any method to combat the problem of inoperable satellites).

[19] GEO is a higher-altitude orbit occupying a plane directly above the Earth's equator at an altitude of 35,786 km. WILLIAMSON, *supra* note 2, at 35.

[20] Daniel Engber, *Where Satellites Go When They Die: To a Higher Plane*, SLATE.COM, Apr. 26, 2005, http://www.slate.com/articles/news_and_politics/explainer/2005/04/where_satellites_go_when_they_die.html.

[21] *Id.*

satellite radio,[22] telecommunication,[23] digital data,[24] Global Positioning Systems (GPS),[25] and others.

Despite the problems with removal of non-operational satellites, production and launch of new satellites continues to be profitable. Even the high cost of manufacturing and launching satellites does not deter the increased demand for satellite services. Euroconsult predicts that through 2018 the average price of a satellite will be $99 million.[26] This price only includes the actual manufacture of the satellite and not the launch. The launch price is predicted to average $51 million.[27] Despite these astounding figures, in the GEO telecommunications market, which comprises the core of the commercial satellite market, Euroconsult predicts that there will be a 15 percent increase in the number of these types of satellites.[28] Between 2009 and 2018, it is expected that 234 of these satellites will be launched,[29] adding to the congestion of orbital space.

III. THE INADEQUACY OF CURRENT SPACE LAW

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, commonly known as the "Outer Space Treaty," established the general legal basis for peaceful uses of outer space.[30] As of January 1, 2006, ninety-eight countries had ratified this treaty and twenty-seven others had signed it.[31] The treaty designates outer space and orbital space as a common pool resource

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[22] RAY HORAK, TELECOMMUNICATIONS AND DATA COMMUNICATIONS HANDBOOK 68 tbl.2.5 (2007).

[23] *Id.*

[24] *Id.*

[25] *Id.*

[26] Peter B. de Selding, *Space Forecast Predicts Satellite Production Boom*, SPACE.COM, June 15, 2009, http://www.space.com/6839-space-forecast-predicts-satellite-production-boom.html.

[27] *Id.*

[28] *Id.*

[29] *Id.*

[30] 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, 610 U.N.T.S. 205 [hereinafter *Outer Space Treaty*].

[31] *Space Law: Frequently Asked Questions*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, http://www.oosa.unvienna.org/oosa/FAQ/splawfaq.html#Q4 (last visited Apr. 25, 2012) (follow "How many States have signed and ratified the five international treaties governing outer space?" hyperlink). The latest data available for the number of countries that have signed and ratified the Outer Space Treaty according to the UN Office for Outer Space Affairs was dated Jan.

subject to international law.[32] The only evident restriction for the use of outer space is that the use must be peaceful.[33] The treaty encourages the nations of the world to explore and undertake commercial actions in outer space.[34] The treaty also gives nations the responsibility for preventing their citizens from violating the treaty.[35] Another important feature is that the document vests jurisdiction over launched space objects in the launching state.[36]

The treaty provides an important baseline for space activities, but it also lacks the important elements essential for space debris cleanup. The treaty does not even mention space debris.[37] While the treaty states (generally) that nations should avoid the "harmful contamination" of outer space, it fails to define the phrase.[38] A recurrent criticism of space treaties is that the documents are too broad and not specific enough to address the complexity of the space debris issue.[39] Another criticism is that it merely creates a procedural hurdle but does not impose any definite consequences for such adverse actions.[40]

Just as the Outer Space Treaty created a basic framework for space law, the 1972 Convention on International Liability for Damage Caused by Space Objects (Liability Convention) set forth the basic policies for tort law associated with space endeavors.[41] The main concern of the convention was damage caused by space objects when they re-entered Earth;[42] the

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1, 2006. *Id.* There are 196 countries in the world and as of July 2006, there were 192 UN member states. Matt Rosenberg, *The Number of Countries in the World*, ABOUT.COM, Jan. 26, 2012, http://geography.about.com/cs/countries/a/numbercountries.htm; *Member States of the United Nations*, UNITED NATIONS, http://www.un.org/en/members/ (last visited Oct. 27, 2011).

[32] *Outer Space Treaty*, *supra* note 30, art. II.

[33] *Id.*

[34] *Id.* at art. I.

[35] *Id.* at art. VI.

[36] *Id.* at art. VIII.

[37] *See generally Outer Space Treaty*, *supra* note 30.

[38] *Id.* at art. IX.

[39] N. Jasentuliyana, *Space Debris and International Law*, 26 J. SPACE. L. 139, 141 (1998).

[40] Natalie Pusey, Note & Comment, *The Case for Preserving Nothing: The Need for a Global Response to the Space Debris Problem*, 21 COLO. J. INT'L ENVTL. L. & POL'Y 425, 437 (2010).

[41] Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389 [hereinafter *Liability Convention*].

[42] HOWARD A. BAKER, SPACE DEBRIS: LEGAL AND POLICY IMPLICATIONS 79 (1989).

document does not address damages incurred in space.[43] At the time of drafting, orbital space debris was considered "relatively exotic"; therefore, the Liability Convention does not address the space debris topic.[44] "Damage" was defined in a way that only extended to people and property, not to the environment of space itself.[45] In order for a state to be liable under the Liability Convention, the debris must harm a person or property.[46] A state is not liable under the Convention for generally polluting Earth's orbit.[47]

The Liability Convention attempted to improve upon the Outer Space Treaty by defining "space object" to include "component parts of a space object as well as its launch vehicle and parts thereof."[48] With the rise of technology and space commercialization, however, the entities responsible for most objects launched into space have a pecuniary interest in leaving the terms purposefully vague to avoid liability for damage caused by their space debris.[49] Another inadequacy of the Convention is that it requires fault to be assigned before addressing liability, and so it does nothing to deter debris creation.[50] Fault is difficult to prove in the space environment, and according to the Liability Convention, liability does not attach when damages result from unintentional effects of space debris.[51] The agreement offers no incentive for nations to minimize space debris in the future or to clean up existing debris.[52]

Establishing claims under the Liability Convention has proved difficult. In 1979, Canada sought damages against the Soviet Union stemming from an incident in January 1978 in which a

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[43] *Liability Convention*, *supra* note 41.
[44] BAKER, *supra* note 42, at 79.
[45] *Id.*
[46] *Id.*; *see also Liability Convention*, *supra* note 41, art. II (establishing liability only for damage "on the surface of the earth or to aircraft flight.").
[47] *Liability Convention*, *supra* note 41, art. I (excluding pollution of Earth's orbit from definition of "damage").
[48] *Id.*
[49] Jasentuliyana, *supra* note 39, at 143.
[50] Joseph S. Imburgia, *Space Debris and Its Threat to National Security: A Proposal for a Binding International Agreement to Clean Up the Junk*, 44 VAND. J. TRANSNAT'L L. 589, 617 (2011).
[51] *Id.*; *see also Liability Convention*, *supra* note 41, art. III (stating liability will only be assigned to the state "if the damage is due to its fault or the fault of persons for whom it is responsible.").
[52] Imburgia, *supra* note 50, at 617.

Soviet satellite re-entered the atmosphere and spread radioactive debris throughout western Canada.[53] Canada asserted that the Soviet Union failed to warn about the danger associated with the satellite re-entry because the Soviet Union believed the satellite would completely burn up in the atmosphere somewhere above the Aleutian Islands.[54] In reality, the satellite was a nuclear reactor satellite containing uranium-235 and the majority of fragments discovered by the Canadian government were radioactive, with some fragments containing lethal levels of radioactivity.[55] During the course of Canada's search operations, the government requested that the Soviet Union release the technical information necessary to locate all of the debris and assess the harmful effects; the Soviet Union rejected the requests to provide the information.[56] Canada spent $14 million (CAD) cleaning up the radioactive debris.[57] In its Article II claim under the Liability Convention, Canada sought $6 million (CAD) in damages from the Soviets.[58] Ultimately, the countries settled for $3 million (CAD) in 1981.[59] The Soviet Union never admitted liability and the legal procedures established in the Liability Convention were not used to resolve the dispute.[60]

The 1975 Convention on Registration of Objects Launched into Outer Space (Registration Convention) is also silent about space debris.[61] The Registration Convention requires nations to register the space objects launched from or launched by that nation.[62] The launching state must guarantee that the launched object complies with the Registration

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[53] *Canada: Claim Against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954*, 18 I.L.M. 899, 902 (1979) [hereinafter *Canada*].
[54] *Id.* at 902–03.
[55] *Id.* at 902–04.
[56] *Id.* at 913–28.
[57] BAKER, *supra* note 42, at 66.
[58] *Canada*, *supra* note 53, at 906.
[59] BAKER, *supra* note 42, at 66.
[60] *Id.*
[61] Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695 [hereinafter *Registration Convention*].
[62] *Id.* at art. II, P 1.

Convention.[63] Each launching state must also provide the Secretary-General of the UN with the information from its national registry; the UN then merges all the national registries into an international registry, which gives the public full access to the information.[64] The Registration Convention only requires nations to provide the most basic information about the launched object: nodal period, inclination, apogee, perigee, and the general function of the space object.[65]

The Registration Convention would be more useful if it required nation states to provide other information such as satellite orbital positions, notifications of orbit changes, and notifications if an object has broken apart.[66] Currently, nations are allowed to provide this information at their discretion.[67] The major defect of the Registration Convention is that there is no requirement to continuously update the information about launched space objects to the merged registry.[68] Once the objects are initially launched and registered, the nation's obligation ceases.[69] This makes it difficult for other parties to evaluate the space debris risks involved with their proposed launch.[70]

The Registration Convention also fails to provide a specific deadline for when the space object must be registered.[71] The Convention urges that the UN Secretary-General should be

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[63] *Id.*

[64] *Id.* at art. III, P 2. *See generally Index of Notifications by Member States and Organizations on the Establishment of National Registries of Objects Launched into Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, http://www.unoosa.org/oosa/SORegister/nat_reg_notif_idx.html (last visited Oct. 28, 2011) (providing an online index of registered space objects).

[65] *Registration Convention*, *supra* note 61, art. IV, ¶ 1. Nodal period is the time between two successive northbound period crossings of the equator and is usually measured in minutes. *Convention on Registration of Objects Launched into Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, http://www.oosa.unvienna.org/oosa/en/SORegister/index.html (last visited Oct. 28, 2011). Inclination refers to the incline of the orbit with polar orbit being ninety degrees and equatorial orbit set at zero degrees. *Id.* Apogee is the highest altitude that the object will travel above Earth's surface; this number is measured in kilometers. *Id.* Perigee is the lowest altitude that the launched object will travel above the Earth's surface and is also measured in kilometers. *Id.*

[66] BAKER, *supra* note 42, at 77.

[67] *Id.*

[68] Michael W. Taylor, *Trashing the Solar System One Planet at a Time: Earth's Orbital Debris Problem*, 20 GEO. INT'L ENVTL. L. REV. 1, 45 (2007).

[69] *Id.*

[70] *Id.*

[71] *Registration Convention*, *supra* note 61, art. II, ¶ 1.

notified "as soon as practicable" following the space launch.[72] Although lack of timely registration is a significant problem, objects are frequently launched without any registration. Registration of space objects has actually declined; from 1980 to June 2006, at least 225 objects were launched into space but never registered.[73] Between 2001 and 2003, registration occurred only 75 percent of the time, compared with registration occurring 91 percent of the time in 1991.[74] Analysts speculate that all military-related launches go unregistered because no satellite registered with the UN claims a military purpose.[75] Failure to register objects hinders the ability to later identify debris and assign liability under the Liability Convention if any damage is incurred in the future.[76] Finally, the Registration Convention does not create enforcement mechanisms to ensure nations are registering launched space objects and does not assign any penalties for failures to register.[77]

Within the United States, NASA and the Defense Advanced Research Projects Agency (DARPA) are trying to develop cost-effective means to remove space debris.[78] De-orbiting of satellites in GEO is not currently possible because the altitude of GEO is too high to allow the object to return to LEO and re-enter Earth's atmosphere.[79] The only existing cost-effective option to alleviate problems associated with decayed GEO satellites is to move them into a "graveyard orbit" where the satellites can stay without interfering with the desired placement that operational GEO satellites occupy.[80] Under this option, the inoperable GEO satellites would remain in the graveyard orbit until the appropriate disposal technology is developed to collect

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[72] *Id.* at art. IV.
[73] *Space Security 2011*, SPACESECURITY.ORG, 50 (2008), *available at* http://www.spacesecurity.org/SSI2007.pdf.
[74] *Id.* at 49.
[75] *Id.*
[76] Imburgia, *supra* note 50, at 619.
[77] *See generally Registration Convention*, *supra* note 61.
[78] *NASA and DARPA Sponsor International Debris Removal Conference,* ORBITAL DEBRIS Q. NEWS, Jan. 2010, 1, 1–2. The conference was the first of its kind and was held in Chantilly, Virginia from December 8–10, 2009. *Id.*
[79] WILLIAMSON, *supra* note 2, at 76.
[80] Christopher D. Williams, *Space: The Cluttered Frontier*, 60 J. AIR L. & COM. 1139, 1187 (1995).

them.[81] Essentially, this does not alleviate or eliminate the problem of orbital space debris, but moves the debris into a less disruptive area of GEO.[82] Yet moving the satellites into graveyard orbit may not even be cost-effective because it also requires the payload to carry extra fuel and results in a more expensive space object launch without any actual cleanup occurring.[83]

In February 2012, Switzerland announced a plan to launch a space debris sweeping satellite named CleanSpaceOne.[84] For its first mission, CleanSpaceOne will retrieve the first satellite ever launched by the Swiss, Swisscube.[85] According to the Swiss Space Center's Muriel Richard, CleanSpaceOne will "rendezvous with Swisscube, round it up, grab it[,] and bring it down to enter the atmosphere."[86] It is expected that the junk sweeping satellite will be launched by 2015.[87] There are no reports, however, regarding the costs of operating CleanSpaceOne and there are no reports stating the minimum diameter of debris that CleanSpaceOne could retrieve.

IV. FUNDING THE DEVELOPMENT OF TECHNOLOGY TO CLEAN UP ORBITAL SPACE DEBRIS

An orbital maintenance fund, funded by a space access fee, could finance the technologies necessary to clean the debris from orbital space.[88] The key is to mandate these fees and connect the fees to a mandatory registry paid before launch.[89] While no realistic estimates have determined exactly how much money will be needed to fund a major cleanup of space, it is certain that if nothing is done and the debris continues to compound in orbital space, access to desirable orbits could become impossible. Even if the space access fee seems high at the start of

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[81] *Id.*
[82] Imburgia, *supra* note 50, at 628.
[83] Williams, *supra* note 80, at 1187.
[84] Jason Koebler, *Switzerland Announces Plan to Clean Up Space Junk*, USNEWS.COM, Feb. 17, 2012, http://www.usnews.com/news/articles/2012/02/17/switzerland-announces-plan-to-clean-up-space-junk.
[85] *Id.*
[86] *Id.*
[87] *Id.*
[88] WILLIAMSON, *supra* note 2, at 270.
[89] *Id.*

implementation, the cost will be eclipsed by the cost of lost revenue in the private sector if orbits become completely inaccessible.[90] Conservative projections estimate the manufacturing cost of a single satellite can reach nearly $100 million and may be significantly higher depending on the specifications desired for the particular satellite.[91] Estimates speculate an additional $50 million is expended to launch a satellite into orbit.[92] Given the high launch costs, a minor space access fee would not deter future launches, but would help establish a general orbital maintenance fund. Implementing a space access fee would mimic procedures already in place on Earth to fund other transport infrastructures.[93] The fee can be compared to the way the United States maintains highways: United States drivers must pay a yearly fee to the State when cars are registered; the revenue from the car registration fee is used to maintain highways. [94]

The space access fee could also be modeled after California's Electronic Waste Recycling Fee.[95] The State imposes a waste recycling fee on the purchase of specified electronic video devices; the fee can be paid by the retailer or the consumer.[96] Fee revenues fund the environmentally safe disposal of hazardous materials found in the specified electronic devices.[97] Fees are determined based on the size of the electronic device purchased, with consumers or retailers of larger devices paying higher fees accordingly.[98] Consumers or retailers pay the fee at the time of purchase, essentially pre-paying for the eventual disposal of the device before ever using it.[99] This pre-payment of the fee has proved lucrative for the State. From January 2005 to February 2010, California's program collected over $344 million, which funded the recycling of

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[90] *Id.*
[91] de Selding, *supra* note 26.
[92] *Id.*
[93] WILLIAMSON, *supra* note 2, at 270.
[94] Pusey, *supra* note 40, at 448–49.
[95] STATE BOARD OF EQUALIZATION, ELECTRONIC WASTE RECYCLING FEE (Dec. 2010), *available at* http://www.boe.ca.gov/pdf/pub95.pdf.
[96] *Id.* For the official legislation, *see* Electronic Waste Recycling Act, Cal. Pub. Res. Code § 42460 (Deering 2009).
[97] STATE BOARD OF EQUALIZATION, *supra* note 95 (listing the covered electronic devices (CED)).
[98] *Id.*
[99] *Id.*

over 760 million pounds of hazardous electronic waste.[100] The space access fee could provide a similar pool of resources at an international level in order to fund the environmentally safe and necessary cleanup of orbital space. Within a relatively short period of time, the fee could create the financial resources necessary to fund the cleanup.

A space access fee would also be beneficial because it would not financially encumber nations that do not actively use space; only those nations that access space would pay the fee. It should also be noted that the fee should be paid by the nation that registers the launched object. Nations, however, should in turn collect this fee from the private entity that desires to launch a private satellite into space. This could effectively spread the cost among private industries that profit from the satellites and alleviate the financial burden on nation states. Private industries may be better able to pay the fee because the satellites launched by private companies generate revenue, usually due to monthly subscriptions paid by citizens who utilize the services. In contrast, government satellites usually do not generate revenue and often serve a non-profit function such as data collection, research, or military purposes.

The space access fee also helps focus nation states on the future cleanup of orbital space, not on the distraction of assigning liability or attempting to assign a lump sum market-share liability amount for the damage already inflicted in the form of orbital debris. The danger of quoting each nation an amount for the damage already done is that the cost of the cleanup is presently unknown, and even if it were known, each nation's contributing share would likely be immense. The probability that nations could pay such a high one-time fee is low. Similarly, even if nations could pay a high one-time fee, some might refuse. A space access fee for governments and private industry would quickly create an orbital maintenance fund because the

[100] UPDATE ON CALIFORNIA'S COVERED ELECTRONIC WASTE RECYCLING PROGRAM IMPLEMENTATION OF THE ELECTRONIC WASTE RECYCLING ACT OF 2003 (SB 20, SHER), DEP'T OF RES. RECYCLING AND RECOVERY (2010), *available at* http://www.deq.state.or.us/lq/pubs/docs/sw/PSWorkgroupUpdateCACoveredEWaste.pdf.

fee would be relatively small and paid frequently by many different launching states and private launching companies.

The most logical treaty to amend in order to create a space access fee is the 1975 UN Registration Convention. The Registration Convention already requires the launching state to register objects launched by or from that state.[101] In addition to the currently required information, the Convention should be amended to include the payment of the space access fee at the same time.

The Registration Convention should also be amended to require launching states to update the status of launched objects at least annually or upon the occurrence of an important event, such as a collision or explosion. This would ensure that other nations planning launches could have the most up-to-date information as to the status of formerly launched objects. For example, if a formerly launched object was moved into a graveyard orbit or if the object performed a controlled re-entry, this information should be noted and updated with the UN Registry. This amendment would make the Registration Convention more useful because it could serve as a central depository for launching information. As the Registration Convention stands today, the registry is never really current and serves no meaningful purpose. The proposed amendments would provide several needed services: a mechanism to establish the space access fee, a central location for the current status of registered objects, and a resource to assist nations in planning effective space object launches to avoid potential collisions with orbital space debris.

Finally, the Registration Convention should also be amended to require a specific deadline for the registration of future space objects and payment of the space access fee. This Comment proposes that launched space objects should be registered and the space access fee

[101] *See generally Registration Convention*, *supra* note 61.

should be paid before the satellite is launched. This would alleviate the problem of nations either significantly delaying registration or failing to register altogether. It would also ensure prompt payment of the fee in order to finance the orbital maintenance fund. If a launching entity pays the fee before launch and then circumstances change so that the launch does not occur, the fee can be refunded upon request by the launching entity. Similarly, if a launching entity fails to register and pay according to the amended Registration Convention, an increased cost for future launches could be imposed. After several violations of the Registration Convention, treaty parties could impose sanctions on the violating entities, such as prohibition of future launches temporarily or permanently. This amendment could provide the concreteness and enforcement mechanisms lacking in the original Registration Convention and the amendment could help compel action to combat the orbital space debris problem.

In order to amend the Registration Convention, a state that is a party to the Convention must propose the amendment. The United States, as a space exploration pioneer and space development leader, should propose the amendments.[102] The UN Convention amendment process may be lengthy. During the process, the United States should also exercise its diplomatic clout to convince the nations that have not signed and ratified the Registration Convention to become parties to the Convention. Convincing non-party UN members to sign and ratify the Convention would increase the number of nations bound by the Convention and eventually increase the amount of money in the orbital maintenance fund. Because space is a common environmental asset to be shared by all nations, it is imperative that as many nations as possible be parties to the Registration Convention.

[102] For details of the UN treaty amendment process, see generally *Key Events in a Multilateral Treaty*, UNITED NATIONS, http://untreaty.un.org/ola-internet/Assistance/handbook_eng/chapter4.htm (last visited Apr. 25, 2012).

In addition, the UN should establish an international joint center to develop, implement, and administer an effective orbital space cleanup regimen. Examples of such centers are commonly found in United States university settings, such as the Engineering and Applied Science Faculty Research Groups at the California Institute of Technology.[103] Establishing such a center may initially prove challenging, particularly because of difficulties encountered in securing adequate staffing, facilities, and resources. For example, in order to employ the top scientists from space exploring nations, the joint center must provide attractive compensation packages for the scientists and researchers who will need to relocate to the joint center. Similarly, the joint center will need to be established in a nation that has the capabilities and infrastructure to support an international space cleanup initiative. Finally, the logistics of providing the resources necessary to implement the cleanup plan must be accessible to the joint center. This involves the testing facilities, the actual engineering of the cleanup solution, and the eventual execution of the cleanup missions. The specific mechanics of a joint center for orbital space debris cleanup are beyond the scope of this Comment; there is, however, a clear need for such a center to serve as a permanent entity, to actively combat the orbital debris problem, and to ensure that orbital space remains accessible for future generations.

V. CONCLUSION

> *Interestingly, according to modern astronomers, space is finite. This is a very comforting thought—particularly for people who can never remember where they have left things.*
>
> *– Woody Allen*[104]

With every satellite launch, the problem of orbital space debris is mounting. Debris encircles Earth and threatens to deny access to vital orbits modern society relies on daily.

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[103] *See generally Research Centers*, CALIFORNIA INST. OF TECH., http://www.eas.caltech.edu/research_centers (last visited Nov. 28, 2011).

[104] WOODY ALLEN, THE INSANITY DEFENSE: THE COMPLETE PROSE 231 (2007).

Immediate steps must be taken to remove orbital debris; mere mitigation procedures are no longer adequate. International space law must be amended to reflect the severity and immediacy of the problem. Because the cost of developing viable technology to remove the debris is high and will take many years to develop, cooperation between space exploring nations is vital to debris removal success. Current space law may provide an amendable framework to develop the necessary policies for eventually eliminating clutter from the space environment and restoring space as a viable and sustainable commercial asset. If the international community waits until the orbits are unusable, it will be too late to effectuate the removal. Funding remains one of the foremost obstacles to developing a viable removal technique. By amending the 1975 Registration Convention to include a space access fee and establish an orbital maintenance fund, the economic hurdle to the technological development of an orbital debris removal method can be overcome. Although nation states and private industry may initially be reluctant to pay a new fee, in the long term, a per-launch fee is more affordable than a complete bar to space accessibility. Unlike many environmental problems, which once created cannot be undone, removal of orbital space debris has the potential to restore space to a virtually debris-free realm all of humanity can enjoy, and where private industry, governmental research, and commercial space tourism can safely coexist.