SPACECRAFT MOTION MANAGEMENT (SMM): INSTITUTIONAL AND LEGAL FRAMEWORKS

by

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INTRODUCTION AND ABSTRACT

With space technology proliferating and the interest in the use of space for civil, military, and commercial purposes increasing, the notion of spacecraft motion management (SMM) is taking on new significance. As used here, "SMM" refers to the adoption, implementation, and/or enforcement of laws, regulations, policies, and customary practices concerning the location, motion, and disposal of spacecraft and their component parts in the Earth orbital environment. The term "spacecraft" is used here in the broad sense, encompassing satellites and launch vehicles, regardless of whether they are operational.

Several international organizations and U.S. domestic agencies have SMM responsibilities (Part I). However, the existing international and U.S. domestic legal frameworks for SMM are still very rudimentary, with relatively few requirements or restrictions applicable with respect to trajectories, orbits, and disposal of spacecraft or their component parts (Part II).

I. INSTITUTIONS WITH SMM RESPONSIBILITIES

A. Regulators and Institutional Operators Distinguished

A fundamental distinction particularly relevant to SMM, is the one between regulators of space operations and institutional space operators. Only the regulators are dealt with here because they have the authority to carry out SMM responsibilities on a more pervasive basis. Granted that institutional space operators manage large space programs, they nonetheless have responsibility only for their own programs, although it is true that the contractors supplying these space programs are affected by institutional SMM through procurement policies.

Accordingly, the International Telecommunication Union (ITU), an international regulatory organization with jurisdiction over certain aspects of spacecraft operation, is considered here, while the International Telecommunications Satellite Organization (INTELSAT), for example, is not. INTELSAT operates about fifteen telecommunications satellites, but has no regulatory responsibilities beyond its own satellite operations. Similarly, while the U.S. Department of Transportation's (DOT) Office of Commercial Space Transportation (OCST) is responsible for regulating launch vehicles, it does not operate them. The United States National Aeronautics and Space Administration (NASA), on the other hand, is an operator, not a regulator.

B. International Organizations

Two international organizations have SMM authority: the ITU and the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). While they share SMM authority in common, their particular jurisdictional foci and functions are somewhat different.

1. The International Telecommunication Union

An international organization headquartered in Geneva, Switzerland, the ITU is responsible *inter alia* for managing the international radio frequency spectrum, including the part of the spectrum which is used for communications with

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spacecraft. In order to discharge this responsibility, the ITU has assumed a management role also with respect to the locations of satellites in the geostationary orbit.

The ITU derives its authority from the International Telecommunication Convention (ITU Convention).[1, 2] The ITU Convention authorizes the ITU to 1) allocate radio frequencies for use by satellites; 2) coordinate the efforts of member States to eliminate harmful interference between satellites; 3) register frequency assignments made by national authorities for satellite operations; and 4) adopt regulations pertaining to its responsibilities for spectrum management.[3] The ITU first concerned itself with frequencies for space communication in 1959.[4]

In order to prevent interference between the transmissions of geostationary satellites, their orbital locations must be carefully coordinated. Consequently, the ITU requires its member States to coordinate the orbital locations of their proposed new satellite systems, or those of their authorized private entities, with the orbital locations of existing and other planned satellite systems.[5] Successful coordination generally is a prerequisite for registration of the frequency assignment used by a geostationary satellite.[6] Registration is essential because it protects the satellite operator using a particular orbital location and associated frequencies from harmful radio interference from operations in subsequently registered frequency assignments.[7] The rules for coordination and registration are set forth in the ITU Radio Regulations.[8]

[1] *Done* at Nairobi, Kenya, Nov. 6, 1992, *entered into force* Jan. 4, 1984, T.I.A.S. 8572.

[2] *See id.*, art. 33, *cf.* art. 4.1(b), (c) (concerning the ITU's jurisdiction over the geostationary orbit).

[3] *Id.*, art. 4.2(a), (b), (g).

[4] *See* R.L. White & H.M. White, THE LAW AND REGULATION OF INTERNATIONAL SPACE COMMUNICATION (1988) (offering a history of ITU Regulation of Satellites).

[5] World Administrative Radio Conference, Geneva 1979, *Final Acts, as revised*, (ITU Radio Regulations), art. 11, section II.

[6] ITU Regulations, art. 13, Nos. 1504, 1526.

[7] *Id.*, No. 1559.

[8] ITU Radio Regulations, *supra* note 5.

In addition to providing for coordination of geostationary orbital locations, the ITU, through its International Radio Consultative Committee (CCIR), has adopted recommendations concerning end-of-life measures for geostationary satellites and rocket bodies. (See II.A.3., below). The CCIR is a body within the ITU charged with studying "technical and operating questions relating specifically to radio communication."[9]

2. The United Nations Committee on the Peaceful Uses of Outer Space

The U.N. COPUOS is the primary international space "law making" body. It has formulated five treaties[10] and two resolutions.[11] COPUOS is not, however, a regulatory body like the ITU with implementing and enforcement responsibilities. All of the treaties and resolutions formulated by COPUOS have been implemented through the national laws and regulations of theratifying/signatory States. (After being formulated by COPUOS, the treaties were adopted by the U.N. General Assembly and put out for signature and ratification by U.N. member States).

[9] ITU Convention, art. 11.1.

[10] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies [hereinafter Outer Space Treaty], *done* Jan. 27, 1967, *entered into force* Oct. 10, 1967, T.I.A.S. 6347; Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched Into Outer Space [hereinafter Rescue and Return Agreement], *done* Apr. 2, 1968, *entered into force* Dec. 3, 1968, T.I.A.S. 6599; Convention on International Liability for Damage Caused by Space Objects [hereinafter Liability Convention], *done* Mar. 29, 1972, *entered into force* Sept. 1, 1972, T.I.A.S. 7762; Convention on Registration of Objects Launched Into Outer Space, [hereinafter Registration Convention], *done* Jan. 14, 1975, *entered into force* Sept. 15, 1976, T.I.A.S. 8480; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies [hereinafter Moon Treaty], U.N.G.A. Res. 34/68 (1979), *entered into force* Jul. 12, 1984.

[11] Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting, U.N.G.A. Res. 37/92 (1982); and Principles Relating to Remote Sensing of the Earth From Space, U.N.G.A. Res. 41/65 (1986).

COPUOS' charter is broad. The committee is empowered to "study the nature of legal problems which may arise from the exploration of outer space."[12] Certainly, SMM is a legitimate concern of COPUOS. Indeed, some of the treaties that COPUOS has formulated contain SMM-related provisions (See Part II.A.). There is no indication at this time that COPUOS is even considering dealing with SMM as a special concern.[13]

C. United States Regulatory Agencies

Three United States regulatory agencies have varying SMM responsibilities: the Department of Transportation's (DOT) Office of Commercial Space Transportation (OCST), the Federal Communications Commission (FCC), and the Department of Commerce's (DOC) National Oceanic and Atmospheric Administration (NOAA). The DOT's OCST is the agency with the most clearly articulated SMM responsibilities. The FCC's and NOAA's SMM concerns are more ancillary to their other regulatory responsibilities.

1. The Department of Transportation's Office of Commercial Space Transportation

The DOT is charged with licensing and regulating the operation of private launch vehicles and launch ports pursuant to the Commercial Space Launch Act of 1984 (Launch Act).[14] The safety, safety of property, and national security Secretary of Transportation is authorized to issue licenses consistent with "the public health and interests and foreign policy interests of the United States"[15] and to adopt regulations to carry out its responsibilities under the Launch Act.[16] The OCST carries out these licensing and regulatory responsibilities under delegated authority. DOT's authority over launch vehicles has been interpreted to cover "reentry vehicles," as well.[17]

Moreover, OCST has limited authority to review certain aspect of the payload. With regard to foreign payloads and U.S. payloads not requiring a license under Federal law (e.g., a microgravity experiment does not require a license), OCST may take action to prevent the launch if the payload would "jeopardize the public health and safety, safety of property, or any national security interest or foreign policy interest of the United States."[18] With regard to payloads that require Federal license, the language of the Launch Act appears to limit the Secretary's authority to ascertaining whether the required license has been obtained.[19] (Licenses are required from the Federal Communications Commission and the Department of Commerce, respectively, for telecommunications and remote-sensing satellites). It is possible, however, that OCST's safety responsibilities may also encompass these payloads to the extent that its safety review does not impinge on the traditional licensing responsibilities of the FCC and DOC.[20]

2. The Federal Communications Commission

The FCC is charged with licensing and regulating privately-owned radio stations and radio communications, pursuant to the Communications Act of 1934.[21] The FCC formally assumed jurisdiction over satellites in 1970

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[12] U.N.G.A. Res. 1472 (XIV) Dec. 12, 1959, Item 1(b).

[13] *See* U.N. Report, *infra* note 68 (concerning COPUOS' interest in orbital debris).

[14] 49 U.S.C. secs. 2601-2623 (1988).

[15] *Id.*, sec. 2606.

[16] *Id.*, sec. 2612.

[17] *See* 57 Fed. Reg. 19213 (1992) (concerning OCST safety criteria for reentry vehicles). Rocket upper stages were "intentionally excluded" from definitions in the Launch Act of "launch vehicle" and "payload." S. Rep. 68-656, 98th Cong., 2nd Sess., Oct. 3, 1984 [hereinafter 1984 Senate Report], at 8. If supplied by the payload owner, which is the case, e.g., for Martin Marietta Titan launches, the upper stage is not licensed by OCST.

[18] 49 U.S.C. sec. 2605(b)(2) (1988).

[19] *Id.*, sec. 2605(b)(1), *cf.* sec. 2605(c)(2).

[20] Support for this conclusion is found in a Congressional Report accompanying the Launch Act, which indicates that the Secretary's (OCST) safety review extends also to FCC and DOC licensed payloads. H.R. Rep. 98-816, 98th. Cong. 2. Sess. May 31, 1984, at 11. *See* also1984 Senate Report, *supra* note 17, at 3 (stating that "[n]othing in this Act is meant to affect existing payload licensing authority").

[21] 47 U.S.C. sec. 151, *cf.* sec. 152 (1988).

when it determined that a satellite meets the definition of a "radio station"[22] appearing in the Communications Act.[23] In order to obtain a license to launch and operate a satellite, the FCC must determine that the applicant and proposed satellite operation meet the legal, technical, and financial qualification requirements set forth in the Communications Act[24] and the FCC's own rules,[25] and that the proposed satellite operation will serve the "public interest."[26]

While the FCC's primary focus is on the communications aspect of a radio station (satellite) operation,[27] the agency has the authority to determine "the location of classes of [radio] stations or individual [radio] stations."[28] Ever since it began authorizing satellites in the early 1970s, the FCC has exercised jurisdiction over geostationary orbital locations.[29] It has adopted orbital assignment policies pursuant to which it has designated orbital locations to satellite operators.[30] To date, all the satellites licensed by the FCC have been geostationary.

3. The Department of Commerce, National Oceanic and Atmospheric Administration

The DOC is charged with licensing and regulating private remote-sensing satellites pursuant to the Land Remote Sensing Commercialization Act of 1984 (Landsat Act).[31] The criteria for obtaining a license are compliance with the "national security" and "international obligations" of the United States.[32] The DOC's licensing and regulatory responsibilities have been delegated to NOAA. Only one remote sensing satellite license has been issued to date.[33] (NOAA is also an operator of weather satellites).

II. SMM: A SURVEY OF PUBLIC INTERNATIONAL AND U.S. DOMESTIC LAW

A. Public International Law

International law does not prescribe specific trajectories, orbits, or locations for space activities. It does, however, require States to submit certain information on the orbits and locations they have selected. Moreover, international law occasionally imposes restrictions on the use of certain orbits and locations. Because relatively few SMM-related requirements exist, it is difficult to establish liability for damage due to collision or physical impact in space. A breach of duty is necessary for liability to attach.

1. Trajectory, Orbital Path, or Location Generally Not Prescribed; However, Duty to Notify

With minor exceptions,[34] international law does not dictate the location or movement of objects in space. Indeed, the 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) proclaims that space is "free for exploration and use by all States."[35] Neither it nor any of the other U.N. COPUOS space

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[22] *Id.*, sec. 153(k).

[23] *Establishment of Domestic Communications Satellite Facilities by Non-Governmental Entities*, 22 F.C.C. 2d 86 (1970) [hereinafter DOMSAT I], Appx. C, entitled "Memorandum on Legal Issues."

[24] 47 U.S.C. sec. 308(b) (1988).

[25] 47 C.F.R. sec. 25.140-141 (1991).

[26] 47 U.S.C. sec. 309 (1988).

[27] *Id.*, secs. 151-152.

[28] *Id.*, sec. 303(d).

[29] *See Licensing of Space Stations in the Fixed Satellite Service*, 48 Fed. Reg. 40233 (1983) (discussing the FCC's orbital assignment policy).

[30] *See* e.g. *Assignment of Orbital Locations to Space Stations in the Domestic Fixed Satellite Service* (1988 Orbital Assignment Order), FCC 88-373, *released* Dec. 7, 1988 (designating orbital locations to new satellite operators).

[31] 15 U.S.C. secs. 4201-4277 (1988).

[32] 15 U.S.C. sec. 4241(b) (1988), *cf.* 15 C.F.R. sec. 960.6(d) (1990).

[33] *See* H.R. 3614 and S. 2297 (proposing amendments to the Landsat Act which would relax the regulatory burdens on private remote sensing satellite operators).

[34] For example, the World Administrative Radio Conference for the Planning of the Broadcasting Satellite Service in the 12 GHz Band, Geneva 1977, Radio Regulations, *supra note* 5, appx. 30, adopted plans for broadcasting satellite service in ITU Regions 1 and 2, essentially, Europe, Africa, and Asia, in which specific orbital locations were allotted on an *a priori* basis to each country encompassed by the plans.

[35] Outer Space Treaty, art. I.

treaties[36] prescribes trajectories, orbital paths, or locations for space activities conducted by States or entities authorized[37] by them.

Although international law does not prescribe trajectories, orbital paths, and locations, it does require States to notify of their use. Article XI of the Outer Space Treaty requests that States inform the U.N. Secretary General "to the greatest extent feasible and practicable" of the "locations" of space activities. This requirement has been further elaborated in the Convention on Registration of Objects Launched Into Outer Space (Registration Convention). States Parties to that treaty shall "as soon as practicable" furnish information on the following orbital parameters: nodal period (the period of revolution); inclination (the angle between the plane of the orbit and the Earth's equator); apogee (the high point of an elliptical orbit); and perigee (the low point of an elliptical orbit).[38] These are some of the classical elements needed to define the orbit. For a geostationary orbit, the apogee equals the perigee (22,300 miles). The inclination may vary from 0 to 15 degrees, and the nodal period is about 24 hours.

Significant information requirements also are found in the ITU Radio Regulations. Article 11 requires States that are planning satellite systems, or whose private, authorized entities are planning such systems, to submit to the ITU's International Radio Frequency Board (IFRB) certain orbital information, among other information.[39] For a geostationary satellite, this information must include "the planned nominal geographical longitude on the geostationary satellite-orbit and the planned longitudinal tolerance and inclination excursion."[40] In other words, orbital location and East-West and North-South station keeping information is required.

For non-geostationary satellites, States must indicate "the angle of inclination of the orbit, the period, the altitude in kilometers of the apogee and perigee of [the satellite] and the number of satellites used having the same characteristics."[41] With respect to non-geostationary satellites for voice communications to and from mobile, cordless, hand-held units in the L-band[42] (e.g., Motorola's proposed Iridium constellation), additional orbital information requirements apply pursuant to a resolution adopted at an ITU World Administrative Radio Conference in 1992.[43] Information to the IFRB on these systems must include "right ascension of the ascending node;" "argument of perigee;" and "active service arc."[44]

Moreover, under Article 13 of the ITU Radio Regulations, States must provide the same orbital information no later than three months[45] before they or their authorized entities actually bring their satellite systems into use.[46] While the information under Article 11 is submitted at the very early planning stage, to allow the IFRB to place other satellite planners and operators on notice of the proposed new system ("advance publication"[47]), the Article 13 information serves to notify the IFRB that the launch of the planned system is imminent (notification).

2. Restrictions on the Selection of Trajectory, Orbital Path, and Location

While international law generally does not prescribe specific trajectories, orbital paths, and locations in space, it does impose certain con-

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[36] *See supra* note 10 (listing the U.N. COPUOS space treaties).

[37] Article VI of the Outer Space Treaty requires that private entities conducting space activities be authorized and supervised by a State.

[38] Registration Convention, art. IV(d).

[39] ITU Radio Regulations, art. 11, No 1042, *cf.* Appx. 4. The orbital information, must be sent not earlier than six years, and not later than two years, before the date of bringing into use of the satellite. *Id.*

[40] ITU Radio Regulations, Appx. 4, Item 4(a).

[41] *Id.*, Item 4(b).

[42] U.S. companies applying to the FCC for authorization to provide such services are requesting frequencies in the 1610-1626.5 MHz band, among others.

[43] World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum, Malaga-Torremolinos 1992 (WARC-92).

[44] *Interim Procedures for the Coordination and Notification of Frequency Assignments of Non-Geostationary-Satellite Networks in Certain Space Services and the Other Services to Which the Bands are Allocated*, ITU Res. COM5/8 (WARC-1992) [hereinafter ITU Res. COM5/8], Annex, Section A.

[45] ITU Radio Regulations, art. 13, No. 1496.

[46] *Id.*, No. 1488-1491, *cf.* Appx. 3, Item 5(a), (b).

[47] *Id.*, No. 1044.

straints on their selection and use. In addition to a possible restriction on the duration of the use, these constraints include vaguely formulated duties to take into consideration the interests of other States; requirements to coordinate with other States before selecting a satellite location in the geostationary orbit; and what is tantamount to a prohibition on the use of orbital locations which are being used by, or have been "reserved" for, others.

Article II of the Outer Space Treaty prohibits "national appropriation" of space by "means of use or occupation." The prohibition extends also to private corporate and natural citizens because States are responsible for the activities of their nationals in space.[48] The notion that the occupation of a particular location in the geostationary orbit amounts to an "appropriation" has been dispelled because the use is neither permanent[49] nor exclusive.[50] However, situations are conceivable where the nature and duration of the use and occupation are such that, in essence, an orbital path, or a collection of orbital paths, is being appropriated.

Several provisions of the Outer Space Treaty, although they are vaguely formulated, require States to consider the interests of other States when selecting trajectories, orbital paths, and locations for their space projects. For example, Article 9 prescribes that "States Parties to the Treaty shall ... conduct all their activities in outer space ... with due regard for the corresponding interests of all States Parties to the Treaty." Moreover, if a State Party has reason to believe that activities planned by it may cause "potentially harmful interference with activities of other States Parties," the former State has a duty to consult with the latter.[51] Presumably, the former State could be requested to modify its selection of trajectory, orbital path or location.

Pursuant to Article 11 of the ITU Radio Regulations, States that are proposing, or whose private entities are proposing, to launch geostationary satellites are required to coordinate their use of frequencies, as well as orbital locations, with other States that operate or have authorized satellites, in order to avoid harmful radio interference.[52] In certain cases, it is necessary even to coordinate with States whose satellite operations, or those of authorized private entities, merely are in the planning stage.[53] Pursuant to a resolution adopted at the ITU World Administrative Radio Conference in 1992, many of the coordination requirements set forth in Article 11 for geostationary satellites apply on an interim basis also to non-geostationary satellites in certain frequency bands, pending the adoption of permanent procedures.[54]

The requirement to coordinate in good faith could imply certain restrictions on the selection of orbital paths or locations. Indeed, with regard to a geostationary satellite that already is in operation, or whose frequency assignment has been notified (II.A.1., above), the requirement to coordinate generally amounts to a compelled acceptance of the right of that satellite to retain its orbital location under a "first-come, first-served" theory[55] and thus a prohibition on the use of the location by others operating in the same frequency band. So far, the ITU has not concerned itself with the orbital paths of non-geostationary satellites.[56] This situation may change with the advent of several planned non-geostationary satellite constellations now being proposed in the U.S. and other countries.[57]

Query: Would it be accurate to say that a rule of customary international law has evolved over decades of space exploration and use to the effect that an operational satellite, or satellite constellation, has a priority on the use of the particular orbital path, or collection of paths, it occupies? Probably not. The two essential elements of customary international law (consistent State practice and *opinio juris*, i.e., the belief by States that the particular practice is legal or constitutes a

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[48]Outer Space Treaty, art. VI.

[49]With present state technology, geostationary satellites have an operating life of about 10 to 12 years.

[50]Satellites are often co-located at the same orbital location.

[51]Outer Space Treaty, art. IX.

[52]ITU Radio Regulations, art. 11, Nos. 1060-1065.

[53]*Id.*

[54]ITU Res. COM5/8, *supra* note 44.

[55]ITU Radio Regulations, art. 13, No. I569.

[56]*Id.*, art. 29, No. 2613, affording priority in the resolution of interference problems to geostationary satellites.

[57]*See* ITU Res. COM5/8, *supra* note 44 (prescribing interim procedures for certain non-geostationary satellites).

legal duty[58]) are not present. It is true that States generally do not interfere with the space activities of other States or lay claim to the orbital paths they occupy. However, is the motivation behind this practice a perception of legal duty, or is it simply self-interest coupled with the fact that space is so vast and that, so far, it has been possible to accommodate a project elsewhere in space? Probably, the latter is true.

A discussion of restrictions on the selection and use of trajectories, orbital paths, and locations in space would not be complete without mention of the fact that no legal boundary has yet been drawn between airspace and outer space. In other words, it is not clear exactly where airspace ends and space begins. A boundary is significant, because completely different legal regimes apply in these two spheres. Airspace is sovereign to the subjacent State,[59] while space is *res communes*, i.e., free for use by everyone and not to be appropriated by anyone.[60] For years, the issue of delimitation of outer space has been debated within the U.N. COPUOS, so far without a resolution.[61]

3. No Requirement to Execute End-of-Life Disposal Maneuvers

There is no requirement under international law to execute particular disposal maneuvers at the end of the useful life of a spacecraft. None of the provisions of the Outer Space Treaty or any of the other U.N. space treaties requires States to take specific measures at the end of the useful life of a spacecraft or its component parts, e.g., a rocket stage. The Registration Convention merely requires States Parties to "notify" the U.N. Secretary General, to "the greatest extent feasible" and "as soon as possible" when a registered object "no longer [is] in earth orbit," i.e., has reentered the atmosphere.[62]

Nonetheless, several space operators today perform voluntary end-of-life maneuvers. For example, geostationary satellites often are boosted into higher so-called "grave yard" orbits in order to clear the geostationary arc, and low-Earth orbit satellites are sometimes caused to reenter the atmosphere and burn up.[63] Moreover, spent rocket stages often are vented of excess fuel and sometimes caused to reenter.[64]

These end-of-life procedures fail the test of customary international law, however, because they are not motivated by a perception of legal duty and because they lack the consistency necessary to elevate them to the level of international law. For example, while several operators boost their geostationary satellites to into higher orbits, the altitudes of such orbits vary, usually from about 50 km to about 300 km. Opinions differ as to what is the most suitable grave yard orbit, although a consensus appears to be emerging among scientists that boosting at least to 300 km super-synchronous orbits will be necessary to prevent physical interference with geostationary satellites at a later time.[65]

Interestingly, the ITU's International Radio Consultative Committee (CCIR) in 1991 adopted draft recommendations for end-of-life procedures for satellites. According to these recommendations, a geostationary satellite "should be transferred, before complete exhaustion of its propellant, to a super-synchronous grave yard orbit that does not intersect with the geostationary orbit."[66] There also is a provision for shortening the time in geostationary transfer orbit of spent rocket stages, requiring that measures be taken that will allow the apogee of the orbit to decay

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[58] *See* M.N. Shaw, INTERNATIONAL LAW (1986), at 59-81 (discussing the sources of customary international law). *See* also *Corfu Channel Case*, 1949 I.C.J. 23; and the *Chorzow Factory Case*, 1928 P.C.I.J., ser. A, No. 17 (representing World Court precedents).

[59] Convention on International Civil Aviation (Chicago Convention) *done* Dec. 7, 1944, *entered into force* Apr. 4, 1947, T.I.A.S. 1591, art. I.

[60] Outer Space Treaty, arts. I and II.

[61] *See* e.g. Report of the Committee on the Peaceful Uses of Outer Space to the U.N General Assembly, Off. Rec. 46 Sess., U.N. Doc. Supp. No. 20, A/46/20 (1991), at 21 (discussing COPUOS' progress on the matter).

[62] Registration Convention, art. IV.3.

[63] *Orbital Debris Mitigation Techniques: Technical, Legal, and Economic Aspects*, Special Project Report, Prepared under the Auspices of the American Institute of Aeronautics and Astronautics (AIAA), at 2.

[64] *Id.*, at 2.

[65] Satellites at that altitude are subject to solar and lunar perturbations.

[66] *Draft Recommendation on Environmental Protection of the Geostationary Orbit*, ITU Doc. 4A/TEMP/50-E (CCIR Study Group June 12, 1991).

more rapidly.[67] It is important to note that CCIR recommendations are not legally binding on ITU member States, although they carry substantial authority. However, if they were to be incorporated into the ITU Radio Regulations, even if only by reference, they would be considered legally binding.

Pressure is mounting within the United Nations to have COPUOS consider the issue of orbital debris, an important aspect of which concerns end-of-life maneuvers for satellites and spent rocket stages. The U.N. General Assembly has suggested that space debris would be an appropriate item for inclusion on the COPUOS agenda.[68] To date, the U.S. has resisted successfully the consideration by COPUOS of guidelines or any other legal instrument on orbital debris.

4. Liability for Damage Caused by Physical Interference in Space

International liability for damage caused by physical interference in space is governed by the Outer Space Treaty,[69] the Convention on International Liability for Damage Caused by Space Objects (Liability Convention),[70] and customary international law. Pursuant to each of these sources, at least three conditions must be satisfied for liability to attach: 1) the claimant State (or a person on whose behalf the State is acting) must have suffered damage; 2) the State against which a claim is directed (or the persons for whom it is responsible) must been at fault; and 3) a causal link must exist between the faulty act and the damage caused. Additionally, in order for the Liability Convention to apply, damage must have been caused by one "space object" to another "space object."[71]

Establishing that each of these conditions are met will be extraordinarily difficult in a case of physical interference in space. Because the rules regarding motion and location of space objects are few and often vaguely formulated, they cannot generally be relied upon to establish fault. With no duty, there can be no breach, and therefore no fault. Moreover, due to limitations on space object tracking capabilities, identifying positively the party responsible for the damage-causing object may be close to impossible. In addition, the reference to a "space object" in the Liability Convention is particularly troublesome if damage is caused by anything other than a functioning space object. It is unclear whether an inactive payload, a spent rocket body, a discarded lens cap or other debris created during normal deployment, or a piece of fragmentation debris would be considered a "space object."

B. United States Domestic Law

U.S. regulatory agencies designate geostationary satellite locations and subject launch trajectories to approval. So far, none of these agencies has imposed end-of-life requirements for spacecraft, although they have the authority to do so. Establishing liability under U.S. tort law for damage caused by physical interference with a space object would be difficult for the reasons discussed above, with respect to international law.

1. Trajectory, Orbital Path, or Location: Designated or Approved

Orbital locations occupied by U.S. geostationary satellite operators are designated by the FCC, pursuant to the agency's orbital assignment policy. Launch trajectories are subject to review and approval by the OCST, pursuant to Section 7 of the Launch Act[72] and its implementing regulations. Orbital parameters for remote-sensing satellites must be consistent with the criteria specified in Section 401 of the Landsat Act[73] and its implementing regulations.

a. The Federal Communications Commission

Requests for particular geostationary orbital locations in the context of satellite license applications are not dispositive of the FCC's grants of orbital locations.[74] The FCC designates orbital locations

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[67] *Id.*

[68] U.N.G.A. Res. 45/72 (1991). *See Report of the Committee on the Peaceful Uses of Outer Space to the U.N.G.A.*, U.N. Doc. Supp. No. 30 A/46/20 (1991) [hereinafter U.N. Report], at 17.

[69] Outer Space Treaty, art. VII.

[70] Liability Convention, art. III.

[71] *Id.*

[72] 49 U.S.C. 2606 (1988).

[73] 15 U.S.C. 4241(b) (1988).

[74] *See* e.g.1988 Orbital Assignment Order, *supra* note 30, at. para. 3 (offering this policy statement).

pursuant to orbital assignment policies adopted and revised by it periodically in order to accommodate new satellite applicants. Current orbital assignment policies are based on uniform two-degree separations between satellites operating in the same frequency bands.[75] If an operator has been assigned an undesirable orbital location, it can seek to exchange location with another operator, subject to FCC approval, or otherwise request a modification from the FCC.[76]

As of this writing, the FCC has not addressed the issue of orbital paths and potential physical interference between satellites in non-geostationary orbits. Several companies have applications pending before the FCC to construct, launch, and operate satellite constellations, with anywhere from two to 77 satellites, at orbital altitudes ranging from about 630 km to 10,360 km. The FCC is expected to act on these applications early in 1993, and it will be interesting to see how, if at all, the agency addresses the physical coordination aspects of these satellite operations, including orbital altitudes, configurations, end-of-life measures, and more.

b. Office of Commercial Space Transportation

The launch trajectory proposed by a launch vehicle operator seeking a license from OCST is subject to a safety review and a review for consistency with national security and foreign policy interests of the United States.[77] OCST reviews the launch operator's procedures for "trajectory flight safety analysis" and for "safe flight operations from ignition ...through orbital injection or escape velocity" in order to ensure that the "public health and safety and safety of property" are not jeopardized by the launch.[78] Thus, while specific trajectories are not prescribed, as is the case with geostationary locations granted by the FCC, OCST does require that the requested trajectory meet its safety and other above-mentioned statutory criteria. However, if it were necessary in order to carry out OCST's safety mandate, the office probably has the authority to prescribe specific trajectories on a case by case basis or through regulation.[79]

As noted, OCST also has certain authority to review payloads (see I.B.1., above) to ensure that they do not jeopardize the "public health and safety, safety of property, or any national security interest or foreign policy interest of the United States."[80] Falling within this review, it would seem, is the intended orbital path of a payload. If the payload does not meet the safety and policy tests set forth above, OCST "may take such action ... as [it] deems necessary to prevent the launch..."[81] Query: Given this authority and the more general authority to ensure the safety of launch operations,[82] can OCST prescribe orbital paths, system configurations, or altitudes on a case-by-case basis or through regulation?[83]

c. National Oceanic and Atmospheric Administration

An applicant for a license from NOAA to operate a remote sensing satellite must provide "[a]dequate operational information ... including ... [t]he range of orbits and altitudes requested for the authorized operation."[84] the "date of intended commencement of operations, and the expected duration of such operations."[85] In addition, the Landsat Act provides that the licensee must "obtain advance approval of any intended deviation from such [orbital] characteristics, and inform the Secretary [of Commerce, NOAA] immediately of any unintended deviation."[86] NOAA reviews this information for consistency with the "international obligations and national security concerns of the United States."[87]

Applicants for satellite authorizations must provide information on orbital locations they request, 47 C.F.R. sec. 25.114(6) (1991).

[75] 1988 Orbital Assignment Order, *supra* note 30, para. 5.

[76] 47 U.S.C. sec. 308 (1988), *cf.* 47 C.F.R. sec. 25.117 (1991).

[77] 49 U.S.C. sec. 2606 (1988).

[78] 14 C.F.R. sec. 415.13(b), *cf.* sec. 415.11 (1991).

[79] 49 U.S.C. sec. 2612 (1988).

[80] *Id.*, sec. 2605(b)(2) (1988) *cf.* 14 C.F.R. sec. 415.21 (1991).

[81] *Id.*

[82] 49 U.S.C. secs. 2601(7), 2606, 2607(b) (1988).

[83] Regulation is subject to a rulemaking proceeding. *Id.*

[84] 15 C.F.R. sec. 960.6(d)(3) (1990).

[85] *Id.*, 960.6(d)(1).

[86] 15 U.S.C. sec. 4242(b)(5) (1988).

[87] *Id.*, 4241(b), *cf.* 4241(a).

Query: Does NOAA have the authority under the Landsat Act to prescribe orbital paths, configurations, and altitudes of remote sensing satellites, should it wish to do so? It is authorized to "condition" the licenses it issues[88] and to issue regulations[89] as necessary to ensure consistency with the international obligations and national security concerns of the United States. Because of the modest interest displayed in private remote sensing satellite activities to date, NOAA is presently inclined to defer to OCST for dealing with the physical aspects of remote sensing satellite operations as part or its safety responsibilities under the Launch Act.

2. End-of-Life Maneuvers

None of the U.S. regulatory agencies have prescribed end-of-life procedures for the space operations they regulate. For example, the FCC does not require operators to boost their geostationary satellites to higher orbits, although this is now a relatively common practice. Moreover, OCST does not require launch vehicle operators to vent excess fuel from, or reenter, rocket upper stages. NOAA, which so far has licensed only one remote sensing space system, and that on board the NASA Space Shuttle, also has imposed no end-of-life requirements.

However, each of these regulatory agencies has the authority pursuant to their respective charters to impose end-of-life disposal requirements for space hardware within their jurisdictions. As mentioned earlier, the FCC is empowered to determine the locations of satellites.[90] Further it is charged with promoting communications,[91] which might be impeded if inactive payloads are left to drift in popular orbits, since these payloads, or their debris, pose a collision hazard to operational satellites. OCST's safety responsibilities,[92] discussed above, are broad enough to encompass end-of-life procedures for launch vehicles and, at least, certain payloads. NOAA has explicit authority under the Landsat Act to prescribe the method of disposition of a remote-sensing satellite upon termination of operations, subject to the approval of the President of the United States.[93]

3. Liability for Damage Caused by Physical Interference in Space

Although the specific rules of United States tort law and their formulations may vary from one state to another, they have certain key features in common. They require proof of damage, proximate causation, and, generally, fault. As with international liability, due to the difficulties of establishing fault and causation, recovery may elude the victim of a collision in space.

U.S. tort law could come into play when both parties to a suit are American, or otherwise in an international dispute, if the parties so desire and the rules of conflict of laws permit. It is interesting to note that the Liability Convention offers the victim the option of pursuing a claim through the domestic judicial system of the State responsible for the damage or through the procedures set forth by the convention itself.[94]

CONCLUSION

SMM-related rules and regulations are relatively sparse today. As increasing numbers of States and private entities conduct space operations, and as the uses of space continue to diversify, prudent SMM will be critical to maintaining order in the orbital environment and to protecting expensive space assets from damage through physical impact.

To a large extent, the institutional frameworks and necessary legal powers to adopt an SMM regime are in place today. International organizations and U.S. regulatory agencies should begin to consider the need for such a regime, but should not act prematurely by adopting and implementing *a priori plans* for partitioning or allocating certain parts of the orbital environment for specific uses or systems. Rather, they should monitor carefully space infrastructure developments and allow for SMM-related rules and regulations to evolve in an organized fashion.

In order for an SMM regime to evolve in an organized fashion, coordination among U.S.

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[88] *Id.*, sec. 4243(1).
[89] *Id.*, sec. 4244.
[90] 47 U.S.C. sec. 303(d) (1988).
[91] *Id.*, sec. 151 (1988).
[92] 49 U.S.C. sec. 2606 (1988).
[93] 15 U.S.C. 4242(b)(3) (1988).
[94] Liability Convention, art. XIX.

regulatory agencies is imperative. It may be logical for DOT's OCST to assume a leadership role in such a coordination effort because of its safety responsibilities. The coordination effort could be expanded to include the U.S. Department of Defense and NASA, as well. (Compare the Interagency Working Group on Orbital Debris).

Moreover, to be truly effective, an SMM regime ultimately must be implemented on an international level. In any event, the hallmark of an SMM regime must be the flexibility to accommodate new technologies and new concepts and methods of space operation.