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SPACE TRAFFIC MANAGEMENT STANDARDS

PAUL B. LARSEN*

TABLE OF CONTENTS

ABSTRACT	360
INTRODUCTION: INTERNATIONAL MINIMUM SPACE TRAFFIC STANDARDS	361
I. IMPORTANCE OF TRACKING	364
II. EXISTING SPACE LAW REGULATION OF SPACE TRAFFIC MANAGEMENT (STM)	365
A. SPACE TRAFFIC MANAGEMENT UNDER THE OUTER SPACE TREATY	365
B. THE AGREEMENT ON RESCUE OF ASTRONAUTS, THE RETURN OF ASTRONAUTS, AND THE RETURN OF OBJECTS LAUNCHED IN OUTER SPACE	367
C. THE LIABILITY CONVENTION	367
D. THE REGISTRATION CONVENTION	368
III. UTILITY OF INTERNATIONAL SPACE TRAFFIC STANDARDS IN CONTEXT OF SPACE DEBRIS..	368

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IV.	POSSIBLE INSTITUTIONAL MODELS FOR ESTABLISHMENT OF MINIMUM STANDARDS AND PROCEDURES FOR OUTER SPACE TRAFFIC	370
A.	THE INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) MODEL	370
B.	THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE (COPUOS) SUSTAINABLE DEVELOPMENT MODEL	372
C.	INTERNATIONAL TELECOMMUNICATIONS UNION (ITU) RADIO REGULATIONS BOARD MODEL	373
D.	THE INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE MODEL	375
E.	THE INTERNATIONAL GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) STANDARDIZATION IN THE COPUOS MODEL	377
F.	INTERNATIONAL SPACE MANAGEMENT STANDARDS BASED ON PROPOSED CODE OF CONDUCT FOR SPACE TRAFFIC	378
G.	NONGOVERNMENTAL PRIVATE SECTOR STANDARD-SETTING MODEL	379
V.	STAKEHOLDERS IN SETTING INTERNATIONAL STANDARDS	382
A.	NONGOVERNMENTAL STAKEHOLDERS	382
B.	INTERNATIONAL GOVERNMENTAL ORGANIZATIONS	383
C.	NATIONAL GOVERNMENT STAKEHOLDERS	383
VI.	COMPARISON OF MODELS	384
A.	THE ICAO MODEL	384
B.	ITU RADIO REGULATIONS BOARD MODEL	385
C.	INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE MODEL	386
D.	THE COPUOS GUIDELINES FOR REACHING SUSTAINABLE MODEL	386
E.	NONGOVERNMENTAL PRIVATE SECTOR STANDARDS-SETTING MODEL	386
VII.	CONCLUSION	387

ABSTRACT

This article is about the need for space traffic standards. It specifically focuses on international space traffic standards. Space traffic is currently tracked by radar. But, many objects—mainly space debris—moving in outer space are too small to be

tracked and are still dangerous. The Kessler Syndrome predicts frequent collisions with increasing space debris in outer space in the near future. A four-fold increase in navigable outer space objects is likely. Therefore, organization of space traffic is urgently needed.

INTRODUCTION: INTERNATIONAL MINIMUM SPACE TRAFFIC STANDARDS

EXISTING SPACE TRAFFIC MANAGEMENT is linked to existing space law, primarily the Outer Space Treaty, the International Telecommunications Union (ITU) legal regime, and the Inter-Agency Space Debris Coordination Committee (IADC) space debris guidelines. Currently, there are no “rules of the road” in outer space. Even if one country adopts unilateral space traffic rules of the road, it cannot thereby control the traffic from other countries. Only international traffic rules can establish effective rules of the road for space objects. The premise of this paper is that international minimum space safety regulations will be implemented through domestic laws and regulations, and that international uniformity can be achieved. The minimum space traffic standards would apply to civilian traffic only.

There are very successful models for international minimum standards in international civil and maritime transportation.¹ There are equally successful international standards in international satellite telecommunication.² All these regimes—air, sea, and space—concern safety, control, and management of traffic in territory that is not sovereign and thus not subject to regulation by national states. Besides the International Civil Aviation Organization (ICAO) and ITU models, this article also discusses models based on the current Committee on the Peaceful Uses of Outer Space (COPUOS)’s work on sustainable action guidelines, the IADC space debris guidelines, the COPUOS efforts to coordinate Global Navigation Satellite System (GNSS) services, and on traffic data coordination by the Space Data Association.

¹ Convention on International Civil Aviation, Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 [hereinafter Chicago Convention]; Convention on the Intergovernmental Maritime Consultative Organization, Mar. 6, 1948, T.S. No. 22, 289 U.N.T.S. 48.

² See generally Constitution of the International Telecommunication Union, reprinted in COLLECTION OF THE BASIC TEXTS ADOPTED BY THE PLENIPOTENTIARY CONFERENCE, <http://search.itu.int/history/HistoryDigitalCollectionDocLibrary/5.21.61.en.100.pdf> [<https://perma.cc/WC8J-JMAX>] [hereinafter ITU Constitution].



These six models should be considered only insofar that any of them or any of their parts suit new space technology.

Because of the extreme speed with which objects move,³ outer space is inherently ultrahazardous. It is difficult to keep space objects from colliding. The outer space environment is unforgiving. It cannot be repaired. It does not have Earth's capability of constant reconstitution. Thus, huge amounts of dangerous space debris from past space activities have accumulated. For example, the Cosmos-Iridium collision in 2009 and the Chinese destruction of a defunct satellite in 2007 resulted in great increases of space debris.⁴ It is not yet possible to clean outer space. Moreover, outer space is inherently fragile. There is no tolerance of collisions and accidents.

At this time, it is as if the world is waiting for major traffic collisions to occur in outer space in order to be motivated to establish international rules of the road. Space traffic management is a public safety issue. This will become evident as outer space collisions begin to multiply.

As space traffic is changing from being predominantly military to being mostly civilian, the nature of space traffic management is changing from having a predominantly national security purpose to predominantly addressing the civil issue of public safety. Outer space traffic is expected to increase four-fold in the near term.⁵ The explosive growth of small satellites during the next few years plus the increase in space debris without any immediate prospect of significant debris removal will intensify the dangers. The collision prospects described by the Kessler space debris syndrome are looming. One expert predicts that "from 2036 collisions [will] start to occur regularly[.]"⁶ After that time, it will be increasingly difficult to maneuver satellite traffic adequately to avoid collisions. The greatest traffic danger will be in

³ An interstellar object is currently moving through the solar system at a speed of 40,000 miles per hour. Dennis Overbye, *An Interstellar Visitor Both Familiar and Alien*, N.Y. TIMES (Nov. 22, 2017), <https://www.nytimes.com/2017/11/22/science/oumuamua-space-asteroid.html>.

⁴ See *2007 Chinese Anti-Satellite Missile Test*, WIKIPEDIA, https://en.wikipedia.org/wiki/2007_Chinese_anti-satellite_missile_test [<https://perma.cc/DYQ3-JTNZ>].

⁵ See Paul B. Larsen, *Small Satellite Legal Issues*, 82 J. AIR. L. & COM. 275, 277 (2017).

⁶ See Göktug Karacalioglu, *Impact of New Satellite Launch Trends on Orbital Debris*, 9 SPACE SAFETY MAG. (June 2, 2016), <http://www.spacesafetymagazine.com/space-debris/impact-new-satellite-launch-trends-orbital-debris/> [<https://perma.cc/B7M8-KPSJ>].

low Earth orbit (LEO) because of the rapid increase in small satellites orbiting in LEO.

The Outer Space Treaty, Article VI,⁷ places the duty on the individual states to license and continuously supervise their non-governmental outer space operators to ensure that they comply with the Outer Space Treaty and other international space law. There are no international space traffic navigation standards and procedures. Currently space traffic management occurs through individual states. There is only negligible international coordination of space traffic such as through the UN space debris guidelines and the ITU regulation of satellite orbits. The great speed with which all objects orbit in outer space makes their coexistence more tenuous. Moreover, the kinds of objects in orbit differ greatly. One of those orbiting objects is the International Space Station with astronauts on board. Fortunately, the space station is constantly being navigated to avoid objects threatening it in orbit. In the future, more inhabited space vehicles aimed for deep space will pass through the earthly orbits of other objects.

A major incentive for establishing order in space traffic is that the operators do not want to endanger their satellites in collisions or be subject to interferences. Thus, the operators are practicing maximum space situational awareness. But devastating accidents are beginning to occur. The 2009 Iridium collision with a defunct Cosmos satellite in LEO was a warning. The Chinese annihilation of one of their spent satellites by an anti-satellite weapon (ASAT) in 2007 in LEO illustrates how one collision will result in thousands of additional uncontrolled small space

⁷ The relevant space law treaties include:

- (1) 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, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty];
- (2) Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1974, 28 U.S.T. 695, 1923 U.N.T.S. 15 [hereinafter UN Registration Convention];
- (3) Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention];
- (4) Agreement on Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue and Return Agreement]; and
- (5) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3.



debris objects in outer space.⁸ The launching states are responsible for negligent acts in accordance with the Liability Convention, Art. II.⁹ Thus, each satellite operator and its launching state incurs a huge liability exposure by negligently causing debris. In addition to traffic hazards, there are considerable hazards in outer space caused by transit of deorbiting live and defunct space objects requiring coordination with air traffic management.

Outer space traffic could safely be managed much more intensely so as to allow more traffic in outer space similar to the way air traffic is managed in air space.¹⁰ International space flight rules could result in greater efficiency. Space traffic in Geostationary Orbit (GSO), in Mid Earth Orbit (MEO), and in LEO differ in kind and intensity. The GSO is so unique and narrow that the ITU early identified GSO orbital slots as being scarce and requiring special management, including special consideration for the developing countries.¹¹ MEO is used by GNSS satellites,¹² and LEO is used by a variety of small remote sensing communication satellites. Prospectively there will be visits by tourists.¹³ A complication of a different nature is the extensive use of all these orbits by diverse military satellites and weaponry. All these space objects tend to be navigable. International space flight rules would greatly improve space traffic management in GSO, MEO, and LEO.

I. IMPORTANCE OF TRACKING

The U.S. Department of Defense (DOD) constantly tracks about 23,000 large items in outer space (satellites as well as large space debris).¹⁴ Much more intensive DOD tracking technology will be deployed beginning in 2018.¹⁵ It will be more powerful and will be able to track ten times as many objects in outer

⁸ See *2007 Chinese Anti-Satellite Missile Test*, *supra* note 4.

⁹ See Liability Convention, *supra* note 7, art. II.

¹⁰ See FRANCIS LYALL & PAUL B. LARSEN, *SPACE LAW: A TREATISE* 268–70 (2d ed. 2018).

¹¹ See ITU Constitution, *supra* note 2, art. 44.

¹² See Paul B. Larsen, *International Regulation of Global Navigation Satellite Systems*, 80 J. AIR L. & COM. 365, 378 (2015).

¹³ See Larsen, *Small Satellite Legal Issues*, *supra* note 5, at 300.

¹⁴ See Mark Garcia, *Space Debris and Human Spacecraft*, NASA 6 (Aug. 7, 2017), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html [<https://perma.cc/7EWV-98FX>].

¹⁵ See, e.g., Stephen Clark, *U.S. Military Sleuth Launched to Track Satellite and Space Debris Movements*, SPACEFLIGHT NOW (Aug. 26, 2017), <https://spaceflightnow.com>.

space. However, it will still not be able to track the smallest space debris. The purpose of DOD tracking is to protect its military satellites; the DOD has been willing to share its tracking information with civilian operators thereby greatly benefitting the safety of civilian space objects.¹⁶ Commercial operators strongly favor governmental tracking for the greater protection of their space objects from collisions with the dangerous space debris traveling through outer space at speeds up to 17,500 miles per hour.¹⁷ The cost of tracking civilian traffic is carried by the military authorities (e.g., DOD). The U.S. government is now considering transfer of space tracking to the civilian side of the government.¹⁸ It is unknown whether and to what extent the U.S. government would be willing to fund the cost of civilian space traffic management, including the establishment and maintenance of minimum space traffic standards. It is noteworthy for the purpose of space traffic management (STM) discussion that even the nongovernmental space companies want space traffic management. Other governments that also engage in tracking space objects, space debris, and outer space traffic are Russia and the European Space Agency (ESA).

II. EXISTING SPACE LAW REGULATION OF SPACE TRAFFIC MANAGEMENT (STM)

Minor international regulation and standardization of traffic control, GNSS, and space debris are already happening within COPUOS. It is worth examining the existing international space law to see whether it contains possibilities for more comprehensive STM.

A. SPACE TRAFFIC MANAGEMENT UNDER THE OUTER SPACE TREATY

The Outer Space Treaty, Article I, requires all operators to use outer space “for the benefit and in the interests of all countries, irrespective of their degree of economic and scientific de-

.com/2017/08/26/u-s-military-sleuth-launched-to-track-satellite-and-space-debris-movements/ [https://perma.cc/94RE-EL2L].

¹⁶ Mike Gruss, *Good (Space) Fences Make for Good (Orbital) Neighbors*, SPACE NEWS (Sept. 19, 2016), <http://www.spacenews.com/good-space-fences-make-for-good-orbital-neighbors/> [https://perma.cc/2Z7S-CEPD].

¹⁷ See Garcia, *supra* note 14.

¹⁸ See Jen DiMasceo, *Both Ways, Commercial Space Companies Need the Government—Sometimes*, AV. WK. & SP. TECH., Oct. 30, 2017, at 19.

velopment, and shall be the province of all mankind.”¹⁹ Article I must be read together with Article II, which indicates that the states, including their nongovernmental operators, cannot appropriate outer space by any means. Operators may be allowed the use of outer space orbits, but they cannot own orbits. Under Article III, they are required to respect international law, including the UN Charter. Under Article V, they must render assistance to astronauts in distress in outer space. Article VI allows nongovernmental operators to operate in outer space if they have been given specific authority by their national state, but they are subject to continuing oversight by the authorizing state to assure that they comply with all the terms of the Outer Space Treaty. Under Article VII, the state from which they are launched is liable for any damage they may cause while in outer space. Article VIII requires that while in outer space, they are subject to the jurisdiction and control of their state of registry. Article IX requires that they must also respect the “corresponding interests” of other states. Finally, Article XI requires their state to inform the United Nations “to the greatest extent feasible and practicable, of the nature, conduct, locations[,] and results of such activities.”²⁰ Outer Space Treaty application can be extended to states that are not parties to the Treaty because its essence now constitutes customary international law.²¹ This means that states and their operators remain subject to its provisions even if a state decides to withdraw from the Treaty.

The Treaty provisions apply directly to the states and their individual commercial operators. The individual operators are required to obey the Treaty requirements, and the states are required to ensure that the Treaty requirements are observed. States can be held responsible under international law for their failures to observe the Treaty rules. Thus, they may need to adopt domestic laws to implement the Article VI requirement of authorizing and monitoring outer space activities by their nongovernmental entities. Some states have not yet implemented this requirement. For example, the United States has not legislated authority to its Federal Aviation Administration (FAA) to supervise the U.S. nongovernmental activities in outer space.²²

¹⁹ Outer Space Treaty, *supra* note 7, art. I.

²⁰ Outer Space Treaty, *supra* note 7, art. XI.

²¹ See LYALL & LARSEN, *supra* note 10, at 49–50.

²² Such legislation should be speedily adopted to allow the FAA to regulate civilian space traffic and to enforce any international space traffic standards for the greater safety of all space traffic.

Neither have India and China implemented Outer Space Treaty, Article I.

The Outer Space Treaty does not provide the opportunity to assign space traffic management functions to new international decision-making STM authorities, that is, unless the Treaty is amended to establish a standing international organization for STM, like ICAO was established to organize international aviation traffic standards.²³ States could adopt an STM protocol to the Outer Space Treaty, like the Space Protocol to the Cape Town Convention.²⁴ The protocol would apply to those states that have ratified it. The protocol, being an independent treaty instrument, would override any contrary treaty obligations of a previous date. Likely, the states interested in such a protocol would be the space-capable states. They would be the moving parties in negotiating the protocol and would also be the main beneficiaries. Such an institution would handle technical matters, as ICAO does, and would entail many of the features of ICAO, specifically the establishment of minimum international traffic standards for civil space traffic.

B. THE AGREEMENT ON THE RESCUE OF ASTRONAUTS, THE RETURN OF ASTRONAUTS AND THE RETURN OF OBJECTS LAUNCHED INTO OUTER SPACE

The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space requires countries and their governmental and nongovernmental operators to assist astronauts as well as to return space objects.²⁵ This treaty authorizes states to engage in assistance outside their territories and could become influential in authorizing states to apply traffic standards beyond their current jurisdictional limits.

C. THE LIABILITY CONVENTION

The Liability Convention²⁶ provides that launching states may be liable for the damages caused in outer space by governmen-

²³ See Chicago Convention, *supra* note 1, arts. 54, 57.

²⁴ See Protocol to the Convention on International Interests in Mobile Equipment on Matters Specific to Space Assets art. II, 17 Unif. L. Rev. 756, 762 (2012), available at <https://www.unidroit.org/instruments/security-interests/space-protocol> [hereinafter the Berlin Protocol]. See Paul Larsen, *Berlin Space Protocol Update*, 64 ZLW 361, 361–363 (2015).

²⁵ See Rescue and Return Agreement, *supra* note 7, art. 2.

²⁶ See Liability Convention, *supra* note 7, art. II.

tal as well as for nongovernmental objects. The launching states' prospects of liability are a limiting factor in authorizing and monitoring outer space traffic. States are, and should be, hesitant to authorize risky operations that could result in governmental liability of the authorizing state.

D. THE REGISTRATION CONVENTION

The Registration Convention²⁷ requires governmental and nongovernmental operators to register their orbital parameters with their launching states so that their locations are known; thus collisions with them can be avoided and new satellites located in non-conflicting orbital locations. The Registration Convention gives the launching states leverage to refuse registration and thus gain some control over its liability. The registration process is a possible avenue for avoiding risky outer space activities.

III. UTILITY OF INTERNATIONAL SPACE TRAFFIC STANDARDS IN CONTEXT OF SPACE DEBRIS

International space flight standards will be valuable despite the growing problem of space debris. The amount of non-navigable space debris vastly exceeds the number of navigable space objects in outer space. Space debris is an increasing danger and an obstacle to navigable space objects. It represents a real danger to outer space traffic and would undercut international space traffic safety standards.²⁸ The question may well be asked: what is the utility and benefit of international space traffic standards if space debris particles in outer space cannot be controlled? Nevertheless, international rules should be established for navigable space objects, such as the International Space Station and other space objects, to avoid known non-navigable objects. This establishment is frequently done in other types of traffic where there are analogies and precedents for channeling international traffic, including navigable objects, around non-navigable objects.

The International Maritime Convention—Articles 15, 21, and 28—authorizes the International Maritime Organization (IMO)

²⁷ See UN Registration Convention, *supra* note 7, art. II.

²⁸ LYALL & LARSEN, *supra* note 10, at 273; see also discussion of the IADC guidelines, *infra* note 61.

to establish international safety standards.²⁹ These standards not only guide ships to avoid collisions with each other but also guide ships to avoid fixed objects, such as light towers on dangerous rocks in the open seas like the Eddystone Lighthouse in the English Channel.³⁰ ICAO is authorized to establish flight standards.³¹ Airplanes can be directed to avoid flying over prohibited areas.³² The ITU, in order to avoid radio interference, can preclude use of interfering radiofrequencies and orbital slots.³³ Space debris represents similar non-maneuverable traffic hazards for space traffic. Consequently, all states and satellite operators now agree to reduce and control growth of space debris.³⁴ International space flight standards represent one way that the dangers of space debris can be reduced. Collision danger can be diminished if all navigable space objects follow the same, standardized traffic rules in navigating outer space. A concerted, international scheme, such as unified space flight standards, has the benefit that all space objects use the same rules for avoiding other navigable space objects and non-navigable space objects.

The scope and extent of international standardization are important. For example, space flight standards can be established to strengthen the construction and operation of space objects—the way space objects are built and navigated—the same way that airplane construction and navigation are standardized by the ICAO flight standards. The more space flight is standardized, the safer it is.

It may be concluded that, first, there is adequate precedence in other traffic modes for the creation of international standards regulating navigable and non-navigable objects and, second, that such flight standards are beneficial and should be encouraged.

²⁹ See Convention on the Intergovernmental Maritime Consultative Organization arts. 15, 16, 21, 28, *supra* note 1, at 4–7. See also Convention on the International Regulations for Preventing Collisions at Sea, Oct. 20, 1972, 28 U.S.T. 3459, 3467–99, 1050 U.N.T.S. 16, 22–37. The collision regulations contain thirty-eight standards aimed at preventing collisions at sea.

³⁰ See *Eddystone Lighthouse*, WIKIPEDIA, https://en.wikipedia.org/wiki/Eddystone_Lighthouse [<https://perma.cc/LN5A-TDWP>].

³¹ See Chicago Convention, *supra* note 1, arts. 44, 47.

³² See Chicago Convention, *supra* note 1, art. 3(c). ITU can prevent use of radiofrequencies and orbital slots, in order to avoid radio interference. See *infra* note 55.

³³ See ITU Constitution, *supra* note 2, art. 44.

³⁴ See INTER-AGENCY SPACE DEBRIS COORDINATION COMM. (IADC), <https://www.iadc-online.org/> [<https://perma.cc/SC47-MVCU>].



IV. POSSIBLE INSTITUTIONAL MODELS FOR THE ESTABLISHMENT OF MINIMUM STANDARDS AND PROCEDURES FOR OUTER SPACE TRAFFIC

A. THE ICAO MODEL

The ICAO was created by the 1944 Chicago Convention.³⁵ It is also a subagency of the United Nations and governed by the standing ICAO Council. The Chicago Convention, Article 37, provides that the Council must adopt international uniform standards and procedures for air traffic control practices and related air traffic activities.³⁶ The number of international traffic standards illustrates the extensive international uniformity of air traffic management. Space traffic standards would be different from aviation standards because of the different technology and environment. Nevertheless, it is useful to examine the range of ICAO standards and related procedures for the sake of comparison.

Extensive space traffic standards will require much management. Many factors must be considered. For example, ICAO not only establishes minimum actual flight standards but also sets minimum standards for accident investigation. Once the cause of a particular type of accident is known, future collision in traffic can be avoided. So, the international minimum standards for outer space may well have to include accident investigation standards. The collision of the Iridium satellite with the Cosmos satellite in 2009 illustrated the international nature of outer space accidents and the need for international standards on accident investigation.³⁷ The Chicago Convention, Article 56, provides

³⁵ See Chicago Convention, *supra* note 1, art. 43.

³⁶ See Chicago Convention, *supra* note 1, art. 37. Article 37 of the Chicago Convention requires minimum standards and procedures in eleven areas:

- (1) Communication systems and air navigation aids;
- (2) Airport characteristics;
- (3) Rules of the air and air traffic control practices;
- (4) Licensing of operating and mechanical personnel;
- (5) Airworthiness of aircraft;
- (6) Licensing of aircraft;
- (7) Registration and identification of aircraft;
- (8) Collection and exchange of meteorological information;
- (9) Log books;
- (10) Customs and immigration procedures; and
- (11) Aircraft in distress and investigation of accidents.

³⁷ Air traffic accident investigation requires examination of data to establish behavior and uses that lead to accidents. It is necessary to analyze and discover the factors that ultimately reveal the "event trajectory" indicating practices and

for the establishment of the ICAO Air Navigation Commission (ANC).³⁸ The ANC has nineteen members who are all experts in air navigation. ANC members are drawn from among ICAO members. The function of the ANC is to draft the international technical standards and to amend existing standards. Initial study and drafting of standards take place in panels of technical experts on a particular subject. These technical experts do not represent states. Drafts of standards are circulated to states and nongovernmental international organizations, such as the International Air Transport Association (IATA) for comments. The ANC considers these comments and prepares final drafts for submission to the ICAO Council for adoption. The Council sends the final standards to the member states for incorporation into national rulemaking and enforcement. At that point in time, the individual states must notify ICAO of any national deviations from the international minimum standards. States may adopt standards that are different than the ICAO minimum standards.³⁹

Traffic standards need continuous administration after their adoption because of changes in technology, changes in traffic patterns, and new traffic problems. Significant changes are subject to the same administration and requirements as the original standards. Thus, establishment of standards requires a standing commission of experts.

The Chicago Convention applies only to civil aviation. It does not apply to state aircraft.⁴⁰ Thus, the ICAO flight standards do not apply to military aircraft. Nevertheless, military aircraft tend to follow the ICAO flight standards for their own safety. An organization similar to the ICAO navigation commission could be created for civil outer space traffic to prevent collisions in outer space. The standards would be set by an international space safety commission. Safety standards would be continuously updated. Safety standards would be final, except that each state would be entitled to file variances when necessary.⁴¹

uses that lead to accidents and collisions. See J. Beatty, *Use Data to Avoid Accidents*, AV. WK. & SP. TECH., Nov. 27–Dec 10, 2017, at 66. Similar analysis and kinds of intensive data analysis are necessary for prevention of space traffic investigation to avoid future accidents and thus improve space traffic safety. See generally *2009 Satellite Collision*, WIKIPEDIA, https://en.wikipedia.org/wiki/2009_satellite_collision [<https://perma.cc/BY8B-9LX7>].

³⁸ See Chicago Convention, *supra* note 1, arts. 56, 57.

³⁹ See Chicago Convention, *supra* note 1, art. 38.

⁴⁰ See Chicago Convention, *supra* note 1, art. 3.

⁴¹ See Chicago Convention, *supra* note 1, art. 38.

B. THE COPUOS SUSTAINABLE DEVELOPMENT GOALS MODEL⁴²

In 2010, the COPUOS Science and Technical Subcommittee (STC) established a working group on Long-Term Sustainability of Outer Space Activities to study and formulate best practices in the form of guidelines for launch, in-orbit operations, and satellite disposal. The draft guidelines of the COPUOS working group are directed at implementing the seventeen Sustainable Development Goals (DDG) established by the UN.⁴³ It is not charged specifically with drafting space traffic rules. Instead, the COPUOS Working Group on Long-Term Sustainability of Outer Space Activities has formed four expert subgroups: (1) Sustainable Space Utilization and Sustainable Development on Earth; (2) Space Situational Awareness (SSA); (3) Weather; and (4) Regulatory Regime and Guidance for Actors in Space. The four groups are actively considering collection of data on defunct space objects, guidelines on re-entry notification, and prelaunch and maneuver notification. In 2014, the working group was developing thirty-one draft guidelines to the STC of which twelve draft guidelines were already submitted to STC. STC is waiting for submission of the remaining nineteen guidelines from the drafting group so that it can act on them as a whole.

These guidelines place the responsibility on the states to “conduct the outer space affairs in a safe and responsible manner” and to assess all risks to the long-term sustainability of outer space activities.⁴⁴ Draft guideline 3 stresses the importance of maintaining communication lines with all relevant government

⁴² See generally *Sustainable Development Goals*, WIKIPEDIA, http://en.wikipedia.org/wiki/Sustainable_Development_Goals [https://perma.cc/EZ6M-24N7]. These goals were aimed to be reached in 2013. The UN is engaged in this effort. The COPUOS work is based on UN Resolution 70/1 and on implementation by the states of Outer Space Treaty, Article VI. The draft guidelines of the COPUOS working group are directed at implementing the seventeen Sustainable Development Goals (DDG) established by the UN. The draft guidelines have value in creating space traffic management guidelines: (1) the draft COPUOS guidelines include concern for the safety, reliability, and economy of outer space traffic; (2) the guidelines are also evidence that that COPUOS can produce guidelines for outer space that may later establish a precedent for specific COPUOS space traffic guidelines. See G.A. Res. 70/1, at 14 (Oct 21, 2015); Outer Space Treaty, *supra* note 7, art. VI; Comm. on the Peaceful Uses of Outer Space, Guidelines for the Long-Term Sustainability of Outer Space Activities, U.N. Doc. A/AC.105/C.1/L.362/Rev. 1 (2017) [hereinafter COPUOS Guidelines].

⁴³ See COPUOS Guidelines, *supra* note 42, at 3.

⁴⁴ See COPUOS Guidelines, *supra* note 42, at 3–4.

and nongovernmental bodies that are competent regarding the specific space activities under consideration.⁴⁵

The COPUOS work began in 2010.⁴⁶ The Working Group on the Long-Term Sustainability of Outer Space Activities consists of a broad range of experts reflecting the views of the COPUOS member states.⁴⁷ They develop broad-gauge guidelines for long-term sustainability of outer space rather than specifically establishing minimum traffic standards for outer space.⁴⁸ The 2017 draft guidelines⁴⁹ evidence their hortatory nature. They are not clear and direct guidelines that could easily be incorporated *verbatim* into national legislation and regulation. Rather, they guide states and international organizations to implement existing space laws treaties and the ITU legal regime as well as the Sustainable Development Goals stated in in Resolution 66/288.⁵⁰ In the draft guidelines, states are asked to share information about their activities in outer space, to pay due regard to the activities of other states, to minimize risks, to improve safety, and to refrain from causing harm. The work in COPUOS is progressing slowly.

C. THE ITU RADIO REGULATIONS BOARD MODEL

ITU Regulation of Radiofrequencies and Orbital Slots of all Space Objects⁵¹ reflects ITU's special interest in the security of communication satellites and in the security of the entire radiofrequency network necessary for the navigation of all satellites. Radiofrequencies and orbital slots are scarce resources and must be used rationally, efficiently, and economically.⁵² In the interest of interference-free radiofrequencies and orbital slots, all space objects are now required by the ITU to be registered.⁵³

⁴⁵ See COPUOS Guidelines, *supra* note 42, at 3–4. Organizations involved in standardization are, for example, the International Standardization Organization, the Committee on Space Research, as well as all the users of outer space.

⁴⁶ See *Long-term Sustainability of Outer Space Activities*, U.N. OFFICE FOR OUTER SPACE AFFAIRS, <http://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html> [<https://perma.cc/5MM7-CSCE>].

⁴⁷ *Id.*

⁴⁸ The draft guidelines of the working group have not yet been considered by the Science and Technical Subcommittee.

⁴⁹ See COPUOS Guidelines, *supra* note 42, at 2–11.

⁵⁰ See G.A. Res. 66/288, annex, *The Future We Want* (July 28, 2012).

⁵¹ See ITU Constitution, *supra* note 2; see also LYALL & LARSEN, *supra* note 10, at 189–225.

⁵² See ITU Constitution, *supra* note 2, art. 44; see LYALL & LARSEN, *supra* note 10, at 509.

⁵³ See Larsen, *Small Satellite Legal Issues*, *supra* note 5, at 283–87.



The ITU is a sub-agency of the United Nations. Its Radio Regulations Board consists of no more than twelve members elected by the member states at the ITU plenipotentiary conferences held every four years. Board members are elected on the basis of geographic distribution. The Radio Regulations Board members serve only part-time and they receive no salary, except that they are paid their expenses for attending board meetings. The Board members do not serve as representatives of their States but are custodians of the public trust. They are required to be experts in the subject matters coming before the Board. Board members are prohibited from ruling on matters pertaining to their national state. The Board meets regularly, at least four times a year, to conduct business. The Board usually acts by consensus but is not required to do so. The chairman of the Board is elected annually. The chairman serves one year, after which time the chairman is replaced by the vice chairman. Its main work is to make decisions on the assignment of radiofrequencies and related orbital slots.⁵⁴

Requests for radiofrequencies and orbital slots from developing countries must be given special consideration by the ITU Radio Regulations Board. Each satellite orbiting in outer space needs a cleared radiofrequency by ITU in order to navigate, enter into orbit, avoid collisions while in orbit, and to deorbit or be placed in a graveyard orbit. ITU also requires each satellite to have a secure orbital slot related to use of the assigned radiofrequency. Article 4(3) of the ITU Constitution provides for the establishment of international standards for the purpose of ensuring cleared and protected radiofrequencies.⁵⁵ ITU is an international organization of states, thus the individual satellite operator must obtain radiofrequencies and orbital slots through its national government in accordance with national laws and regulations.

ITU regulation applies to civilian space traffic; ITU Constitution, Article 48, provides that military operators must comply with civilian regulation as "far as possible."⁵⁶ Thus, military operators are not obligated to observe ITU regulations but tend to register their frequencies and orbital slots like civilian operators for the sake of safety to avoid interference and collisions.

⁵⁴ See LYALL & LARSEN, *supra* note 10, at 210–11.

⁵⁵ See ITU Constitution, *supra* note 2, art. 4(3).

⁵⁶ See ITU Constitution, *supra* note 2, art. 48.

Consequently, ITU has some management leverage over international space traffic. Furthermore, because registered ITU users of orbits cannot own their orbits,⁵⁷ the ITU could exercise its legal authority to withdraw recognition of their assigned orbital slots for failure to comply with ITU regulations, for example, for violation of ITU space debris guidelines or for causing radio interference to users of other radiofrequencies and orbital slots. Thus, the ITU has some STM regulatory authority.

The attraction of using the Radio Regulations Board as a model for creating technical minimum international standards for outer space traffic management is that it is inexpensive. The board is small and manageable. It is elected based on geographical distribution so all regions are represented. The existing ITU Radio Regulations Board would not be qualified to write minimum standards for regulation of traffic in outer space. However, the ITU Plenipotentiary Conference meets every four years at which time the ITU could amend its Constitution to assume the additional responsibility of electing a technical board to adopt international minimum space traffic standards. The issue is whether these space traffic standards would be germane to ITU's main function of regulating radiofrequencies.

D. THE INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE MODEL

The Inter-Agency Space Debris Coordination Committee (IADC) deserves special consideration because of its successful space debris guidelines. Space debris is a major factor in space traffic management.⁵⁸ Of the 23,000 objects presently being tracked by the U.S. Air Force, 21,400 are considered to be space debris.⁵⁹ Avoiding collision with non-navigable space debris is a constant concern and worry of all operators. Removing space debris is not yet a realistic option. The objective of the IADC guidelines is to minimize the magnitude of the space debris

⁵⁷ See Outer Space Treaty, *supra* note 7, art. II.

⁵⁸ See Nicholas Johnson, *Origin of the Inter-Agency Space Debris Coordination Committee*, NASA, <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150003818.pdf> [<https://perma.cc/GD7Y-4J8C>]; see also Inter-Agency Space Debris Coordination Comm., *IADC Space Debris Mitigation Guidelines*, at 2, IADC-02-01 (Sept. 2007), http://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf [<https://perma.cc/6DXC-7EXQ>] [hereinafter IADC Space Debris Guidelines]; STEPHEN HOBE ET AL., COLOGNE COMMENTARY ON SPACE LAW, VOL III 628 (2015).

⁵⁹ See Gruss, *supra* note 16; see also Larsen, *Small Satellite Legal Issues*, *supra* note 5, at 299–300.



problem as much as possible. The IADC is a committee of the thirteen most influential governmental space agencies. Experts from these thirteen agencies drafted and adopted seven technical guidelines on how best to avoid collisions with space debris.⁶⁰ These guidelines were approved by the STC and adopted by COPUOS and the UN General Assembly as basic space debris minimization guidelines.⁶¹ Most of the states, including the ESA, have adopted these guidelines and made them mandatory standards. Thus, these guidelines have reduced the danger of collisions in space and have contributed greatly to STM. Nevertheless, these guidelines suffer from a lack of effective enforcement which COPUOS cannot provide.

The IADC represents only the thirteen member states. It is not representative of all the states in the world. Nevertheless, the technical expertise of the representatives of the thirteen national agencies was sufficiently free of national bias; they were able to prepare acceptable guidelines that were adopted by all the countries in the United Nations.⁶² These space debris guidelines were adopted by the ESA, the United States, and other major space powers as mandatory regulations. Consequently, they also tend to be observed by military space authorities for safety reasons. They have become the most important space traffic management rules so far. These rules are an important precedent for the establishment of rules of the road for outer space traffic management by a group of states acting in the interest of all spacefaring states. They were accepted by COPUOS basically as drafted by the IADC, even though the IADC is not a UN agency.

The reason for considering the IADC model is its success in producing the space debris guidelines (i.e. standards). These guidelines were adopted by COPUOS and approved by the UNGA. The guidelines became mandatory international stan-

⁶⁰ See IADC Space Debris Guidelines, *supra* note 58, at 7–10.

⁶¹ See G.A. Res 62/217, ¶ 1 (Feb 1, 2009).

⁶² See IADC Space Debris Guidelines, *supra* note 58, 7–10. Briefly, the IADC space debris guidelines are to:

- (1) Avoid debris release during normal operations;
- (2) Minimize break-ups;
- (3) Limit the probability of accidental collisions in space;
- (4) Avoid intentional destruction and other harmful activities;
- (5) Minimize potential for post-mission break-ups resulting from stored energy;
- (6) Deorbit space objects in LEO after twenty-five years; and
- (7) Place defunct space objects in GEO in graveyard orbits after use.

dards when implemented by the individual states. Given the multi-purpose international COPUOS structure, it required this outside-determined, single-focus agency, the IADC, to prepare the space debris standards. The thirteen national space agencies had the necessary expertise. Fortunately, the Science and Technical Subcommittee agreed to examine and process the IADC guidelines.⁶³

Space traffic technical experts would be required by the IADC to produce minimum outer space traffic standards. The thirteen IADC space agencies could probably produce space traffic experts to study space traffic standards. The question would be whether the COPUOS member states would accept space traffic standards produced by the thirteen national agencies, or whether the states would require such minimum guidelines to be produced by a geographically representative body.

E. THE INTERNATIONAL GNSS STANDARDIZATION⁶⁴ IN THE COPUOS MODEL

International GNSS services, with the exception of Galileo, are provided by military services. However, the users are primarily civilian.⁶⁵ COPUOS' efforts at the standardization of GNSS is relevant to, and possibly a precedent for, the standardization of international space traffic rules within the COPUOS framework.

The four GNSS systems are currently being coordinated in COPUOS to make them interoperable so that the users of these systems do not need to know which of the four systems they are navigating or operating under. The International Civil Aviation Organization bases its international navigation procedures on use of GNSS.⁶⁶ ICAO has negotiated interoperability among the four GNSS systems. Furthermore, the four GNSS operators meet regularly in the COPUOS International Committee on GNSS (ICG), where they develop soft law guidance and procedures based on a consensus of the technical experts who are involved

⁶³ In view of the threatening Kessler space debris syndrome, minimum debris standards were necessary. See *Kessler Syndrome*, WIKIPEDIA, https://en.wikipedia.org/wiki/Kessler_syndrome. [<https://perma.cc/DW2G-49H3>]; IADC Space Debris Guidelines, *supra* note 58, at 7–10.

⁶⁴ See Larsen, *International Regulation of Global Navigation Satellite Systems*, *supra* note 12, at 392–93.

⁶⁵ See Larsen, *International Regulation of Global Navigation Satellite Systems*, *supra* note 12, at 412. 86% of the users are civilian and 18% are military. *Id.* at 365.

⁶⁶ See generally INT'L CIVIL AVIATION ORG., 2016–2030 GLOBAL AIR NAVIGATION PLAN, Doc. 950-AN/963, https://www.icao.int/publications/Documents/9750_5ed_en.pdf [<https://perma.cc/SE9S-3YT4>].

in the operation of the four systems.⁶⁷ The ICG has established several working groups on specific GNSS issues. The ICG has also established a voluntary GNSS Providers Forum within which the GNSS operators can coordinate their operations. The COPUOS ICG has also established an international GNSS tracking service consisting of more than two hundred tracking and monitoring institutions around the globe where GNSS operators coordinate their signals. The individual GNSS operators ultimately adopt the international guidance as their own procedures and practices. What this means for international space traffic management is that the four GNSS operators and their augmented services are coordinated and operate as one positioning navigation and timing system for the whole world. The four systems back each other up, thereby ensuring against failures of each GNSS operating system. Furthermore, their traffic in outer space is coordinated to avoid collisions and any possible interference with each other's operations.

The four GNSS services similarly provide safe maritime navigation. The International Maritime Organization standards are observed by all GNSS operators. IMO standards require ships to be equipped with GNSS receivers and more than 50,000 ships are subject to this mandatory requirement.

Despite the basically military character of GNSS, technical standardization of GNSS is forming in COPUOS. However, military GNSS signals tend to be encrypted and of higher quality than civilian signals. Thus, civilian and military operators use different signals to navigate.⁶⁸

F. INTERNATIONAL SPACE MANAGEMENT STANDARDS BASED ON PROPOSED CODE OF CONDUCT FOR SPACE TRAFFIC

The ESA's proposed global Code of Conduct for Outer Space Activities would establish voluntary rules for outer space traffic. The proposed Code has seven guidelines.⁶⁹ Under proposed

⁶⁷ See Larsen, *International Regulation of Global Navigation Satellite Systems*, *supra* note 12, at 393.

⁶⁸ See Larsen, *International Regulation of Global Navigation Satellite Systems*, *supra* note 12, at 412.

⁶⁹ See generally International Code of Conduct for Outer Space Activities, Draft, Mar. 31, 2014, http://www.eeas.europa.eu/archives/docs/non-proliferation-and-disarmament/pdf/space_code_conduct_draft_vers_31-march-2014_en.pdf [<https://perma.cc/5JVQ-3T3U>]. Briefly, under the voluntary Code of Conduct guidelines states would:

- (1) refrain from threats or use of force;
- (2) honor existing space legal regime;

guideline 3, states would agree to minimize risky maneuvers and would observe the UN space debris guidelines. Under guideline 5, they would observe full transparency of all outer space activities for the sake of safety and in order to avoid surprises. The proposed Code of Conduct would impact navigation of military spacecraft. That transparency requirement caused the Code project, which depended on universal adoption, to fail. It became an arms-control regime rather than a purely technical space traffic management regime. Russia and China declined to support the proposed Code of Conduct. The lesson learned from the Code of Conduct failure is to make minimum space traffic standards purely technical and to limit the scope of the rules to civilian nongovernmental operations similar to the ICAO air navigation standards and procedures and the ITU radio regulations traffic in outer space.

G. NONGOVERNMENTAL PRIVATE SECTOR STANDARD-SETTING MODEL

What is the potential for international minimum space traffic standards by private agreement among the nongovernment operators? The nongovernmental satellite operators formed the Space Data Association to share information that may importantly impact outer space navigation of the satellites belonging to other companies. The Association was formed in 2009 by Intelsat, SES, and Inmarsat to improve traffic safety through shared data.⁷⁰ All the major satellite companies are members, including satellite communication companies; remote sensing companies; manufacturing companies such as Airbus, NASA; and the German space agency, DLR. The Space Data Association does not include military operators as members. The Association has formed working groups on safety and radiofrequency interference, liaison with government offices, and product development and operations. All satellite owners and operators responsible for control and operation of in-orbit satellites are encouraged to join the Association.⁷¹ The Space

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- (3) minimize risks of accidents in space;
 - (4) provide adequate advance notice of planned activities;
 - (5) be transparent about national security major research projects;
 - (6) have right of international consultations about dangerous situations; and
 - (7) review periodically the Code at an agreed meeting point.

⁷⁰ See generally Space Data Ass'n, <http://www.space-data.org/sda> [https://perma.cc/W2TB-69HM].

⁷¹ *Id.*

Data Association has concluded an agreement with the U.S. Air Force tracking operation, the Joint Space Operations Center (JSpOC), to provide tracking information directly to the Association. Both large-satellite and small-satellite operators are members.

The Space Data Association and its activities are evidence of the intense concerns of the nongovernment operators to protect their investments. In the absence of state coordination, these operators are resorting to self-help. The magnitude of cooperation and activity raises intriguing questions: Could and should the nongovernmental satellite operators agree among themselves to set international safety standards for civilian space traffic? Could the private sector assume responsibility for establishing space traffic rules and for updating those rules on a continuing basis as necessary? There are already indications that the private sector needs space traffic rules and standards to function and expand in outer space activities at the rate it is now growing. The collection of traffic data by the Space Data Association⁷² required agreement on standards regarding the collection of information, its reliability, and methods of distribution. Furthermore, the International Space Safety Federation (ISSF) has expressed the need for an International Institute on Space Safety which would assist the space industry to self-regulate and establish private safety standards.⁷³ The space industry could establish a system of self-reporting similar to the Aviation Safety Reporting System, which is a data collection system by which airlines report accidents to NASA. The space industry would report accident data to its separate database on the basis of which the space industry could agree on voluntary traffic standards.⁷⁴

⁷² *Id.*

⁷³ See Joseph N. Pelton & Andrea Gini, *A New Commercial Approach to Space Safety*, SPACE NEWS (Oct. 16, 2012), <http://spacenews.com/new-commercial-approach-space-safety/> [<https://perma.cc/UF4E-REU7>].

⁷⁴ See Irene Klotz, *Profile — James Van Laak, Director of Commercial Space, National Institute of Aerospace*, SPACE NEWS (Mar. 25, 2015), <http://spacenews.com/profile-james-van-laak-director-of-commercial-space-national-institute-of-aerospace/> [<https://perma.cc/KK8P-Y9LU>]. Another example of international private standard-setting is the International Organization for Standardization (ISO). Standards are adopted by consensus of its members. ISO standards are highly respected. Some ISO standards have already been adopted and are used by the space industry. However, the ISO technical standards do not include operational standards and procedures. See generally *International Organization for Standardization*, WIKIPEDIA, https://en.wikipedia.org/wiki/International_organization_for_standardization [<https://perma.cc/27UE-HGXM>].

Looking for relevant analogies, the maritime industry maintains a private standard-setting organization for safety. The American Bureau of Shipping (ABS) is a non-profit standard-setting organization established in 1862 by the maritime industry.⁷⁵ Before the ABS was created there were no such international maritime standards for the construction and operation of the ships. ABS standards are also established to protect ships from collisions and to protect the maritime environment. Furthermore, the ABS sets standards for the safety and security of marine oil rigs, pipelines, and moorings. About 10,000 ships are classified by the ABS as being in compliance with ABS Rules. Government agencies (in the United States, it is the Coast Guard) contribute data to the ABS standards. The ABS is a large organization with about 3,300 employees. Thus, ABS has agents throughout the world available to examine and rate ships. Governments often delegate the examination of the safety of ships to the ABS to ascertain whether the ships comply with the Load Line Convention, the Safety of Life at Sea Convention, and the Marine Pollution Convention.⁷⁶ The ABS will issue certificates that the ships are in compliance with these international requirements.

The competency of the ABS is tested every time a ship sinks or has an accident.⁷⁷ Such failures bring the competency and reliability of private standard making and enforcement into questions. It brings into issue the old Latin maxim *quis custodiet ipsos custodes* (can the police be trusted to examine its own potential abuses). Can an industry dedicated to making a profit be trusted to police its own abuses? A major concern with industry-controlled standards and enforcement is the lurking danger that profits will dominate safety.

⁷⁵ See *American Bureau of Shipping*, WIKIPEDIA, https://en.wikipedia.org/wiki/American_Bureau_of_Shipping [<https://perma.cc/RNM8-Y823>].

⁷⁶ See *International Convention on Load Lines*, Apr. 5, 1966, 18 U.S.T. 1857, 640 U.N.T.S. 133; *International Convention for Safety of Life at Sea*, Nov. 1, 1974, 32 U.S.T. 47, 1184 U.N.T.S. 278; see also *Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter*, Mar. 13, 1975, 26 U.S.T. 2403, 1046 U.N.T.S. 120.

⁷⁷ ABS certified the oil tanker *Prestige* as being seaworthy. It was defective. A severe oil spill resulted. It caused significant coastal damage in France and Spain. Such accidents brought the reliability of the ABS into question. The U.S. courts held that ABS could not be held liable. See *American Bureau of Shipping*, *supra* note 75.

V. STAKEHOLDERS IN SETTING INTERNATIONAL STANDARDS

A. NONGOVERNMENTAL STAKEHOLDERS

Profit tends to be the major motive of the nongovernment space business interests. The satellite operators, such as INTEL-SAT, SES, INMARSAT, and EUTELSAT, tend to launch large satellites into outer space and operate them there for long periods of time. They operate mostly in GSO. They have huge sums of money invested in each satellite, perhaps as much as a half-billion dollars when all costs are included. Loss of one satellite is a major event. They want their assets to be safe. Many investors have large stakes in their companies. Thus, these large companies have joined in order to safeguard their investments. They aim for order, stability, and transparency in space.

Small satellite operators like Planet Lab, One Web, Cicero, and Eros Radarsat that operate primarily in LEO similarly have significant stakes in the safety of their satellites.⁷⁸ Their operations differ from the large-satellite operators because small satellites must be replaced frequently, which requires more back and forth traffic. They are also interested in the safety of their satellites through order, predictability, and transparency.

Both large and small manufacturers of satellites, whether they are large like Space-X or not, also have significant stakes in all aspects of space traffic management. They are for-profit operations and want to protect and promote their markets for the sale of satellites and other assets. Some manufacturers, like Space-X and Airbus, are both manufacturers and operators. Thus, they have dual interests in maintaining order and predictability in outer space.

Companies that insure satellites from production through launch to operating capabilities in outer space have a stake in safety and order in space. Otherwise, they will have to reimburse the insured for their losses from collisions.

The customers of the business entities described above have stakes in good space traffic management. The customers are users of the communication satellite companies and the satellite remote-sensing operators. The customers will be hurt if a satellite business service on which they depend disappears due to a collision. Customers are not a cohesive group that can apply significant pressure on large entities.

⁷⁸ See Larsen, *Small Satellite Legal Issues*, *supra* note 5, at 277–79, 301.

B. INTERNATIONAL GOVERNMENTAL ORGANIZATIONS

The United Nations and COPUOS have responsibilities regarding space traffic management and are therefore interested in STM developments.

ITU has responsibilities for radiofrequencies and for orbital movement of satellites in assigned orbits. ITU's interest is primarily to avoid radio interference and to assure the safety of satellites. ICAO adopted a resolution on the use of GNSS satellites by airplanes for navigation. Therefore, ICAO has a stake in the continued availability of GNSS. IMO has a similar interest in the use and safety of GNSS satellites. All three, ITU, ICAO, and IMO, are stakeholders with significant interests.

C. NATIONAL GOVERNMENT STAKEHOLDERS

National governments have multiple stakes in STM. Management of outer space traffic is a major public safety problem not only for the spacefaring countries but also for all other countries as well. At the beginning of the space age, at the time of the launch of Sputnik in 1957, there were only government operators in outer space. The space treaties were originally intended to regulate state use of outer space. For most states, use of outer space is still primarily governmental. Some states, like the United States and the EU, have developed nongovernmental operators. But even these governments continue substantial government activities through their national space agencies, such as NASA in the United States and DLR in Germany.

National governments are also protectors of the public interests through services relating to safety, communication, and weather prediction. They also have a stake in providing favorable space business climates. Some governments are extensively involved in space exploration and science and wish to protect these interests. Some national governments, like those of the United States, Germany, France, the UK, and Luxembourg, have significant authorization and oversight responsibilities for their private operators in outer space. They are responsible for the liabilities of their private operators and act in many ways as guarantors for the outer space operations of the nongovernmental operators that they authorize and supervise. The governments increasingly engage in space safety negotiations.

Military authorities have an interest in civilian space traffic standards and procedure because they need to avoid collisions



with nongovernmental space objects.⁷⁹ Although not bound by the technical civilian standards and procedures, the military operators would likely adopt the civilian standard in part or in toto. Thus, the military operators may wish to engage in the development of the civilian standards. As military operators are also government entities, they would normally express their interest through their governments.⁸⁰

VI. COMPARISON OF MODELS

It is important to re-emphasize that military traffic is regulated neither by the ITU nor by ICAO or IMO. Inclusions of military traffic into what must essentially be a technical discussion unnecessarily brings military and political issues to the forefront. Inclusion of military traffic would be detrimental and fatal to the creation of international civil standards. All military space activities, including tracking, should remain outside any consideration of civil minimum international minimum standards.

A. ICAO MODEL⁸¹

International traffic management is most extensive in ICAO. The activities of the ICAO Air Navigation Commission illustrate well what is entailed in full-scale international space traffic standard regulation. The success of the ICAO minimum standards and related procedures is well-illustrated by actual practice. ICAO effectively establishes international traffic standards. It also administers those standards after adoption by evaluating their effectiveness; it strengthens ineffective standards. Whenever there is a serious air traffic accident—for example the disaster of the disappearance of the Malaysia Airlines plane over the Indian Ocean⁸²—ICAO acts expeditiously to examine and amend the standards to prevent a repetition of accidents.

⁷⁹ See Paul Larsen, *Outer Space Arms Control: Can the USA, Russia and China Make This Happen?*, J. CONFLICT L. 1, 7 (2016).

⁸⁰ See NAT'L SPACE POLICY OF THE UNITED STATES OF AMERICA, 2 (June 28, 2010) https://www.nasa.gov/sites/default/files/national_space_policy_6-28-10.pdf [<https://perma.cc/D9H5-H4B2>]. U.S. policy is to cooperate with interagency, international, and commercial partners to define and promoting safe and responsible space operations. This includes sharing space situational awareness and flight safety information, as well as supporting the development of transparency, confidence building, and behavioral norms promoting reasonable space operations.

⁸¹ See generally IADC, *supra* note 34.

⁸² See generally *Malaysia Airlines Flight 370*, WIKIPEDIA, https://en.wikipedia.org/wiki/Malaysia_Airlines_Flight_370 [<https://perma.cc/T4Q5-ABLD>].

Ultimately, comprehensive standards similar to the ICAO safety regulation will be necessary for traffic in outer space. That will require a significant international organization such as a Space Navigation Commission. It may need to establish: (1) minimum standards and procedures on communication and navigation; (2) standards for civilian space launch facilities; (3) standards for space traffic control; (4) operational licensing; (5) standards for space worthiness of space objects; (6) standards for registration; (7) information procedures regarding space flight conditions; (8) records requirements; (9) standards on navigational aids; (10) customs and immigration procedures; (11) standards for spacecraft accident investigation; and (12) on how to best channel practical information from nongovernmental operators and users about actual traffic conditions and needs into the standard-making process. The above categories are drawn from the Chicago Convention Article 37 and are only examples.⁸³ Outer space traffic may require other safety standards. Adoption of the ICAO model for international minimum standards for outer space traffic would require a new treaty instrument which either could be a new independent treaty or it could be a protocol to the Outer Space Treaty as described above.⁸⁴

B. ITU RADIO REGULATIONS BOARD MODEL⁸⁵

The search is for a model that fits the requirements for producing space traffic standards. A simple ITU-like board might suffice if the scope of rulemaking is small and simple. The Board consists of only thirteen members; they work part-time and meet only four times year. An ITU Board would need strong administrative support from a permanent staff. Such a staff might have to be obtained from COPUOS. However, if outer space requires extensive, ongoing standard-setting, then the ITU Board model would not suffice. Thus, this model may not be a natural fit, but it could perhaps be used in the absence of better models.

⁸³ See Chicago Convention, *supra* note 1, art. 37.

⁸⁴ See Berlin Protocol, *supra* note 24, art. II; see also Larsen, *Berlin Space Protocol Update*, *supra* note 24, at 361–63.

⁸⁵ See ITU Constitution, *supra* note 2, art. 44; see also LYALL & LARSEN, *supra* note 10, at 509.

C. THE INTER-AGENCY SPACE DEBRIS COORDINATION
COMMITTEE MODEL⁸⁶

The IADC model is also small. The national agencies would be represented by experts on space traffic. If the agencies' space traffic management is small, then a small institutional model would suffice, and little expense would be involved. However, in the case of the IADC, it would be possible that these experts, owing allegiance to their national agencies, could not be trusted to act impartially "in the interest of all countries" as required by Outer Space Treaty Article I.⁸⁷

D. THE COPUOS GUIDELINES FOR REACHING
SUSTAINABLE DEVELOPMENT GOALS⁸⁸

The work in COPUOS on guidelines to reach sustainable development goals (SDG) is progressing very slowly. The different scope of the SDG guidelines raises questions about whether the working group on sustainable development is a suitable model for producing guidelines for space traffic. It also raises questions about whether COPUOS has the technical resources to establish a different working group on guidelines for space traffic. The work in COPUOS illustrates the magnitude of STM for which international minimum standards and procedures may be needed. In other words, STM standard setting is not a matter of small, simple guidelines narrowly focused like the space debris guidelines. The STM traffic guidelines will encompass a broad area, like the ICAO standards.

E. NONGOVERNMENTAL PRIVATE SECTOR
STANDARD-SETTING MODEL⁸⁹

An international nongovernmental standard-setting body similar to the ABS for shipping is unlikely to be accepted by the states in COPUOS nor by an international diplomatic conference. The international space safety standard would therefore not have an international treaty basis such as the sea, air, and telecommunications standards. However, it could exist for private industry standards like those of the International Standardization Organization, which have already begun to apply in outer space. It would be important for the space industry to have ade-

⁸⁶ See IADC, *supra* note 34.

⁸⁷ See Outer Space Treaty, *supra* note 7, art. I.

⁸⁸ See discussion *supra* note 42.

⁸⁹ See Space Data Ass'n, *supra* note 70.

quate input into the international decision-making process whenever an international standard-setting process begins.

VII. CONCLUSION

The comparison of models narrows the choice of organizational frame to an independent civilian international standard-setting institution, such as ICAO and its Air Navigation Commission. However, only those parts of this model that fit the space technology and space traffic should be considered.

Under the ICAO model, a treaty instrument in the nature of a protocol to the Outer Space Treaty or an independent treaty instrument similar to the International Civil Aviation Convention would establish a space navigation commission like the ICAO ANC, which would draft minimum traffic standards for outer space and submit the drafts for final adoption by a space navigation council. Upon adoption by the individual states, the standards would become mandatory. However, as permitted under the ICAO regime, each state should be able to file variances from the international minimum standards and procedures.⁹⁰

In consequence, uniform international space traffic standards would be established. As with international aviation, military traffic would be exempted from the civilian technical standards. However, for the sake of safety and for their own protection, the military authorities would probably find it to be in their interest to navigate under the international civilian standards.⁹¹ A standing space traffic commission, consisting of technical experts, similar to the ICAO ANC, would draft the minimum traffic standards and procedures for outer space. The Commission should be small. It should be formed to receive maximum input from all the stakeholders involved in space traffic.⁹²

⁹⁰ See Chicago Convention, *supra* note 1, art. 38.

⁹¹ A similar arrangement exists under ITU regulations where the military authorities can deviate from the civilian standards. See ITU Constitution, *supra* note 2, art. 48.

⁹² See *supra* section III; see also Larsen, *Small Satellite Legal Issues*, *supra* note 5, at 227.