Private Risk Management in Orbital Operations

Inter-operator Liability and the Space Data Association

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The recently released US Space Policy highlights the fact that the space environment is in a period of evolution and growth. In particular, the policy notes:

- ***The space environment is rapidly changing*** and these changes will require a corresponding change in our actions.
- ***Greater international cooperation is desirable***, including leveraging the existing and planned space capabilities of allies.
- ***"Responsible operations in space" are critical*** and this will necessitate improved information collection and sharing to avoid collisions and to protect critical space systems.
- ***The government should increase its reliance on commercial space activities*** and consider innovative approaches such as public-private partnerships.[2]

The policy recognizes that as more countries and more commercial entities develop space capabilities, there will be a need to better define the rules for responsible behavior in space. As the space environment continues to grow and evolve, this will create new stresses on existing public and private law. This paper examines current private sector initiatives to enhance data sharing between commercial satellite communications operators through the Space Data Association Limited (SDA).[3] It will discuss the international policy and legal implications of the SDA and the efforts being made by the participants to manage both legal and physical risk.

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[1] The opinions expressed in this article are solely those of the authors and do not reflect the official opinions or policy of the Space Data Association or any of its members, including but not limited to Intelsat, SES, and Inmarsat.

[2] President Barack Obama administration, *National Space Policy of the United States of America*, White House, 28 June 2010, http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf.

[3] Space Data Association Limited is a private company limited by guarantee and incorporated in the Isle of Man. It also trades as "the Space Data Association" and/or "the SDA".

Focusing on the Need for Change

For decades, the US and the Soviet Union maintained a near monopoly on access to and the exploitation of space. Now, many more countries have access to space and new transportation capabilities suggest that the number will continue to expand rapidly. In addition to countries, numerous commercial operators are investing billions of dollars to provide a wide range of essential services from space.

Although seemingly vast, near-Earth space is ultimately a finite resource that must be managed. This is particularly true with respect to the more desirable orbits for communication and remote sensing. Radio frequency spectrum, long acknowledged by experts to be a scarce resource, has been under significant pressure lately to accommodate new terrestrial and space actors and applications. The Obama space policy embraces the belief that rapid and significant change in the space environment has created an urgent need for nations to work cooperatively together to ensure that we can sustain the current uses of the space environment and preserve its value for future generations.

The theme of change can be found in the space policy's introduction:

> The legacy of success in space and its transformation also presents new challenges. When the space age began, the opportunities to use space were limited to only a few nations, and there were limited consequences for irresponsible or unintentional behavior. Now, we find ourselves in a world where the benefits of space permeate almost every facet of our lives.… The now-ubiquitous and interconnected nature of space capabilities and the world's growing dependence on them mean that irresponsible acts in space can have damaging consequences for all of us.[4]

In a similar vein, in December of 2009, the European Union issued a draft code of conduct for outer space activities which also is predicated on the assumption that space activities have grown sufficiently complex to warrant additional governmental attention.[5] The code was designed to encompass civilian and military uses of space. Key features of the text include a voluntary commitment to refrain from intentionally harming space

[4] Ibid
[5] Council of the European Union, *Council Conclusions and Draft Code of Conduct for Outer Space Activities*, Brussels, 17 December 2008, Http://register.consilium.europa.eu/pdf/en/08/st17/st17175.en08.pdf.

objects; measures to control and mitigate space debris; and, mechanisms for cooperation and consultation. The European Union is now holding consultations to encourage other countries to embrace these principles.

Accepting that the space environment is undergoing a rapid transition, it is still unclear what steps countries and the international regulatory community should take in response. US and European officials seem to be taking prudent steps in initiating a broad, international dialogue about the management of the space environment while declining to suggest specific bureaucratic or international regulatory solutions. Like the 'rules of the road' that developed to govern the conduct of nations on the high seas, 'rules of the road' for space are best developed, over time, in response to real problems and with the guidance of long experience.

Data Sharing to Ensure Responsible Operations in Space

Major commercial satellite operators routinely share information with each other about their flight operations on an informal, ad-hoc basis. The data exchange usually consists of the latest location information, near-term maneuver plans, transmission frequencies, and contact information for further discussion. These data exchanges are motivated by the very real need to avoid the collision of space objects and to minimize radio frequency interference. The need to share data has increased with the number of satellite operators and the rapid growth of individual fleets. Intelsat, for example, operates a fleet of more than 50 satellites.

In response to business opportunities and changing market needs, global satellite operators regularly replace satellites and relocate satellites in orbit. To change the orbital location of a satellite, operators must delicately move a minibus-sized, multi-ton object, traveling thousands of kilometers per hour, through the crowded geostationary arc, avoiding the potential for collisions with, or disturbing the radio communications of, any of the more than 250 other commercial communications satellites in that orbit.

With the exception of the initial grant of approval by a national regulator, this entire process is managed without governmental regulation or oversight, using informal, *de facto* rules developed through experience and implemented by consensus among the commercial operators themselves. This process has been used effectively and without incident since the commercial satellite communications era began in the 1960s. This remarkable example of international and inter-company cooperation and self-reliance is premised on a simple realization that the results of a collision could be catastrophic.

Data sharing is possible because operators continuously and accurately track the locations of their own satellites. Most operators also incorporate information from the US Joint Space Operations Center when analyzing potential close approaches between satellites or between satellites and trackable space debris. The basic information (referred to as two-line element [TLE] data) used in this process is available to authorized users of the US Government's "www.space-track.org" website.

There are drawbacks to the current close-approach monitoring process. In addition to a lack of standards for TLE modeling, TLE data does not have the required accuracy for credible collision detection. An operator that relies on TLE data must increase the calculated collision margin to avoid potential close approaches, therefore increasing the number of maneuvers. Maneuvers based on inaccurate data can waste fuel, shorten the life of satellites, and in some cases, introduce uncertainties that actually decrease the safety of space operations. In most cases, threats identified using basic TLE data are downgraded after coordination with other operators or further evaluation with more precise orbital data. TLE data also lacks reliable planned maneuver information, which limits the usefulness of data for longer-term predictions.

Adding complexity to this problem is the fact that there is no single standard for representing the position of an object in space. Operators characterize the orbital position of their satellites differently depending on the software used for flight operations. In addition, there is no single agreed-upon protocol for sharing information, and coordinating operators must be prepared to accommodate the practices of other operators. To do this, operators must maintain redundant file transfer protocols and tools to convert and reformat information so that it is consistent with other software systems for computing close approaches. Some operators write their own software tools for monitoring and predicting the close approach of other spacecraft, while others contract with third parties for this service. Therefore, separate tools for each operator are necessary to exchange data. The magnitude of the effort to maintain space situational awareness grows quickly as the number of coordinating operators increases. Further, not all satellite companies participate in close-approach monitoring due to lack of financial resources or appropriately skilled technicians.

Since TLE data is relatively imprecise, US Strategic Command (USSTRATCOM) has been working to develop a procedure for granting operators access to information that goes beyond the basic TLEs.[6] USSTRATCOM recently authorized Joint Functional

[6] CFE was a pilot replacement for the NASA program sharing orbital data with non-USG users from 1960s-2003. The Air Force Space Command executed the CFE Pilot Program under the authority granted by Congress in November 2003 (FY04 NDAA) and extended (in FY07 and FY09) to 30 September 2010.

Component Command for Space (JFCC SPACE) to share conjunction summary messages (CSMs) with satellite operators whose satellites have been identified as closely approaching another space object.[7] CSMs contain vector and covariance data computed using Special Perturbations theory and are, therefore, more accurate than the TLE data.

In response to the recognition that better and broader inter-operator information sharing is desirable and to augment the services available from the Air Force, a number of satellite operators recently began a broad dialogue on how to best ensure information sharing within the satellite communications industry. As a result, the major satellite operators have formed the SDA, which is an interactive repository for commercial satellite orbit, maneuver, and payload frequency information.[8] The principal goal of the SDA's Space Data Center (SDC) is to promote the safety of space operations by encouraging coordination and communication among its operator members. Satellite operators maintain the most accurate information available on their fleets in the data center systems; augment existing TLE data with precise orbit data and maneuver plans from the operator's fleets; and retrieve information from other member operators when necessary. As a result, the data center:

- Enhances safety of flight.
- Provides efficient, timely, accurate conjunction assessments for members.
- Reduces false alarms, missed events.
- Minimizes member time and resources devoted to conjunction assessment.
- Establishes common format conversions and a common information repository.
- Provides radio frequency interference geolocation and resolution support, allowing operators to more rapidly find and address interference sources.
- Encourages the evolution of best practices for members.

The SDA has offered to augment currently available global sensor data with more precise operator-generated data to improve the accuracy of conjunction monitoring. The SDA could also provide a standardized method and focal point for operators to share information and facilitate communications between satellite operators and governments interested in making available timely space object catalogues.

Since 2003, the CFE program has provided registered users (documented by an on-line registration agreement) access to basic orbital data via an online web site (www.space-track.org). Further, CFE offered additional limited collision avoidance support using specific request procedures for a limited set of users pursuant to bilateral agreements.

[7] Statement of Major Duane Bird, USAF, US Strategic Command to *AMOS Conference*, September 2010.

[8] See: www.space-data.org.

By creating the SDA, commercial industry took a giant step towards accomplishing the Obama space policy goal of "promoting safe and responsible operations in space" and those of the European Code of Conduct which seeks: "measures to control and mitigate space debris; and, mechanisms for cooperation and consultation." Hopefully, with the passage of time, the US and other governments will be able to fully capitalize on this industry sponsored and funded initiative. Solving the problem of government/industry data sharing and the role of the SDA should be a key objective in future international discussions on this topic.

The Current Environment

As discussed above, international activity regarding the protection of the outer space environment has been the province of space-faring nation states and international organizations such as the International Telecommunication Union (ITU) and the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOUS). These governmental entities have endeavored, through ad-hoc cooperation, bilateral agreements, and multilateral treaties such as the 1967 Outer Space Treaty and the 1972 Space Liability Convention, to establish a legal framework for the peaceful utilization and protection of the outer space environment.[9] However, the legal regime that has been established through these governmental efforts was not written to meet the needs of today's commercial space operators. When the seminal treaties and primary working groups were established, national governments were the sole operators in earth orbit and outer space. Accordingly, it is actions by these governments and not commercial enterprise that have been the main focus of their deliberations. In today's operational environment, this is insufficient. UN COPUOUS itself recently acknowledged that ". . . international space law does not establish a sufficient and appropriate legal regime to internationally regulate the challenges created by space debris. It is therefore imperative that States **and other stakeholders** consider additional initiatives . . ." (emphasis added).[10]

This is not, however, to completely discount or dismiss the work of governments in space situational awareness. The Inter-Agency Space Debris Coordination Committee

[9] *See* Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, October 1967; and Convention on International Liability for Damage Caused by Outer Objects, September 1972.

[10] Towards Long-term Sustainability of Space Activities: Overcoming the Challenges of Space Debris, A Report of the International Interdisciplinary Congress on Space Debris," United Nations Committee on the Peaceful Uses of Outer Space Scientific and Technical Subcommittee, 48th Session, Vienna, 7-18 February 2011, A/AC.105/C.1/L.306, January 2011, 5.

(IADC), for example, an international governmental forum, has provided an important set of voluntary guidelines regarding the mitigation of man-made and natural debris in space.[11] The primary objectives of the IADC are to exchange information on space debris research activities between member national space agencies, to facilitate cooperation in space debris research, to review the progress of ongoing cooperative activities, and to identify debris mitigation options. Although important, the IADC's work is still only a set of guidelines for national regulators to consider.

Satellites can cost hundreds of millions of dollars and take up to three years to design, build, and launch into orbit. The exponential increase in the number of government and commercial operators in space, the meteoric rise in space debris, and the inability of the current legal regime to encourage practical solutions are perfect examples of how the "tragedy of the commons" is being replicated in earth orbit.[12]

Under the traditional tragedy of the commons scenario, independent actors deplete a shared, limited common resource until it is used up and no longer viable. Today, the valuable, but limited resource of near-earth orbit, is in some jeopardy of suffering "the tragedy of the commons" as a result of the significant increase in both space debris and RFI interference. As these threats multiply, so too does the risk to satellite operators, their significant financial investments, and likewise to the customers who depend on their services in both commercial and consumer markets.

There is a corollary to the "tragedy of the commons" referred to as the "tragedy of the anticommons." The "tragedy of the anticommons" is used to describe the situation where the existence of numerous rightsholders can also prevent the realization of a socially desirable outcome.[13] In orbit, it can be argued that the lack of proper, regular coordination on debris, conjunction analysis, and RFI mitigation prevent the full and most efficient use of orbital slots. Numerous national regulators have worked to create an interlocking mesh of distinct, national rights without any clear means to effectively arbitrate these rights when they come into conflict in the international arena. The current

[11] See: http://www.iadc-online.org. The IADC member agencies include the following: ASI (Agenzia Spaziale Italiana), CNES (Centre National d'Etudes Spatiales), CNSA (China National Space Administration), CSA (Canadian Space Agency), DLR (German Aerospace Center), ESA (European Space Agency), ISRO (Indian Space Research Organisation), JAXA (Japan Aerospace Exploration Agency), NASA (National Aeronautics and Space Administration), NSAU (National Space Agency of Ukraine), ROSCOSMOS (Russian Federal Space Agency), UKSpace (UK Space Agency).

[12] Concept first presented in the seminal article by Garrett Hardin, "The Tragedy of the Commons," *Science*, Vol. 162, No. 3859 (December 13, 1968). The tragedy of the commons posits the situation where rational individuals, acting in their own self-interest, may ultimately render a shared and limited resource unusable, even when it is clearly not in their interest to do so.

[13] *See* Heller, Michael, "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets," 111 Harv. L. Rev. 621 (1998).

international legal regime, anchored by the Outer Space Treaty, is insufficient to redress these conflicts, respond to the harm already done to the outer space environment, or encourage responsible behavior going forward. Furthermore, there is no mechanism in the current regime for the resolution of disputes among parties other than nation states. Accordingly, there are limited incentives for states-Parties to the regime to engage in practical cooperation in protection of this limited resource.

Overview of the Space Data Association

The SDA is a not-for-profit association dedicated to safe and responsible satellite operations, including the prevention of collisions in space and improving satellite communications. As a going concern, the SDA can be compared in many respects to a multilateral organization, where the principal members are commercial enterprises rather than nation-states. Commercial satellite operators have a very real and vested interest in maintaining the earth's orbit as a safe and reliable operating environment, and reversing current trends. In a recent article on the problem of space debris, *The Economist* noted, "What is needed is an international civil satellite-awareness system that would provide everyone from small governments to big businesses with the information they need to operate safely."[14] The SDA was created as a private sector initiative to address this very purpose and complement the work of nations by applying the considerable expertise of its members to the very real problems of conjunction analysis, radio-frequency interference, and orbital debris.

In some respects, the SDA functions as both a trade association and a multilateral joint venture. However, whereas the common purpose of a joint venture generally is to generate revenue for the partners, the purpose of the SDA is to protect the environment in which its members operate, and therefore, protect the ability of its members to generate revenue on an individual basis. As explained below, the SDA is not backed by equity, but rather by member guarantees and membership dues which support the organization's operations. Furthermore, unlike most trade associations, the primary focus of the SDA is operational, rather than legislative.

To this end, the SDA has developed the SDC, a secure, reliable completely automated analytical information system to address conjunction analysis and RFI mitigation, and improve upon the current methodology for management and analysis of each category. The SDC is the operational component of the SDA and its primary activity. It is the software system that has been created to allow members to share real-

[14] "Flying blind: The tragedy of the commons meets the final frontier," The Economist, Feb. 19, 2009.

time critical operational data essential to the better protection of their respective satellite fleets and management of the overall earth orbit environment. Analytical Graphics, Inc., a leading US software company focusing on spaceflight and national security, was selected to design, implement, and operate the SDC on behalf of the SDA. Satellite operator members of the SDA contribute operational data to the SDC through a secure web-based interface on a regular (daily) basis. This data is processed by in SDC to perform real time collision avoidance ("conjunction") and RFI analysis for SDA members' satellites. The greater the membership of the SDA, the more comprehensive the system, and the more accurate the analysis will be. A more detailed discussion of the SDC including permitted and prohibited uses is provided below.

Additional complementary services are being explored for future augmentations of the SDC. Membership in the SDA is open to all satellite operators. As new satellite operators continue to join the SDA, the SDC will be populated with more data, continually improving its reliability in all satellite arcs and developing the system into a truly global and comprehensive system for space situational awareness.

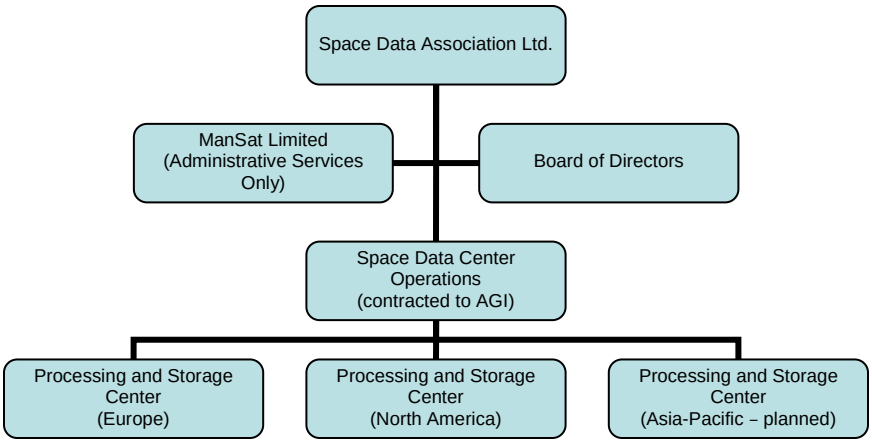
Incorporation and the Isle of Man

The Space Data Association is a private limited liability company incorporated in the Isle of Man as a non-profit entity. The company is backed by a limited guarantee from each of its members, rather than by shares. This arrangement makes the company easier to administer, as guarantees do not count as company assets and therefore do not have to be allotted, brought, and sold in the same manner as shares. Accordingly, new members in the SDA are not required to purchase shares. Correspondingly, existing members do not need to find someone to purchase shares of a departing member and that member's guarantee is terminated in accordance with the Articles of Association.

The Isle of Man is a self-governing British Crown Dependency, but not a member of the United Kingdom or the European Union. Historically a territory of Norway, and later Scotland in the Middle Ages, the island finally became an undisputed British territory in 1765, but remained internally self-governing, a status it continues to enjoy today. The Isle of Man has its own parliament (the Tynwald) which is the oldest continuous parliament in the world, its own common law, and own set of statutes and regulations. The island's legal system is highly regarded as a favorable corporate environment, and has become a well-established and sophisticated center of international business and finance.

In recent years, the Isle of Man has developed a niche in the commercial space sector, particularly as a global provider of financial and administrative support services for space commerce, with a particular focus on telecommunications.[15] Rather than focusing on a full-fledged, independent space program, the Manx Government focuses on providing a regulatory level playing field while cooperating with industry to provide financial, legal, and orbital slot filing assistance as well as strategic support services for telecommunications, aerospace, banking, and manufacturing companies within the international space industry.[16] The island has gone so far as to establish an Institute for International Space Commerce, and declare a zero tax rate for space enterprises.[17] Several major aerospace and satellite enterprises have established a presence on the Isle of Man, including SES S.A., the commercial satellite service provider and a founding member of the SDA, Excalibur Almaz, a private spaceflight company, and Odyssey Moon, a leading competitor in the Google Lunar X-Prize competition.

The island's legal system was considered to be very suitable for establishment of the SDA. Benefits of the Man corporate legal system include a fairly quick and straight-forward incorporation process, a zero tax rate for space companies, simplified financial reporting requirements, and the use of member guarantees rather than authorized or capital shares (the benefits of which have been discussed above).[18] On the island, the SDA has engaged ManSat Ltd., which provides administrative and related services.[19] A basic organizational overview chart of the SDA is provided below.



[15] Innovative Strategies for Space Competitiveness: Assessing the SpaceIsle's Policy and Results, 4 (Futron Corporation, February 1, 2011).
[16] *Id.* at 9.
[17] *See* Income Tax (Amendment) Act of 2006, Isle of Man (April 2006).
[18] *See* Companies Act of 1931, as amended, Isle of Man (2009).
[19] It is important to note that the SDA itself plans to have no full-time staff. Members have appointed representatives from their companies to provide project, technical, and legal support, as required. Operation of the Space Data Centre is performed by AGI, SDA's technology partner, on a 24 by 7 basis.

Membership Categories

The SDA has established three categories of membership under the Memorandum and Articles of Association. The first category, Executive Membership, is open to owners and operators of more than ten geosynchronous satellites in operation. This category reflects the SDA's initial focus on the geosynchronous arc at the time of its founding. The second category, Standard Membership, is open to owners and operators of at least one satellite, regardless of orbital arc, geosynchronous, low earth orbit, or medium earth orbit. The SDA has established a third category of membership, Associate Membership, which will be open to individuals, corporations, or organizations who "show genuine interest in the objectives of the [SDA's] objectives."[20] Each prospective Associate Member requires the approval of the Board of Directors. The SDA envisions that this category will be open, generally speaking, to research institutions, learned scholars, satellite-related businesses who neither own nor operate assets in space, non-governmental organizations, international trade associations, and international governmental organizations. Associate Members, who have no data to contribute, may be granted limited access to the SDC at the sole discretion of the Board. Accordingly, membership in the SDA does not automatically grant access to the SDC.

The affairs and priorities of the SDA are set by a Board of Directors. The Board is composed of Executive and Standard Members. Each Executive Member may appoint one director. The group of Standard Members may elect up to two directors, depending on the total number of Standard Members. The Board must have a minimum of two directors but has no set maximum. To further the objectives of the SDA, the Board has established working groups to address specific areas of importance including membership, flight safety, and Data Center operations.

Membership Rules, Use of the SDC, and Liability

Rules of membership in the SDA and SDC primarily address access to and usage of the SDC.[21] The SDA operates the SDC to provide a safe environment for conjunction analysis, the sharing of operational data and to facilitate EMI/RFI resolution, thereby allowing the satellite operators to enhance situational awareness, reduce interference and improve flight safety. SDA members contribute their data to the SDC which is then

[20] Memorandum and Articles of Association of Space Data Association Limited, as filed on 17 June 2010, Article 7.1

[21] It is important to note that the terms and conditions of the Space Data Centre are privileged and confidential to SDA members only. Therefore, only a general discussion of these rules will be undertaken in this article, with the permission of the SDA Board of Directors.

processed through the system to contribute to the provided services. As discussed above, Associate Member access to the SDC is reviewed on a case-by-case basis.

Members may access the SDC solely for the benefit of their own internal operations and only for expressly permitted uses according to the SDC Rules. Those uses include: (1) operational support, including safety of flight; (2) EMI/RFI resolution of actual harmful interference, including resolution of such issues in official proceedings before the ITU; (3) support for insurance underwriting policies; and (4) as legally required by the member's governing national regulatory authority to comply with conditions of their licenses or other lawful requests.

Access to the SDC and information generated to a member is limited, by both membership rules and system architecture and design to that member's specific satellites. Accordingly, a satellite operator whose fleet operates solely in the Latin American region, for example, will not be able to access data on incidents in the Middle East. This technical safeguard is designed to protect each member and use of the SDC from unauthorized purposes, as further explained below. If the purpose of the SDC is to ensure a safe and efficient space operating environment, there must be technical safeguards and express prohibitions against using the system either for one's own competitive advantage or to obstruct the regular business operations of another.

Unauthorized or prohibited uses of the SDC include: (1) any commercial purpose whatsoever, including, for example sales and marketing or competitive strategy planning; (2) securing orbital spectrum rights before the ITU or a national regulatory agency; (3) transmittal of SDC data to third parties, unless required to protect safety of flight operations in accordance with the above-listed permitted uses; (4) intentional interference with the operations of any member; and (5) any other use not expressly permitted by the SDC Rules. Any breach of the rules is considered to be a serious matter that has the potential to undermine the cooperative objectives of the SDA. Accordingly, the rules set forth severe liabilities for any breach of these rules whether the breach is member-to-member, or member-to-SDA.

It should be noted that whereas the international legal regime addresses liability for actual damage caused by nation states, the SDA's contractual liability regime is focused primarily on the use or misuse of SDC data by SDA members. SDA liability rules are designed to protect both the integrity of the system and the confidence of its members that their data will be used solely for the stated objectives of the Association. Both the SDA itself and SDA members have the right to enforce violations of the rules with regard to their own data (the SDA for Association data and members for their individual data),

in accordance with the terms and conditions of those rules and through arbitration on the Isle of Man in accordance with Manx law.

Conclusion/Summary

Earth orbit is no longer the exclusive province of government satellite systems. Commercial enterprise and consumer services make up the bulk of the usage of the space environment in the twenty first century. Consequently, a new approach to enhancing the safety and efficacy of the space environment is required to complement the groundwork established by nation states over fifty years ago. The Space Data Association is the first step on this path. By establishing an international cooperative organization that allows satellite operators to share real time data, we can address practical solutions to very real and very present issues.

It is the authors' hope that as more operators join the SDA, and other related activities proliferate -- such as the European Code of Conduct –that the international legal regime will begin to slowly address questions that currently remain unanswered. What is the duty of care of a satellite operator in earth orbit? Would membership in or abstention from an organization like the SDA be considered as prima facie proof of a satellite operator's conscientiousness or negligence, respectively? Would a satellite operator with access to SDC data who failed to take action be held liable for its lapse? How will the insurance markets view the SDA and its attempts to improve operational safety? We expect that these questions will be the subject of future debates, articles, and hopefully, a new set of industry best practices and voluntary but generally accepted norms of conduct observed by commercial and state operators alike.

# # #

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