

SERVICING SATELLITES ON-ORBIT BY AUTOMATION AND ROBOTICS: POTENTIAL LEGAL AND REGULATORY CONSIDERATIONS

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SECTION I INTRODUCTION

It has been contended,³...“Historically, satellites are lasting longer than projected. If a fuel replenishing capability existed, satellites could remain in orbit even longer. On the other hand, satellites become “outdated” soon after they have been placed into orbit because of rapid technological advances”. This assertion refers to related activity where for instance previous manned missions of the US space shuttle dating back to 1984, demonstrated the possibility of retrieving the Westar 6 and Palapa B-2 satellites, or salvaging the Intelsat 603 in 1992. Activity of this kind, re-invent a perennial debate borne out of the revolutionary development and simultaneously increasing involvement of private entities in space activities, within the framework of international law, international principles, international regulations, and national laws, all applicable to space activity.

A debate which poses the fundamental question⁴ whether the family of aforementioned international instruments adequately balance the various interests in outer space and space activities. The purpose of this paper is not to engage in this perennial debate, or attempt to provide solutions to the current state of affairs. This paper will discuss the potential legal and regulatory considerations, which may arise from automated or robotic on-orbit servicing⁵ (“OOS” hereinafter) by private entities, of civilian and commercially oriented satellites, within the said framework. Consequently, Section 2 (two) presents hypothetical scenarios simulating the provision of on-orbit services to civilian, commercially oriented satellites, Section 3 (three) discusses the legal and regulatory considerations, whilst Section four (four) concludes the paper.

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² The views expressed herein are those of the author and do not, nor intend to, reflect the views of Inmarsat Limited.

³ Smith Y.: *2025 Aerospace Replenishment: The insidious force multiplier*. Published in *Air force 2025 USAF Ed*, 1996.

⁴ Von der Dunk F.G.: *Public space and private enterprise – The Fitness of International Space Law instruments for private space activities*, published in *Proceedings of the Project 2001 – Workshop on Legal Issues of Privatising Space Activities*, 19 July 1999, Vienna Austria at page 12.

⁵ It has been contended that 3 (three) distinctive classes of on-orbit services can be performed, *viz*: Motion; Manipulation; and Observation. These 3 (three) classes may further involve various specific services including: re-orbiting; de-orbiting; salvage; maintenance; repair; retrofit; docked inspection; and remote inspection. See Generally: Kreisel J.: *On-Orbit Servicing of Satellites (OOS): Its Potential Market Impact*, 1st Bilateral DLR-CSA Workshop on On-Orbit Servicing of Space Infrastructure Elements via Automation & Robotics Technologies, 25-26 November 2002, Cologne Germany.

SECTION II THE HYPOTHESIS

TABLE 1⁶

STATUS OF SATELLITE	ON-ORBIT SERVICE PROVIDED
End of Satellite mission lifetime due to fuel/propellant depletion. All systems operational.	Re-fuelling <i>in situ</i> to extend satellite mission lifetime.
Total or partial failure of satellite mission due to defective deployment of hardware.	Repair or replacement of failed/malfunctioning part.
Erroneous injection of satellite due to launch vehicle malfunction. Satellite in nominal condition.	Re-boost satellite to transfer/operational orbit.
Extension of satellite lifetime not worthwhile. Threat to other space assets and/or earth.	De-orbit satellite.

SECTION III LEGAL AND REGULATORY CONSIDERATIONS

3.1 Prior Authorization and Licensing

The Outer Space Treaty of 1967⁷ makes provision, in its Articles VI⁸ and VII⁹ respectively, for the responsibility and liability of States for space activities. Specifically, Article VI imposes responsibility on States Parties to the Treaty to ensure that any space activity carried out by government agencies or non-governmental entities is performed safely and in conformity with the Outer Space Treaty and existing regulations of that State. Space activities performed by non-governmental entities are also subject to continual supervision by that State Party. Consequently, in case OOS activities are conducted by private commercial entities, it would be the responsibility of a State(s) Party to the Treaty to ensure that any such activity is performed in compliance with the provisions of the Outer Space Treaty and, hence according to Article III¹⁰, with international law. Therefore before any OOS activity can take place, the commercial entity wishing to perform such operations would have to fulfil any Outer Space Treaty requirements as well as other requirements established by the State Party to the Outer Space Treaty responsible for the activities of that commercial entity. One writer¹¹ recommends that amongst the most important would be the receipt of prior authorization (also referred to as a license or permit¹²).

⁶ Table adapted from: International Space University, *Open for Business: A new approach to commercialisation of the ISS*, Master of Space Studies, Design Project, 1999 at page 133.

⁷ *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies*, adopted on 19 December 1966, opened for signature on 27 January 1967, entered into force on 10 October 1967.

⁸ Provides that: "States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization".

⁹ Provides that: "Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air or in outer space, including the moon and other celestial bodies".

¹⁰ Provides that: "States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding".

¹¹ See: Jasentuliyana N.: Regulation of Space Salvage Operations: Possibilities for the Future, *Journal of Space Law*, Volume 22, No. 1 & 2, 1994 at pages 5 to 21.

¹² See Meredith P. and Robinson G.S.: *Space Law: A case study for the Practitioner - Implementing a Telecommunications Satellite Business Concept*, Martinus Nijhoff Publishers, 1992 at page 42. (Meredith and Robinson).

3.2 Liability and Risk Mitigation

The hypothetical scenarios listed in Table 1 (one) above, pre-suppose that OOS when construed in its simplest form, would give rise to a contractual relationship involving the provision (OOS service provider) of a service, to an operator (customer) of a satellite, in need of servicing. In other words the relationship agreed upon would be governed by a service contract. As with any other commercial arrangement, the parties thereto should necessarily be able to, with a degree of certainty, predict, limit and insure against the burden of civil liability, which can result from the failure of the product or “negligence” in the services provided. This assertion can be further justified as contemporary business practice dictates that, persons or entities providing negligent services or participating in the placement of “defective products” in the stream of commerce become exposed to civil liability for damages which result from the services negligently performed, or from the product defect¹³. This form of liability is synonymous with “first party liability” which may be assumed by the OOS service provider with respect to damages incurable by a customer. Likewise, in the course of conducting servicing operations on-orbit, damages caused by the OOS service provider may result in “third party liability” for injuries suffered by owners of other spacecraft.

The risks of damage and liability are traditionally allocated contractually, or otherwise to all the parties involved in the transaction. To date, the commercial space industry has developed innovative practices in managing these risks¹⁴ (usually in the form of tightly worded contracts and insurance cover) albeit within the framework of the Liability Convention of 1972¹⁵, which imposes international liability for third party damage caused by space objects authorized by States Parties to the Treaty. Amongst other things, innovation will be a key element in the contractual terms and conditions to be agreed upon in contracts for the provision of OOS services, alongside the possible inclusion of potential OOS's within existing on-orbit insurance policies¹⁶.

3.3 Dispute Settlement

It has been contended¹⁷ that although the Outer Space Treaty in its Article IX does not provide much guidance on the question of how States should settle disputes concerning the application of the Treaty, the Liability Convention does indeed contain some provisions on dispute settlement. Consequently, if no settlement of a claim is arrived at through diplomatic negotiations as provided for in Article XI of the Liability Convention, at the request of either party a Claims Commission (“CC”) has to be established. Articles XV to XVII deal with the details of the appointment and the procedure of this CC in a similar way, as it is known from international arbitration. Article XVIII provides that the CC shall decide the merits of the claims for compensation and determine the amount of compensation payable, if any. The decision remains binding only if both parties agree. Bearing the above in mind, it has further

¹³ Spada M.: *Quality control in production of space objects and liability in outer space law*, published in: *Outlook on space law over the next 30 years*, Kluwer Law International, Eds. Lafferranderie G., Crowther D. at page 191 to 199.

¹⁴ See further Meredith and Robinson: note 12 *supra* at pages 249 to 302; 335 to 336.

¹⁵ *Convention on International Liability for Damage Caused by Space Objects* adopted on 29 November 1971, opened for signature on 29 March 1972, entered into force on 1 September 1972.

¹⁶ In-Orbit Insurance commences after a satellite reaches orbit, completes the initial functionality testing, and actual operation begins. The life expectancy of a satellite is approximately 10 years and ends when the satellite's fuel cell depletes. In-Orbit Coverage protects against the risk of a complete or partial failure of the satellite while operating in space. The owner or operator of the satellite is the insured, and the cover is usually a 1-year renewable policies.

¹⁷ Bockstiegel K. *The Settlement of Disputes regarding space activities after 30 years of the Outer Space Treaty*, published in: *Outlook on space law over the next 30 years*, Kluwer Law International, Eds. Lafferranderie G., Crowther D. at page 237 to 249.

been argued¹⁸ that in a relative perspective, dispute settlement plays a greater role for private enterprises than for State institutions, because private enterprises do not have available diplomatic and political means and because private enterprises rely much on calculating the exposure to costs and risks on the fulfilment of contractual obligations and, if necessary, on the enforcement for the other party to fulfil the contract or pay damages. Thus the basic option available to private enterprises (and impliedly, entities wishing to conduct OOS activity) is that between adjudication by State courts and arbitration. While adjudication by courts is available without any specific agreement between the parties, arbitration is only mandatory if chosen by the parties in an arbitration agreement or in an arbitration clause in the contract.

3.4 Protection of Intellectual Property Rights¹⁹

Intellectual Property Rights (IPR), defined within the provisions of Article 2 of the Convention establishing the World Intellectual Property Organisation²⁰, include...*"the rights relating to: literary, artistic and scientific works; performances of performing artists, phonograms, and broadcasts; inventions in all fields of human endeavour; scientific discoveries; industrial designs; trademarks, service marks, and commercial names and designations; protection against unfair competition; and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields"*. An IPR is the right to forbid third party exploitation, or to allow the exploitation by license on terms dictated by the registered IPR owner or his/her designated successor. The filed instruments, such as the claims of a patent, define the scope of IPR protection. The geographical scope of the protection is that of the territory of the State, which has registered the IPR. IPR's have limited lifetimes (e.g. twenty years after the filing date for patents) and possess the dual nature of being both national and international.

In the international context, a patent may not be granted on an invention which had been previously disclosed (perhaps by publication) anywhere in the world. Moreover, a single patent application filed in one country may obtain patents in many countries under certain international treaties and conventions. This dual nature of patent protection, is nowhere more apparent than in the area of protecting inventions made or used in outer space, bearing in mind the fact that an act of invention is made up of two parts *viz*: (1) the complete idea of how to solve the problem; and (2) the building of a working model that actually carries out the solution. Particular problems and questions would arise for inventions made or used in outer space especially because they must be posed within the scope of the two major systems for the protection of IPR's worldwide, traditionally referred to as the 'first to file'²¹ and 'first to invent'²² systems²³. For instance there may not be the presumption that a space experiment, designed and tested successfully on the ground will work exactly as expected in space. Thus under the 'first to invent' system, in the context of OOS related activity, in the event that specific OOS hardware and procedures work or perform as expected in space, would such hardware and procedures be considered as inventions made in space, or were they completed inventions when they were successfully tested on the ground.

¹⁸ *Id.*

¹⁹ See generally: Tramposch A.: *International Aspects of Protection of Inventions Made or Used in Outer Space*, published in Proceedings of the Workshop - *Intellectual Property Rights and space activities A worldwide perspective*, 5 & 6 December 1994, ESA Headquarters, Paris at pages 187 to 197. ("Tramposch" hereinafter).

²⁰ Signed at Stockholm on July 14, 1967 and as amended on September 28, 1979.

²¹ Under this system, the invention belongs to the first inventor who files a patent application, irrespective of the time or place of invention.

²² Under this system the time and place of invention are critical.

²³ For a detailed comparison of the 'first to file' and 'first to invent' systems see: Tramposch, note 18 *supra*.

3.5 Compliance with Debris mitigation Standards and Regulations²⁴

On the issue of compliance with debris mitigation standards and regulations, the hypothesis stated in Table 1, confronts one with a debate currently in a state of flux, within an embryonic international legal and regulatory framework. On the one hand, OOS activity desirous of extending the lifetime of satellites would probably serve to reduce the number of derelict or abandoned spacecraft in orbit. Conversely, in the event that such activity is geared at de-orbiting a satellite, with the attendant possibility of creating debris, capable of causing damage to third parties in outer space or on the surface of the earth, a private entity wishing to engage in commercial OOS related activity would necessarily need to bear in mind, and perhaps comply (as appropriate) with the international legal and regulatory obligations²⁵ placed upon the State that authorizes, licenses or permits it to conduct such activity.

4.1 Efficient use of the geostationary orbit and frequency spectrum

OOS envisages the lengthening of the operational lifetime of satellites in orbit. There are several orbits from where a satellite system can operate. The geostationary satellite orbit ("GSO") is the most used orbit. Furthermore, satellites rely on radio frequencies (radio waves), the use of which is regulated by the International Telecommunications Union ("ITU"). It must be noted that the GSO and radio frequency spectrum have always been regarded as a limited natural resource. Therefore the conduct of OOS activity will necessarily require adherence, by any licensed or authorized private entity, with the general legal principles applicable to international management of radio frequencies and the GSO positions as set forth in the provisions of Article 44, paragraph 2 (formerly Article 33 paragraph 2) of the 1994 ITU Constitution as amended by the 1998 ITU Plenipotentiary Conference.

That Article specifies: *"In using frequency bands for radio services, Member States shall bear in mind that radio frequencies and any associated orbits, including the geostationary-satellite orbit, are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies taking into account the special needs of the developing countries and the geographical situation of particular countries."* It has been stated²⁶ that though Article 44(2) emphasizes the obligation to use the spectrum/orbit resource "efficiently" and "economically", it does not define the said terms. Therefore it is left to the discretion of each ITU Member State to interpret what is efficient and economic. This discretion will most certainly apply and would require careful consideration when taking steps to embark on commercially oriented OOS related activity.

²⁴ See: Brisibe T. and Pessoa-Lopes I.: *The impact of orbital debris on Commercial Space System*, Proceedings of the Colloquium of the International Institute for Space Law, 52nd IAF Congress, 2001, Toulouse, France.

²⁵ In practice, applicable regulations, policies and standards have evolved in a heterogeneous fashion, giving rise to a patchwork of national and intergovernmental rules. Of note are the national regulations, policies and standards of the United States of America ("U.S."). U.S. Government Orbital Debris Mitigation Standard practices developed in 1997, aimed at limiting orbital debris generation by launch vehicle upper stages. The standards are applicable to U.S. Orbital stages (Athena, BA-2, Centaur, Delta, Boeing Inertial, Minotaur, Pegasus, Taurus and Titan). They were also applied to the re-entry of the Compton Gamma Ray Observatory on 4th June 2000; The Federal Republic of Russia ("Russia"). See the Russian Federation Law on Space Activity of 1993; and the member States of the European Space Agency ("ESA"). See the Resolution for a European Policy on the Protection of the space environment from Debris. Adopted by the Council of the ESA on 20 December 2000 ("ESA Resolution"); and the Draft European Space Debris Safety and Mitigation Standard; See also the non-binding Draft International Instrument on the Protection of the Environment from Damage Caused by Space Debris at: <http://www.uni-koeln.de/jur-fak/instluft/draft3.html>.

²⁶ Jakhu R.S., and Serrano V.R.: *International Regulation of Radio Frequencies for Space Services*, published in *Proceedings of the Project 2001 Workshop on Telecommunication* 8/9 June 2000, Berlin, Germany, at page 72.

SECTION IV CONCLUSION

The successful deployment of any commercial space project does not depend solely on the technical capability of the system and the attractiveness of the commercial proposal. Thus, the servicing of satellites on-orbit by robotic and/or automated means would also need to address a number of complex but not necessarily insurmountable legal and regulatory considerations. The provision of legal opinions, performance of legal and regulatory audits, appropriate insurance cover, cumulated with an aggressive public policy involvement strategy, may bring solutions.