

Transparency and Security Assurances for Commercial NewSpace On-Orbit Servicing

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Abstract

News coverage of the space industry announces a new space company, project, or mission every few weeks, each one bolder and more ambitious than the last. The population of private commercial and governmental satellites that might be commercially serviced for profit illustrates one such intriguing and potentially lucrative market opportunity. Commercial satellite servicing, the for-profit ranging and proximity space operations to service, upgrade, refuel, or otherwise prolong the profitable operational lifespan of space assets, or to remove them from valuable orbits, raises significant and unsolved international legal, political, and security concerns. Recent operations by some states, widely covered by the international media, highlight the controversial and unresolved implications of satellite servicing. The dual-use nature of space technology again comes to the foreground amongst states tasked with the licensing, authorization, and continual supervision of national space activities, and whose international treaty obligations require their adherence to a wide body of international law. To circumvent mistrust and misperceptions, and to prevent the escalation of tensions between states, what practices should satellite servicing operators and their national supervisors institute and observe? This paper will discuss and critically analyze the political and legal challenges to the responsible commercialization of satellite servicing – specifically, the necessity of transparency and security assurances for satellite servicing, what legal regimes already exist, and what principles and procedures are needed for this emerging and potentially lucrative NewSpace business.

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1. Introduction

News coverage of the space industry seems to announce a new space company or project every few weeks, each one bolder and more ambitious than the last. Technological innovations like miniaturization and standardization drive down costs and make space activities accessible to a wider field of potential actors. Meanwhile, private capital and the Silicon Valley mindset of pursuing disruptive evolutionary technologies encourage ever more ambitious ventures. The large satellite communications industry has historically been one of the most lucrative fields of space activities, and the population of private commercial and governmental satellites that might be commercially serviced for profit is an intriguing and potentially lucrative NewSpace market opportunity.

Satellite servicing has been eagerly discussed in recent years, and this activity might offer a number of different commercial opportunities. Satellite servicing, also called on-orbit servicing (OOS), includes refueling satellites to prolong their operational lifespan, or repairing and refurbishing satellites on-orbit. End-of-life operations include moving the satellite to a safer and less-valuable “graveyard” orbit, or safely de-orbiting the satellite. A 2010 NASA Goddard Space Flight Center study examined the potential market of satellite servicing, dispelling myths and asserting that there are plenty of satellites to be serviced, that servicing can be done in a cost-effective manner, and that servicing can even be performed on satellites not designed to be serviced.³

While different views exist as to the market opportunities of these activities, not much has been said related to another major aspect of satellite servicing, whether commercial or otherwise. The geopolitical context of satellite servicing must be a major component of any understanding of its commercial viability. The military and political nature of operations in space involving rendezvous and proximity operations (RPO) on satellites, including satellites not designed or anticipated to be interacted with once placed in orbit, are significant. Additionally, the law and policy issues are complicated and solutions are far from agreed-upon.

Neither the satellites flown by states nor by private industry have defensive capabilities against physical attack. It is easy to imagine threats to vulnerable satellites, and they include everything from space-based weapons, such as “spacemines,” theorized to be able to maneuver near a satellite and explode,⁴ to more sophisticated satellite maneuvers that can disrupt or disable normal operations in space. News sources have used terms like “satellite catcher,”⁵ and “satellite killer”⁶ to describe the activity considered here. The danger is amplified if we consider how

³ National Aeronautics and Space Administration – Goddard Space Flight Center, Satellite Servicing Capabilities Office, *On-Orbit Satellite Servicing Study Project Report*, Oct. 2010, pgs. 27-32; Available at: <http://1.usa.gov/1vA316m>. See also International Space University, 2014 Space Studies Program, *Team Project AMOOS (Autonomous Mission for On-Orbit Servicing) – Final Report*; Available at: <http://bit.ly/1Ms2DD5>.

⁴ Space Security Index 2014, Oct. 2014, pg. 77; Available at: www.spacesecurityindex.org.

⁵ Paul Rincon, *Russian Tests “Satellite Catcher”*, BBC News–Science & Environment, 20 Nov. 2014; Available at: <http://bbc.in/1vvnUIL>.

⁶ Terrence McCoy, *A Mysterious Russian Space Object Could be the Return of the “Satellite Killer”*, Washington Post, 18 Nov. 2014; Available at: <http://wapo.st/1DyRzzP>.

critical space assets are to terrestrial military operations, and that ranging and proximity operations have the ability to be a force-leveler between militaries. Equally at risk are the peaceful uses of outer space, such as Earth observation, position, navigation, and timing (PNT) services, and commercial telecommunications. These services underpin the infrastructure supporting the daily lives of millions.

As with most space technologies, satellite servicing capabilities are dual-use. A private space company selling satellite refueling missions to a large satellite operator sounds peaceful, but what if the satellite servicing company is willing to sell their services to whomever is paying? Moreover, what if the underlying technology and hardware to perform satellite servicing is made available to the buyer? Clearly, satellite servicing has the potential to directly impact geopolitical stability, and efforts must be made to ensure conflict prevention in outer space.

To show the geopolitical climate that NewSpace satellite servicing will be subject to, this paper will briefly detail developments from around the world, including the scrutiny given to a Russian governmental mission in 2014. It will then discuss the existing legal framework for satellite servicing, along with gaps in regulation. Lastly, it will make a few normative statements on a feasible path towards politically-sustainable satellite servicing.

2. Governmental and Commercial Developments

Both civil and military agencies from around the world have investigated developing capabilities akin to satellite servicing. In the United States, the ViviSat program worked to develop advanced on-orbit capabilities. ViviSat's Mission Extension Vehicle (MEV) is geared towards working in Geostationary Orbit (GEO) at 35,786 km (22,237 miles) above Earth's equator, providing attitude or stationkeeping assistance and refueling services.⁷ DARPA, the Defense Advance Research Projects Agency, involved in OrbitalExpress since 2007, demonstrated satellite servicing technologies, and in recent years has been working on Phoenix for on-orbit satellite manufacturing.⁸ The US Air Force XS-II program, and Microsatellite Technology Experiment (MiTex) are similarly ambitious programs.

NASA has a Satellite Servicing Capabilities Office (SSCO) at its Goddard Space Flight Center in Greenbelt, Maryland. The SSCO is actively developing robotic on-orbit technologies to refuel, repair, and relocate satellites in low and medium Earth orbits. NASA's Demonstration of Autonomous Rendezvous Technology (DART) program also investigated and tested spacecraft ranging and proximity operations, but was less successful.⁹ It is worth noting that government-led programs aimed at governmental satellites are not subject to commercial market pressures like profitability, an aspect of their operations that may aid their technological development.

⁷ ViviSat, Satellite Life Extension Services; Available at: http://www.vivisat.com/?page_id=10.

⁸ Manny Leinz, *Fostering Sustainable Satellite Servicing Orbital Express Program Summary*, Secure World Foundation, 26 June 2012; Available at: http://swfound.org/media/87149/Leinz-Orbital_Express_Summary.pdf.

⁹ NASA Engineering and Safety Center Report, *NESC Review of Demonstration of Autonomous Rendezvous Technology (DART) Mission Mishap Investigation Board Review (MIB)*; Available at: www.nasa.gov/pdf/167813main_RP-06-119_05-020-E_DART_Report_Final_Dec_27.pdf.

Meanwhile in Europe, the German Aerospace Center (DLR) has been developing DEOS, the *Deutsche Orbitale Servicing Mission*.¹⁰ In Switzerland, CleanSpaceOne is developing the technology for cleaning debris in low-Earth orbit, which has many of the same concerns as satellite servicing. Sweden's Prisma mission, with twin satellites Mango and Tango are another example of European interest in advanced satellite capabilities.

In summary, many actors, including states, private companies, and even universities are working alone and together to develop satellite servicing, both as a commercial venture and as a state capability. Demonstration missions are being planned, technologies are being developed, and hardware is being built. As such, the time is ripe to consider the legal and political implications of this activity.

3. Kosmos-2499

Located hundreds of kilometers north of Moscow at 62.8° latitude, the Plesetsk Cosmodrome was once the Soviet Union's busiest spaceport. Established in 1957, Plesetsk is well-situated for launching satellites into polar, highly-elliptical molniya orbits. In May 2014, a seemingly routine launch of three communications satellites, catalogued as *Kosmos-2496*, *Kosmos-2497*, and *Kosmos-2498*, into an existing communications constellation developed into an intriguing narrative followed closely around the world.¹¹

Before long, the launch began to receive heightened interest from the amateur community, which had been tracking the launch. They began discussing that possibility that an object they first considered launch debris seemingly began to maneuver and slowly change its orbit. RussianSpaceWeb.com and Zarya.info, both amateur-run websites following Russian space activities, compiled the alleged details of this mysterious space object, roughly 0.3 meters in size, designated *Kosmos-2499* by Russia.¹² According to data compiled from the public Space Track catalog maintained by the U.S. military, *Kosmos-2499* lowered its orbital perigee from 1,500 km during the months of July and August to approach the 1,150 km altitude of the upper stage of the Briz-KM rocket that placed it in orbit.¹³ By the end of August, *Kosmos-2499*'s perigee was just above 900 km.¹⁴ This activity was presumably a demonstration of the object's ability to perform rendezvous maneuvers, and potentially on-orbit inspection. The Zarya.info website characterized *Kosmos-2499*'s activities:

“Small satellite with orbit changing capability. Possibly, but speculatively, an inspector satellite with its own Briz-KM rocket body (2014-028D/39764) as a

¹⁰ Deutsches Zentrum für Luft- und Raumfahrt e.V. (German Aerospace Center), *DEOS - Deutsche Orbitale Servicing Mission*; Available at: http://www.dlr.de/rd/en/desktopdefault.aspx/tabid-2266/3398_read-36724/.

¹¹ Russian naming conventions including using “Kosmos” and then a four digit designation for their national security payloads, analogous to “USA” and a three digit designation used in the United States of America.

¹² Russian Space Web, *Kosmos-2499: Is it a Spy or an Assassin... or Both?*; Available at: <http://bit.ly/1DZllhF>. Zarya.info, *Launches to Orbit and Beyond*, <http://bit.ly/1v7DGap>.

¹³ Ibid, caption 2.

¹⁴ Ibid, caption 2.

target. Detected by US tracking sensors and originally catalogued as debris, it was not included in early announcements of the launch. Early 2014 July – started a series of manoeuvres to reduce the separation in orbit planes between itself and the Briz-KM. 2014 November 8/9 it matched planes with the rocket and manoeuvred alongside it, co-orbiting within a few tens of metres. The experiment may then have been complete because, as of 2014 Dec 1, the satellite began identifying itself as amateur radio satellite Radio Sputnik-47 (RS-47). The amateur radio equipment was probably fitted as a secondary payload.”¹⁵

By November 2014, western news sources had picked up the story. The Financial Times, Washington Post, and the BBC brought a wider audience to reflect on the alleged activities of *Kosmos-2499*, ominously renamed “Object 2014-28E” or simply “Object E.”¹⁶

However, Russia had adhered to the usual international practices for the notification of launched space objects with an international registry, as kept by the United Nations Office for Outer Space Affairs (UNOOSA). A party to both the 1967 Outer Space Treaty and the 1975 Registration Convention (which makes international notification mandatory *via* Art. IV), Russia furnished a *note verbale* to UNOOSA on 12 August 2014 in conformity with the Registration Convention.¹⁷ The 24 May 2014 launch’s listed function is “intended for assignments on behalf of the Ministry of Defense of the Russian Federation.”¹⁸ However, as of the time of this writing, OOSA has the *note verbale* from Russia, but has not posted it on the website, stating “[t]he document for this registration submission is presently being processed by the United Nations Secretariat.”¹⁹ Additionally, Object E’s alleged activities involve only another Russian space object, the Briz-KM upper stage it was launched with.

The development of this story is included in this paper not as evidence of Russian actions related to its 24 May 2014 launch, but of the considerable attention given to the alleged actions by others, including the media, academics, and pundits interested in its geopolitical context and

¹⁵ Zarya.info, *see* footnote 12 above. It is also important to note that the US military originally catalogued it as debris. There is no evidence that that Russia said it was debris.

¹⁶ Terrence McCoy, *A Mysterious Russian Space Object Could be the Return of the “Satellite Killer”*, Washington Post, 18 Nov. 2014; Available at: <http://wapo.st/1DyRzzP>. Sam Jones, *Object 2014-28E – Space Junk or Russian Satellite Killer?*, Financial Times, 17 Nov. 2014; Available at: <http://on.ft.com/1BgG68I>. Paul Rincon, *Russian Tests ‘Satellite Catcher’*, BBC News – Science & Environment, 20 Nov. 2014; Available at: <http://bbc.in/1vvnUIL>.

¹⁷ Russian Federation, *Information Furnished in Conformity with the Convention on Registration of Objects Launched into Outer Space*, 12 Aug. 2014, ST/SG/SER.E/728; Available at: <http://www.unoosa.org/oosa/en/Reports/docsr.html>.

¹⁸ OOSA maintains an online searchable database of notifications by Member States; Available at: <http://www.unoosa.org/oosa/showSearch.do>. To find info on this launch, select “State/Organization: Russian Federation (including USSR)”; “Date of Launch: 05/2014”; and “Place of Launch: Plesetsk Cosmodrome, Russian Federation.” However, OOSA states that ST/SG/SER.E/728 (2014) is “a registration submission that is currently being processed by the United Nations Secretariat” at <http://www.unoosa.org/oosa/en/Reports/docsr.html>.

¹⁹ *Ibid*, OOSA website last visited 16 Feb. 2015.

implications.²⁰ Observers have even used provocative and escalatory language, calling *Kosmos-2499* an Anti-Satellite (ASAT) weapon, and even a “satellite killer.” Readers can consider what reception future satellite servicing missions might receive.

For non-technical commentators (such as space lawyers), two salient points emerge from the story above. If true, the story demonstrates that Object 2014-28E took months to slowly change orbits, as both it and the object intended for rendezvous were hundreds of kilometers apart in altitude in their orbital planes, and both travelling at significant speeds along their orbital path. This implies that some ranging and rendezvous component of satellite servicing is a gradual activity taking place over weeks or months. Conversely, the NASA DART mission reached its target satellite in a few hours. Second, the activity was tracked by interested observers, perhaps demonstrating the difficulty faced by any state to hide its space activity. In summary, the story demonstrates the attention given to on-orbit activities resembling satellite servicing, even as between a single government launching state and its own space objects.

4. Balancing Rights and Obligations in Space Law

Despite subsequent characterizations, the 1967 Outer Space Treaty was originally a security treaty, negotiated between Cold War superpowers.²¹ Like any treaty, it balances rights and obligations between states. While a general principle of public international law can be paraphrased as “that which is not explicitly prohibited is permitted,”²² states enter into treaties because treaties explicitly enumerate, define, and delimit internationally binding rights and obligations, providing clarity and predictability between actors. Furthermore, the deep structure of international law is built upon national self-interest and international obligation, working together through treaties to maximize positive outcomes for states. States enter into and observe treaties because treaties conform with their long-term self-interests by reciprocally imposing obligations upon themselves.²³

In space law, the 1967 Outer Space Treaty makes it explicit that states have a right to freely access, use, and explore outer space.²⁴ These broad encouragements to freely access, explore, and use space are carefully balanced with obligations placed upon states. These

²⁰ See also Michael Listner & Joan Johnson-Freese, *Object 2014-28E: Benign or Malignant?*, Space News, 8 Dec. 2014; Available at: <http://bit.ly/1AT4cFo>.

²¹ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 27 Jan 1967; 18 U.S.T. 2410, 610 U.N.T.S. 205; [hereinafter Outer Space Treaty].

²² Both as a general principle of public international law, and as customary rule of public international law as elucidated and examined in the P.C.I.J.’s *Lotus* case.

²³ Jens David Ohlin, *The Assault on International Law*, Oxford University Press, 2015, especially Chapter 4 “Solving the Prisoner’s Dilemma of International Law”.

²⁴ The full title of the Outer Space Treaty makes this clear: Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies [emphasis mine]. It can be argued that the conventional shortening of the title into simply “the Outer Space Treaty”, which removes the word “use”, aids brevity but obfuscates the sovereign and explicit right to use outer space, including the right to use the Moon, and the right to use other celestial bodies.

obligations may be positive obligations, requiring states to undertake certain actions. Or they may be negative obligations, requiring actors to refrain from taking certain actions.

Positive obligations requiring positive action include the obligations for states to oversee national activities for conformity with international law, assume international responsibility for national activities (and international liability for cognizable damage), render assistance to foreign astronauts in distress, and return space objects landing in their territory. Conversely, the treaty contains negative obligations (prohibitions), which require states to refrain from taking certain actions. A major prohibition is listed in the first sentence of Article IV of the Outer Space Treaty:

“States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.”

This explicit prohibition, forbidding certain actions, bolsters the argument that the treaty is security-minded in nature. This prohibition is coupled with an admonishment to states, contained in Article III, that all space activities be carried out in accordance with international law, and in the interest of maintaining international peace and security.

It must also be considered that the establishment of rights in space law consequently creates matching but unstated prohibitions. For example, the right to freely access, explore, and use outer space thereby places upon other states a corresponding negative obligation. Namely, a prohibition against restricting another state’s right to access, explore, and use space. Remembering these fundamental rights and obligations held by states will be crucial in addressing the novel phenomena of satellite servicing and related activities.²⁵

5. Satellite Servicing under International Space Law

All space activities, including satellite servicing, exist under the interconnected web of rights and obligations discussed above. Space law creates further rights and obligations applicable to satellite servicing, including state jurisdiction over its launched and registered space objects, persistent international responsibility and potential liability, obligations to give due regard to the corresponding interests of other states, and related obligations. A state’s international treaty obligations under space law are of great relevance to any commercial space actions, whether done by NewSpace companies or traditional aerospace firms, because of the unique relationship in space law between a state and its non-governmental space actors. According to Article VI of the Outer Space Treaty, states are the sole and ultimate entity responsible for national activities, whether those activities are conducted by the government itself, or by non-governmental entities such as private corporations. States are also tasked with authorizing and supervising the activities

²⁵ It is also crucial to remember that the *lex specialis* of space law exists within the framework of *lex generalis*, namely public international law, including the UN Charter, and the conflict of laws principle *lex specialis derogat legi generali* “special law repeals general law.”

of non-governmental entities for conformity with the treaty. Consequently, the requirements placed on states under space law also apply to companies, including any commercial satellite servicing companies..

National Registration and Jurisdiction

The Outer Space Treaty creates the right for states to assert jurisdiction and control over space objects they launch and subsequently list on their own national space registry.²⁶ For states party to it, the 1975 Registration Convention makes registration mandatory, with a positive obligation on states to 1) register the space object with the international registry maintained by the United Nations;²⁷ and 2) establish their own national space registry.²⁸ Prior to this, international registration was merely encouraged by the United Nations General Assembly (UNGA) Resolution 1721 (B)(XVII).²⁹

Incentivized by Article VIII of the Outer Space Treaty, the right to assert jurisdiction over a space object creates an aspect of state sovereignty in an area explicitly devoid of state sovereignty (as prohibited by Article II of the Outer Space Treaty). It is sometimes forgotten that the national registry is the avenue to assert jurisdiction, while the international registry is a measure to alert the rest of the world of your space activities, and to give notice as to which state is responsible and liable. This international registration, done pursuant to UNGA Res. 1721, can be seen as an early and successful example of transparency and confidence-building measures (TCBMs) in outer space, and should be remembered when considering future space activities such as satellite servicing.

The key insight is that satellites to be serviced, and spacecraft doing the servicing, are under the jurisdiction and control of the state considered their registering state. This is true regardless of whether they are governmental space activities, or activities done by private entities such as corporations. They are under the legislative, judicial, and enforcement jurisdiction of the state registering their space objects.

International Responsibility and Persistent Potential Liability

The positive obligation of continuing international responsibility is created in Article VI of the Outer Space Treaty, with potential international liability for damage as a corollary obligation created in Article VII. This responsibility is the obligation placed on states to ensure that their national activities related to space are conducted in conformity with international law, including the Outer Space Treaty, related UN treaties on space, the UN Charter, and other valid and applicable sources of law – such as other international conventions and treaties, international customary law, and the general principles of international law. Activities of non-governmental

²⁶ Outer Space Treaty, Article VIII.

²⁷ Convention on Registration of Objects Launched into Outer Space, 28 U.S.T. 695, 1023 U.N.T.S. 15, Article II and IV [hereinafter Registration Convention].

²⁸ Registration Convention, Article II.

²⁹ International Cooperation in the Peaceful Uses of Outer Space, G.A. Res. 1721 A and B (XVII) (20 Dec. 1961).

entities, such as corporations and universities, require state authorization and continuing supervision.³⁰

Liability exists for space objects which states actually launched and that subsequently cause damage. However, there are a few different categories of “launching state” under space law, including the state which launches, the state which procures the launch, and the state from whose territory or facility the object is launched. While these categories mean that there may be more than one launching state, each launching state is jointly and severally liable for any cognizable damage.³¹ It is also worth noting that while there may be multiple launching states, there should only be one registering state, to be determined between the launching states.³²

The liability regime for damage caused to uninvolved third parties on the surface of the Earth, or aircraft in flight, is one of absolute liability.³³ The liability regime for damage caused in outer space to the spacecraft of other launching states is one of fault-based liability.³⁴ Absolute liability, sometimes called strict liability, is liability without fault assigned, and means that while the party found liable is under an obligation to provide restitution, no violation of any law or duty is required to be found. Absolute liability requires merely that cognizable damage has occurred and that the defending party caused it. In distinction, fault-based liability requires a showing of the existence of a duty, that the defendant violated that duty, that the violation was the actual and proximate cause of damage, and also that the damage which resulted was of the type for which law allows compensation. Fault-based liability is generally more difficult to prove. Despite these subtleties, responsibility/liability is linked with jurisdiction via national and international registration, as a launching state has the privilege to register that space object and subsequently assert jurisdiction over it.

From these provisions, the key insight for satellite servicing is that the launching states are responsible for the satellite servicing mission to be compliant with international law, and that the launching state is potentially liable for any cognizable damage. The liability regime is different for scenarios where the servicing mission and satellite to be serviced are space objects of a single launching state, and scenarios where the two are from different launching states. If they are the same launching state, domestic regulation will apply and likely completely resolve the issue. If they are from different launching states, the fault-based liability regime detailed in the Liability Convention applies.

Due Regard

Article IX of the Outer Space Treaty creates the principle of cooperation and mutual assistance between states, and develops this with the obligation that states give due regard to the

³⁰ Outer Space Treaty, Article VI, literal 2.

³¹ Outer Space Treaty, Article VII. *See also* Convention on International Liability for Damage Caused by Space Objects, 961 U.N.T.S. 187, 24 U.S.T. 2389, Article V.1 (“*Whenever two or more States jointly launch a space object, they shall be jointly and severally liable for any damage caused.*”) [Hereinafter Liability Convention]. *See also* Cologne Commentary on Space Law, Vol. 1, pgs. 126-145 [hereinafter CoCoSL 1].

³² Registration Convention, Article II.2.

³³ Liability Convention, Article II.

³⁴ Liability Convention, Article V.1.

corresponding interests of all other state parties to the treaty.³⁵ This obligation can be seen as a limitation on the right of free access and exploration throughout the Outer Space Treaty.³⁶ The last two sentences of Article IX causes states to undertake appropriate international consultations with other states before proceeding with any activity or experiment that might potentially harmfully interfere with other state activities. Additionally, any state which has reason to believe that another state's activities in space might potentially cause harmful interference with their own activities can request consultations concerning that activity or experiment with the other state.

Due regard can be seen as the obligation to perform activities with a certain standard of care, attention, or observance.³⁷ Admittedly vague, it certainly connotes that regard should be given to one's actions so as to not damage, harmfully interfere, or obstruct the activities of other states, and to refrain from actions which degrade, subvert, or deny the right of free access, use, and exploration of space enjoyed by other states.

Related to liability in space, the treaties define damage as physical damage. The causation of physical damage gives rise to fault-based or strict liability provisions (as appropriate). However, any non-physical damage, such as harmful interference or other actions degrading corresponding interests or free access and use, might arguably constitute the triggering of the Outer Space Treaty's due regard obligation. Violating this obligation to give due regard is even arguably a violation of a state's international responsibility. Lastly, general principles of state responsibility for internationally wrongful acts subsist behind the specific treaty provisions in the space treaties.³⁸

The key insight from Article IX's due regard obligation requires that states authorizing, supervising, licensing, or actually executing satellite servicing missions must give due regard to the corresponding interests of other states active in the space environment, such as those operating satellites, and therefore not subvert, obstruct, or degrade those interests.³⁹ Additionally, actions in a satellite servicing mission which potentially harmfully interfere with other state interests trigger the consultative mechanism.

Satellite Servicing Missions

Putting together the obligations discussed above, states launching satellites which they have registered on their national registries have municipal jurisdiction over those satellites (including legislative, judicial, and enforcement jurisdiction). As is the normal practice, states register their launched objects on the UN registry, alerting the world that they are the responsible entities for those space objects. The establishment of a national registry of space objects is also normal practice, and the method for the appropriate state to establish its jurisdictional power over its

³⁵ Outer Space Treaty, Article IX, sentence 1. *See also* CoCoSL 1, Article IX.

³⁶ CoCoSL 1, pg. 175, para. 23.

³⁷ CoCoSL 1, pg. 175, para. 25.

³⁸ CoCoSL 1, pg. 181, paras. 48-50. *See also* International Law Commission, *Responsibility of States for Internationally Wrongful Acts*, 2001; Available at: <http://bit.ly/1oKw2hP>.

³⁹ To deconstruct this admittedly obfuscating, logorrheic, and verbose legalese: "do unto others as you would have others do unto you".

launched space object. A satellite to be serviced would fall under this registration regime, as would a satellite-servicing spacecraft.

Liability rules exist in space activities which are relatively clear. If both space objects were launched by the same state, no international issues arise, and national regulations (if not contractual relations between the parties) likely resolve the dispute. If the space objects are owned and operated by separate states, the responsibility, liability, and due regard regime in international space law applies. The obligation to give due regard to the corresponding interests of other countries applies, though this due regard principle might require elaboration specific to particular activities. Consultation with other states might be warranted. These are the black-letter law provisions applicable to satellite-servicing, but given the perception that satellite servicing might create, a number of TCBMs are also appropriate to commercial satellite servicing.

6. International Perceptions and Reactions

Outer space is an area without state sovereignty. However, states have conducted significant and important uses of space, directly related to state sovereignty, since the very dawn of the space age. It can even be argued that all peaceful uses of outer space are tolerated within the context of space as a strategic domain.

As discussed above, while national appropriation is prohibited, an important component of sovereignty, namely state jurisdiction, can exist in space. It can and has been argued, *sensu stricto* (“in a strict sense”), that because states retain jurisdiction over their domestically registered space objects, and perpetually retain responsibility and potential liability over their launched space objects, that any interference with a state’s space object (including their space debris, which space law neither defines nor distinguishes) constitutes a transgression of state sovereignty, and therefore a violation of international law. Article 2(4) of the UN Charter prohibits the use of force, and the threat of the use of force, against another state’s territorial integrity, political independence, or “in any other manner inconsistent with the Purposes of the United Nations.” Additionally, Article 51 of the Charter restricts this prohibition so as not to impair the inherent right of individual self-defense against a UN Member State.⁴⁰ A violation of a state’s sovereignty, and perhaps even a component of its sovereignty like its jurisdictional powers exercised extraterritorially, arguably constitutes a violation of the UN Charter and/or customary international law, therefore giving rise to the right of a state to enact armed countermeasures or response against the transgressing state.⁴¹

This argument follows logically from the framework of public international law between sovereign states and has been made at the Scientific and Technical Subcommittee to the United Nations Committee on the Peaceful Uses of Outer Space.⁴² It was made in order to highlight the

⁴⁰ See also Michael Byers, *War Law*, Part Two: Self Defense, 2005.

⁴¹ See also Ian Brownlie, *Principles of Public International Law* (7th Ed.), pgs. 733-737.

⁴² Committee on the Peaceful Uses of Outer Space, Scientific and Technical Subcommittee, 52nd Session, Working Paper submitted by the Russian Federation, *Achievement of a uniform interpretation of the right of self-defense*

necessity of defining self-defense of outer space, and to highlight the larger concerns of space as a strategic domain. Regardless of its ultimate validity, that this argument exists should show the primacy and importance with which states regard their space objects, and the heightened attention and scrutiny that any on-orbit interaction with another state's space object will engender.

Also important is the general perception, as shown in the various news sources and their alarmed reaction to *Kosmos-2499* and other incidents.⁴³ Such reactions can fuel a cycle of escalating tensions between states, and must be avoided to ensure the long-term sustainability of space activities, and the decades-long streak of purely peaceful uses of outer space.

7. Transparency for Commercial Viability

So how would a commercial satellite servicing company conduct its missions in this atmosphere of heightened scrutiny, tension, and suspicion? A number of recommendations are easily discernable. From the legal discussion above, the appropriate regulating state has international rights and obligations related to the activity, and a number of national regulatory mechanisms. The regulating state ought to comply with its international treaty obligations, including registering the space object with the UN registry of space objects, ensuring its continuing compliance with international law, and consequently not interfering with the corresponding interests of other states in their space activities (due regard), nor infringing or degrading other state's right to access, explore, and use space. As other states retain jurisdiction over their domestically space objects, and responsibility and liability over space objects they have launched, these aspects of state sovereignty must be respected lest an argument that their sovereignty has been infringed upon – a serious violation of the law of nations.

While the current geopolitical climate is not conducive to new treaty-making, the international community considers the promulgation of TCBMs important to fostering space sustainability. The current international legal framework may not fully address the more commercialized and decentralized space age. To lessen the chance of mistrust and misperceptions, and to circumvent the possibility that their actions escalate tensions between nations, a number of more recent international initiatives for space sustainability are of relevance. Within the UN system, two initiatives are relevant: a UN Group of Governmental Experts (GGE) on TCBMs in space, and the ongoing development of non-binding guidelines aimed at the long-term sustainability of outer space activities.

in conformity with the United Nations Charter as applied to outer space as a factor in maintaining outer space a safe and conflict-free environment and promoting the long-term sustainability of outer space activities,
A/AC.105/C.1/2015/CRP.22, paras. 7-13, 2 Feb. 2015; Available at:
http://www.unoosa.org/pdf/limited/c1/AC105_C1_2015_CRP22ER.pdf.

⁴³ See also Jeremy Hsu, *Chinese Satellites Bump During Secret Maneuvers*, Space.com, 03 Sept. 2010; Available at: <http://bit.ly/1MasEDJ>. Brian Weeden, *Dancing in the Dark: The Orbital Rendezvous of SJ-12 and SJ-06F*, the Space Review, 30 Aug. 2010; Available at: <http://bit.ly/1ERNEin>. Katie Drummond, *China's Secret Satellite Rendezvous "Suggestive of a Military Program"*, Wired.com, 31 Aug. 2010; Available at: <http://wrd.cm/1DQWEAb>.

The UN GGE on TCBMs in space concluded its report in July 2013, and its recommendations should be considered and implemented by the appropriate regulating state.⁴⁴ The GGE report explains and stresses the importance of TCBMs in space activities, stating “[i]n general terms, transparency and confidence-building measures are a means by which Governments can share information with the aim of creating mutual understanding and trust, reducing misperceptions and miscalculations and thereby helping both to prevent military confrontation and to foster regional and global stability.”⁴⁵ Among the specific TCBMs recommended, the report lists information exchange on activities in outer space, (including orbital parameters, possible conjunctions, natural space hazards, and planned launches); notifications on risk reductions (such as scheduled maneuvers, uncontrolled high-risk re-entries, emergency situations, intentional orbital breakups; voluntary visits to launch sites and command and control centers, and demonstrations of space and rocket technologies. Consultative mechanisms are also encouraged.⁴⁶

Elsewhere in the UN system, the Working Group on the Long Term Sustainability of Space Activities meets pursuant to an agenda item of the Scientific and Technical Subcommittee on the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). Since 2010, this working group has been developing a set of non-binding guidelines on the long-term sustainability of space activities.⁴⁷ As of early 2015, the draft guidelines are still in discussion by COPUOS member states in the STSC. The latest report consolidates a previous set of 33 guidelines into 18 draft candidate guidelines.⁴⁸ While the work is ongoing, the working group plans to finalize their guidelines in the next few years, and subsequently refer them to the COPUOS, and perhaps even to the UN General Assembly where they may be incorporated into or endorsed by a General Assembly resolution.⁴⁹ The LTS guidelines do not address satellite servicing, or other prospective cutting-edge activities. However, they are addressed to the mitigation of space debris and the general protection of the outer space environment, and

⁴⁴ Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities, U.N. GAOR, 68th Sess., U.N. Doc A/68/189*, 29 July 2013; Available at: http://www.un.org/ga/search/view_doc.asp?symbol=A/68/189. See also Christopher Johnson, *The UN Group of Governmental Experts on TCBMs in Space - A Secure World Foundation Factsheet*, April 2014 [hereinafter GGE Report]; Available at: http://swfound.org/media/109311/swf_gge_on_space_tcbms_fact_sheet_april_2014.pdf.

⁴⁵ GGE Report, pg. 12, para. 20.

⁴⁶ GGE Report, pgs. 19-20.

⁴⁷ Christopher Johnson, *The UN COPUOS Guidelines on the Long-term Sustainability of Outer Space Activities - A Secure World Foundation Factsheet*, Dec. 2014; Available at: <http://bit.ly/1A7bCCK>; See also Laura Delgado López, Christopher Johnson, Victoria Samson, Michael Simpson, and Brian Weeden, *The Importance of the United Nations Guidelines for the Long-Term Sustainability of Space Activities and other International Initiatives to Promote Space Sustainability*, OASIS, Vol. 20, Jul.-Dec. 2014, pgs. 37-53; Available at: <http://bit.ly/1A7beEh>.

⁴⁸ Committee on the Peaceful Uses of Outer Space, Scientific and Technical Subcommittee 52nd Session, *Updated set of draft guidelines for the long term sustainability of outer space activities - Note by the Secretariat*, A/AC.105/C.1/L.340, 22 Oct. 2014; Available at: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L340E.pdf.

⁴⁹ United Nations, *Report of the Committee on the Peaceful Uses of Outer Space*, A/69/20, 2014, pgs. 27-28, paras. 199-200; Available at: http://www.unoosa.org/pdf/gadocs/A_69_20E.pdf.

therefore encourage the sustainable use of space, a future which responsible satellite servicing stands to aid.

Outside of the UN System, the European Union has led the development of the International Code of Conduct for Outer Space Activities.⁵⁰ The EU's European External Action Service's latest version of the draft Code of Conduct, released on 31 March 2014, establishes a number of transparency and confidence-building measures between states. Subscribing to the Code is on a voluntary basis and is not legally-binding.⁵¹ The Code stresses the need to implement policies and procedures to minimize the risk of harmful interference between states, along with the risk of space debris creation and accidents in space. It also involves cooperation mechanisms related to notification on scheduled man oeuvres "that could pose a risk to the safety of flight of space objects of other states," predicted conjunctions, the pre-notification of launch events, collisions, break-ups in orbit, potentially high-risk re-entry events, and malfunctioning space objects.⁵² It also implements a consultation mechanism similar in scope to the consultations in Article IX of the Outer Space Treaty.⁵³ The future of the Code is evolving but it also may be finalized in 2015 or shortly thereafter.

The legal framework of international state responsibility and potential liability described above also requires that the commercial entity conform to national space legislation enacting those requirements for licensing, authorization, supervision, and continuing compliance with international law. National space legislation differs across nations, but will likely involve some aspects of governmental indemnification, insurance provisions, waivers of claims between parties, and procedures for frequency allocation, launch licenses, payload review, and related compliance procedures.⁵⁴ While not further discussed in this paper, understanding and conforming to the domestic regulatory framework is crucial for any NewSpace undertaking.

A few simple insights can be derived by considering what we might want other states and foreign companies to do before and during their satellite-servicing mission: announce the mission, have operators report where the satellite to be serviced is, and have the satellite servicing mission maintain healthy distances with other satellites.

Another activity enhancing trust and transparency between states is the regular reporting of their space activities on the international level. Each year, the member states of COPUOS meet in Vienna, Austria, and a number of opportunities are provided where states can share information and insights on their recently concluded, ongoing, and planned national activities. States and observers make technical presentations under various agenda items, a disclosure

⁵⁰ European External Action Service, *Code of Conduct for Outer Space Activities*, 31 Mar. 2014; Available at: <http://bit.ly/1vTwD5u> [Hereinafter Code of Conduct]. See also Christopher Johnson, *Draft International Code of Conduct for Outer Space Activities Fact Sheet*, Secure World Foundation, Feb. 2014; Available at: <http://bit.ly/1tguNFa>. Rajeswari Pillai Rajagopalan and Daniel Porras, *Commentary - EU Courts Support for Space Code of Conduct*, Space News, 14 July 2014; Available at: <http://bit.ly/1GIIm7z2>.

⁵¹ Code of Conduct 1.4.

⁵² Code of Conduct 5.1.

⁵³ Code of Conduct 7. Consultation Mechanism.

⁵⁴ See also Ram S. Jakhu (Editor), *National Regulation of Space Activities*, Space Regulations Library - Volume 5 (2010); Matthew Kleiman, Jenifer Lamie, and Maria-Vittoria Carminati, *The Laws of Spaceflight: A Guidebook to New Space Lawyers*, 2012.

process that further aids transparency and trust between states. Lastly, A number of experts and practitioners in this fledgling industry have begun to explore what sustainable and transparent satellite servicing operations constitute, and recommend that demonstration missions would help develop the correct norms and rules of the road.⁵⁵

8. Conclusion

This paper first summarized satellite servicing as a capability a number of governmental and non-state actors are developing, along with the heightened scrutiny and suspicion that might arise as a result. It discussed ways that satellite servicing capabilities might stretch or challenge the traditional conception of peaceful uses of outer space. It then discussed the applicable space law, including the obligations of registration, continuing compliance with international law, and gaps in space law in the context of the discussed activity.

As the international political climate is not amenable to treaty-making for space, the international system has resorted to various TCBMs to alleviate tensions, increase transparency and stability, and prevent mistrust and miscalculations in the space realm. These include the existing obligations in space law, such as the regular reporting of space activities to international bodies such as COPUOS, and the specific measures for satellite servicing.

Specific measures include announcing the mission publically, having operators report where the satellite to be serviced is, and having the satellite servicing mission maintain healthy distances with other satellites. These measures are a practical and workable solution that fosters the safe and sustainable uses of outer space, and conforms to the Outer Space Treaty's preambular goal of creating a regime whereby outer space is explored and used for peaceful purposes, and where international cooperation strengthens the friendly relations between states and peoples. New entrants to the commercial uses of outer space can help foster such friendly relations even as they pursue their enterprising business plans.

⁵⁵ Brian Weeden, Tiffany Chow, Agnieszka Lukaszczyk, and Victoria Samson, *International Perspectives on On-Orbit Servicing and Active Debris Removal and Recommendations for a Sustainable Path Forward*, IAC Sept. 2013, Available at: <http://swfound.org/media/119604/IAC-13-E3.4.7-Presentation.pdf>. See also Alanna Krolikowski and Emmanuelle David, *Commercial On-Orbit Satellite Servicing: National and International Policy Considerations Raised by Industry Proposals*, New Space, Mar. 2013; Available at: <http://bit.ly/1wHZoNz>; David Belcher, Scott Freese, Katrina Laygo, and Daniel Osborne, *Analysis of United States Policy and Legal Impediments to On-Orbit Servicing Activities*, Oct. 2013; Available at: <http://bit.ly/1GcaMtB>.