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Legal Issues for Blockchain in an Environment Most Unkind

Tyler Kirsch

April 28, 2020

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The privatization of space is nothing new. In 1962, a space object¹ was launched from Cape Canaveral, Florida, carrying the first commercial satellite.² The Telstar 1 satellite transmitted the first transatlantic television signal.³ To the unaware, space is a final frontier wherein no jurisdiction applies beyond the atmosphere. Many entities may even act like this is still the case. For those that believe in international law, this was never the case, but many questions linger on how to address concerns moving forward. In order to discuss those concerns it is imperative to first briefly discuss how Space Law came to be. That discussion will lead to two problems for non-State actors: the problems with jurisdiction; and the problems with liability, and these will be discussed in turn. Then, modern problems arise for jurisdiction and liability as modern solutions, such as algorithms and smart contracts, are applied. Finally, solutions will be proposed to answer the problems enumerated in this paper. In order to talk solutions, there has to be a question proposed; and that is, "How does liability and jurisdiction work in space for cooperation amongst multiple parties, and how can blockchain help?"

I. Current Space Law⁴

Sputnik I was launched on October 4, 1957, the world's first artificial satellite.⁵ It began six decades of international cooperation to regulate space. In 1967 the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space,

¹ "Space object" will remain purposefully ill-defined. Many works have been written on the subject, but for the sake of this paper, "an object that is launched with the intent of breaching the atmosphere, or an object used in the launching towards that endeavor," will be sufficient.

² *July 12, 1962: The Day Information Went Global*, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, <https://www.nasa.gov/topics/technology/features/telstar.html> (last visited Apr. 20, 2020).

³ *Id.*

⁴ Of the treaties discussed, in order, The Outer Space Treaty is signed and ratified by 109 States, The Liability Convention by 96, and the Registration Convention by 69. For all three treaties, the major space powers are parties.

⁵ *Sputnik and The Dawn of the Space Age*, NASA HISTORY, <https://www.history.nasa.gov/sputnik/> (last visited Apr. 20, 2020).

including the Moon and Other Celestial Bodies (The Outer Space Treaty) was signed.⁶ In comments to the Legal Sub-Committee of the United Nations Committee on the Peaceful Uses of Outer Space (The Committee), the Chairman noted,

... in the three years since the adoption of the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (in 1962)... little progress had been made towards ensuring that outer space was used for man's advancement and not for his destruction. The choice to be made by man was clear, and in that choice the law-maker and the lawyer could not remain neutral.⁷

Within six months, he was able to present The Outer Space Treaty which was quickly adopted by the General Assembly.⁸ Of importance in this treaty are Article III, "State Parties ... shall carry on activities ... in accordance with international law..." Article VI, "States Parties ... shall bear international responsibility for national activities in outer space ... whether such activities are carried on by governmental agencies or by non-governmental entities..." and Article VII, "Each State ... that launches or procures the launching of an object into outer space ... and ... from whose territory or facility an object is launched, is internationally liable for damage..."

A. The Convention on International Liability for Damage Caused by Space Objects

In 1972, The Convention on International Liability for Damage Caused by Space Objects (The Liability Convention) entered into force, building on Article VII of the Outer Space Treaty.⁹ The General Assembly, at the urging of The Committee, adopted the Liability Convention due to "the need to elaborate effective international rules and procedures concerning liability for damage caused by space objects and to ensure ... prompt payment . . ." Importantly, Article V reads,

⁶ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T.2410, 610 U.N.T.S. 205. See also, United Nations Office of Outer Space Affairs,

<http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html>

⁷ Bin Cheng, *Studies in International Space Law*, p 215 referring to A/AC.105.C.2/SR.57 pp. 2-3.

⁸ *Id.*

⁹ The Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187. See also, United Nations Office of Outer Space Affairs,

<http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introliability-convention.html>

1. Whenever two or more States jointly launch a space object, they shall be jointly and severally liable for any damage cause.

2. A launching State which has paid compensation for damage shall have the right to present a claim for indemnification to other participants in the joint launching. The participants in a joint launching may conclude agreements regarding the apportioning among themselves of the financial obligation in respect of which they are jointly and severally liable. Such agreements shall be without prejudice to the right of a State sustaining damage to seek the entire compensation due under this Convention from any or all of the launching States which are jointly and severally liable.

3. A State from whose territory or facility a space object is launched shall be regarded as a participant in a joint launching.¹⁰

The vast majority of the rest of The Liability Convention are exceptions to, or the process of collection of any damages from launching states.¹¹

Importantly, in the next United Nations General Assembly Resolution, the Working Group on Remote Sensing of the Earth by Satellites was also established and convened.¹² This resolution, “[r]equests Member States to submit information on their national and co-operative international activities in this field, as well as comments and working papers, through the Secretary-General to the Working Group on Remote Sensing of the Earth by Satellites. . .”¹³

B. Convention on Registration of Objects Launched into Outer Space.

In 1976, the Registration Convention entered into force.¹⁴ Finding that the previous treaties and conventions had left the phrase “launching State” and liability still too administratively vague, the General Assembly and The Committee determined to “make provision for registration by launching States of space objects launched into outer space

¹⁰ U.N. G.A. Res 2777 (XXVI), Article V (Nov. 29, 1971), see also http://www.unoosa.org/pdf/gares/ARES_26_2777E.pdf.

¹¹ Such as, individuals injured during the launch, that are participating in the launch, but not of the launching state, can't claim damages against the launching party, or tribunals, and logistics of such, for States or their citizens to recuperate damages, or the currency to be used in repaying damages, etc.

¹² Id., U.N. G.A. Res. 2778 (Nov. 29, 1971).

¹³ Id.

¹⁴ The Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15. See also, United Nations Office of Outer Space Affairs, <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introregistration-convention.html>

with a view . . . to providing States with additional means and procedures to assist in the identification of space objects.”¹⁵ Importantly, Article II states,

1. When a space object is launched into earth orbit or beyond, the launching State shall register the space objects by means of an appropriate registry which is shall maintain. Each launching State shall inform the Secretary-General of the United Nations of the establishment of such register.

2. Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object. . .

Article III states the Secretary-General shall maintain the Register and that access to the Register’s information shall be full and open.¹⁶

In both Conventions, “launching State” means: A State which launches or procures the launching of a space object; or, A State from whose territory or facility a space object is launched.¹⁷

Two problems arise from the above information: The first, the regime that exists for entities to launch requires conformity with possibly four jurisdictions per launching party, as well as a notification requirement that allows member States of the United Nations to be notified of the purpose of the registered space object and object.¹⁸ Secondly, if parties want to work together in the future, does one bad faith actor in a constellation¹⁹ result in, as the treaties discuss, all launching States being jointly and severally liable?

C. Enter, SpaceChain in the Space 3.0 world.

In a presentation to the University of Georgia School of Law on October 28, 2019, Brian R. Israel discussed the frameworks that launching entities navigate in the process of putting objects into space. The treaties and resolutions passed under the United Nations

¹⁵ U.N. G.A. Res. 3235, (Nov. 12, 1974). See also, http://www.unoosa.org/pdf/gares/ARES_29_3235E.pdf.

¹⁶ Id.

¹⁷ Id. at Article I, and U.N. G.A. Res. 2778 at Article I.

¹⁸ “Must state scope or technical ability and use of the satellite.” Interview with Alessandra Albano, Chief Operations Officer. SpaceChain (Feb. 26, 2020).

¹⁹ In this paper “Constellation” will refer to a group of satellites that share information, a network, or launch, algorithmic information, etc.

are “Space Law 1.0.”²⁰ The adoption of these international laws into national laws through legislatures of the member States, and the various changes they go through to become national law and other things added to make differences unique to each of the various member States, becomes “Space Law 2.0.”²¹ Mr. Israel imagines a “Space Governance 3.0,” where “private law regimes constructed from contracts between spacecraft operators (and spacecraft, in some cases) in which all space actors, public and private, play on a level field.”²² How does the Space Governance 3.0 look in practice? Enter, SpaceChain.

SpaceChain is a foundation that is “utilize[ing] an open network based on blockchain technology to advance the principles of decentralization and promote international collaboration within the vibrant and global space community.”²³ SpaceChain has two hurdles that it may be able to solve with one answer: a comprehensive, “agnostic” jurisdiction that allows “space exploration [to] no longer be limited at the government level, allowing different companies to participate due to increased accessibility and lower costs.”²⁴ These hurdles, discussed below, are jurisdiction and liability.

II. Problems with Jurisdiction

Jurisdiction is a muddled affair. Jurisdiction can be broken into two components, *jurisdiction* and *jurisdiction*.²⁵ Jurisdiction, when discussing the reach of a State, can be broken into three purviews: National Territory (and similar), Flag-crafts (and similar), and individuals and corporate bodies of the State.

An example may help illustrate this point. Consider a United States citizen aboard a vessel flying a Singaporean flag that is currently docked in Kazakhstan. While docked,

²⁰ ISRAEL, BRIAN, *Space Governance 3.0*, Presented at the Symposium on the Future of Space Governance at the University of Georgia School of Law, (Oct. 28, 2019) (unpublished manuscript, on file with author.)

²¹ *Id.*

²² *Id.* Mr. Israel also states, “My substitution for *governance* in place of *law* for the 3.0 layer in part reflects that it does not rely [on] the coercive powers of a State to enforce. . . .”

²³ *SpaceChain White Paper*, Page 3, <https://spacechain.com/wp-content/uploads/2020/03/whitepaper-200320.pdf>, (last visited Apr. 20, 2020.)

²⁴ *Id.* at page 13.

²⁵ Cheng, Bin *Studies in International Space Law*, 1997, See Annex for chart.

Kazakhstan has jurisdiction and jurisdiction, as both the vessel and the citizen are within Kazakhstan's territory. At the same time, Singapore and the United States have jurisdiction, in that the vessel must still comply with Singaporean law despite Singapore's inability to enforce, and United States law applying to the citizen, whether enforceable or not.

The Singaporean vessel makes its way to international water or to space, and when that happens Kazakhstan loses both jurisdiction and jurisdiction, Singapore's jurisdiction remains and it gains the jurisdiction, where the vessel's officers are required to enforce Singapore's laws. United States jurisdictional position hasn't changed until the citizen is left on unclaimed territory, at which time, the United States jurisdiction still applies, but unless a different individual or the citizen applies it themselves, there is still no jurisdiction.

This problem is compounded when a multitude of entities all launch from different jurisdictions on the same flagged vessel. Currently, corporations are not wont to work with others in orbit without a shared jurisdiction due to the complications that can arise in determining whose jurisdiction applies, and then whose jurisdiction is capable of enforcement.²⁶ These jurisdictional factors are the first hurdle that SpaceChain is looking to clear with the use of blockchain.

SpaceChain is looking to use an operating system based in blockchain for two purposes: first, it can be used to allow a constellation of satellites to communicate; and second, it can be used to ensure compliance to the rules set for the constellation.²⁷ If a group of satellites launch with a smart contract that states both the purposes of the constellation parts and whole, outcomes can be coded into the satellites for compliance purposes.

In Space Governance 3.0, Israel suggests that between the communication aspect and an insurance scheme wherein launching parties buy tokens for two purposes: the first

²⁶ "When you have a number of satellites in orbit, they are connected to ground stations. Not interconnected. If connected, same owner. . . usually same task; imaging, or communications, etc." Interview with Mrs. Albano, Chief Operations Officer, SpaceChain, (Feb 26, 2020).

²⁷ Id. See also, *SpaceChain White paper*, *supra* page 8.

is for the satellites to automate the trading of tokens to determine which satellite should burn some of its finite fuel in order to move, eliminating the threat of satellites crashing into each other.²⁸ The second is for the parties to buy a token that is used as a guarantee that, towards the end of an objects life cycle, the party (through its own means or through smart contracts) deorbits the satellite to free up the orbital real estate that the object was holding.

SpaceChain is hoping, through the use of this OS, to make an “agnostic” jurisdiction. By this, SpaceChain is looking to not build a traditional jurisdiction, but a series of smart contract requirements that work within and sets the bar for requirements so that all actors work within the framework of any jurisdiction. SpaceChain is hoping to disrupt the current dipole that exists between launching entities, which to some extent mirrors the Cold War Era when the treaties were written, where Europe and the United States lie on one side of the equation, while China and Russia lay on the other side. If the OS can create a framework that States agree to, a standard for the interaction between the private and public entities looking to launch, then an agnostic jurisdiction can exist that allows a broader population of the planet to partake in the space race. The current field of satellite companies is small, with six “large” satellite companies and sixteen “small,” but “[w]ith SpaceChain OS, satellite capabilities are increased, causing this sector to flourish alongside communication, and data storage and collection capabilities.”²⁹ This should democratize the market, allowing more parties to launch within and outside of the current dipole.

The SpaceChain OS can act as both the jurisdiction and the jurisdiction, if properly implemented. If, for example, 20 entities from various European countries all launch on one vessel from Cape Canaveral, the entities could have all agreed to the use of the SpaceChain OS, allowing cooperation amongst themselves in computational power, scope of tasks, etc. For example, if all the satellites had the purpose of imaging the Earth, but half

²⁸ ISRAEL, *supra* pages 10, 11.

²⁹ *SpaceChain White Paper*, *supra* page 6.

were tasked with picturing only the Atlantic Ocean, and the other half the Pacific, a shared OS would allow the satellites to all work on one task, and then the other, allowing the completion of the mission in half the time. Or if the satellites were used for data transfer or processing, a shared ecosystem would allow unused computational power in one satellite to be used for others, increasing efficiency.

But an issue arises: what if every party launching into the constellation agrees to tasks A through X, and the State's and the U.N. agree those tasks are acceptable, but then one member of the constellation decides to perform task Y or Z? If damages arise, or political backlash results, is the entire constellation liable for the results?

III. Problems with Liability

Most space objects are controlled by ground stations. This requires approval from the State where the ground station is located to use particular bandwidths of communication. This also allows ground stations to not only collect and transmit data, but also to issue commands and change parameters of missions that the object was originally assigned. Can contact with ground stations be used as evidence of individual liability and not shared liability? Fortunately, and unfortunately, the amount of times that liability for damage resulting from space objects is very low. This results in a less than ideal legal background to pull from. An incident with a Russian satellite crashing in to Canada resulted in a clean-up cost, SkyLab crashed into Australia and resulted in a fine for littering, and the disasters of the Columbia and Challenger shuttles, are all we have. The first of these used the Liability Convention to seek compensation, the second was dealt with diplomatically, and the final two were purely domestic affairs.

Under the Liability Convention above, if the fault happens when a space object is enroute to Earth Orbit, all parties are strictly liable and can later apportion fault amongst themselves.³⁰ If physical damage happens "elsewhere than on the surface of the earth,"

³⁰ Liability Convention, Article II: A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.

then the liability is only apportioned to the party at fault. Does liability stretch from one member of a constellation to others if one object causes damage to another object, in orbit or on earth? Article IV of the Liability Convention ends paragraph 2 with, “. . . if the extent of the fault of each of these States cannot be established, the burden of compensation shall be apportioned equally between them. . .”³¹ What if the damages are not of a physical nature, but instead are the resulting fallout of images or environmental readings of certain environmental or other factors? Pictures of soccer fields during the Cold War resulted in the Cuban Missile Crisis, proving that not all damages are physical, and many are political.³²

The International Space Station is bound by the Intergovernmental Agreement (IGA) between Canada, the United States, the European Space Agency, Japan, Russia, and ten other States. The IGA issues a “cross-waiver of liability” for most parties involved, and for most events that may occur outside of willful misconduct and relationships between an agency and one of their subcontractors.

Given the above, there are two possibilities for limiting liabilities between parties in a constellation. The latter example of contracting liabilities before hand is what the current regime requires but it doesn’t seem to be enough for corporations to be willing to work together and still requires the selection of a jurisdiction that most likely favors some of the launching entities over the others. A different approach, and the one advocated for by SpaceChain, are the use of smart contracts used to create an agnostic jurisdiction that would not favor any individual launching entity but would also enforce compliance through the SpaceChain OS and the algorithm. By creating a series of “if/then” statements, or smart contracts, automated compliance with various issues would be taken care of by individual space objects, or constellations, if and as they arise. Space objects on collision course? Objects expend fuel as needed to reposition away from danger. Or, in the example above

³¹ U.N. G.A. Res 2777 (XXVI), Article IV (Nov. 29, 1971), see also http://www.unoosa.org/pdf/gares/ARES_26_2777E.pdf.

³² Adam Rawnsley, *How Baseball Betrayed Cuba’s Covert Ops*, MEDIUM, <https://medium.com/war-is-boring/how-baseball-betrayed-cuba-s-covert-ops-8270b609ee6c> (last visited Apr. 28, 2020)

regarding Earth imaging satellites, as the orbit results in some being unused, the data is transferred between satellites automatically to speed any processing requirements.

This comports with the system laid out by Brian Israel, in that smart contracts can be used to create a system of governance that dictates when satellites move, “I can’t imagine a system in which operators of maneuverable satellites that conjunct trade credits for maneuvers: I maneuver today, you give me a credit; I use that credit tomorrow with a different operator.”³³ Another use could be to prescribe end of life for satellites in which the a smart contract is used as insurance, paying out automatically once proper procedures are followed by the operators, i.e., properly burning a broken satellite in orbit returns a sizeable insurance deposit via smart contracts.³⁴

IV. Problems created by Algorithms and Smart Contracts

Smart contracts can be referred to as “self-executing contracts or code,” that, much like machine learning algorithms, are fed information (inputs) and act in certain ways (output) based on the information. The foreseeability of this is usually straight-forward, where the outputs are predetermined and in no way a surprise. However, human reasoning is not the same as computational logic, and results may vary. For instance, an algorithm was trained to accept or reject students applying for St. George’s Hospital Medical School in London, and after the initial year of being trained by the people who normally selected the students, the program was set free.³⁵ Four years later, it was found that the training of the program had resulted in biases because it was taught the biases by the original trainers.³⁶ The problem with smart contracts or algorithms, is that machine learning allows people to see the inputs and to see the outputs to determine whether the steps in the middle are acting within the parameters originally set out, without the list of

³³ ISRAEL, *supra* page 11.

³⁴ *Id.* at page 10.

³⁵ Bahar Gholipour, *We Need to Open the AI Black Box Before It’s Too Late* (Jan. 18, 2018), <https://futurism.com/ai-bias-black-box> (last visited Apr. 20, 2020.)

³⁶ *Id.*

inputs and outputs being exhausted, meaning that the process that happens in the middle is unknown and can result in unforeseen outputs.

This may seem to put more issues into who is liable, bringing into the realm of possibilities the individual developers of the algorithms and smart contracts.³⁷

The question arises, is anyone, or everyone, liable for unforeseen outcomes that may arise from a constellation's smart contract reacting in a way that causes damage, physical or political?

V. Solutions

This leads back to the question, "How does liability and jurisdiction work in space for cooperation amongst multiple parties, and how can blockchain help?" Brian Israel proposes a Space Governance 3.0, and SpaceChain's attempts to create a framework that allows actors to contract around liability and jurisdictional issues is the correct way to move forward. By creating a framework that allows actors to work across jurisdictional worries and break the dipole of the United States and Russia, SpaceChain accomplishes this task. The use of blockchain and smart contracts to create the framework allows the agnostic jurisdiction that should be sufficient for private actors to work within, and for States to allow to happen without their direct control.

The additional fear of liability, both with multiple actors working in unison, and with the added algorithm confusion are also addressed under prior existing doctrine or with blockchain. The current regime, through The Liability Convention, addresses this to an extent by which the individual party is at fault. Though, as more cases move forward involving algorithms and smart contracts, there is nothing to suspect anything towards

³⁷ For a brief look at responsibility and programmers, see Andrea Tinianow, *When Blockchains Crash, Who Can Sue?* (Feb. 7, 2019), <https://www.forbes.com/sites/andreatinianow/2019/02/07/when-blockchains-crash-whom-can-you-sue/#149318327775>, (last visited Apr. 20, 2020), and for an in-depth look, "In Code(rs) We Trust: Software Developers as Fiduciaries in Public Blockchains," which is to be included in The Blockchain Revolution: Legal and Policy Challenges, (unpublished manuscript, on file with author.)

strict liability would be found, and if it were, the same premises used under The Liability Convention could apply, wherein the actors apportion the liability amongst themselves.

Negotiating these two issues with smart contracts and SpaceChain OS allows for an even-handed approach that leaves no actor looking to participate in the current space race to be left behind. In looking at how these issues hold back humanity's growth space-ward, the choice to be made is clear, and in that choice the lawmaker and the lawyer should not remain neutral, and when it comes to humanity's future, no one is neutral on an orbiting rock.

Table XIV.3 State Jurisdiction

TYPE	TERRITORIAL		QUASI-TERRITORIAL		PERSONAL	
Object	<i>Terra firma</i> (terrestrial or extraterrestrial) including adjacent maritime belt, subsoil and superjacent space		Ships, aircraft and spacecraft		Individuals, corporate bodies and business enterprises	
Material Scope	In respect of the whole territory, including all its resources, all persons and things therein, and the extraterritorial activities of all such persons, whether individual or corporate		In respect of the craft themselves and all persons and things therein, including the activities of such persons, individual or corporate, whether on board the craft or elsewhere		In respect of individuals, corporate bodies and business enterprises, and all property, rights and legal interests belonging to them, wherever they may be	
Source	<i>International customary law</i> ; sovereignty, law of war and <i>status mixtus</i> , including self-defence and reprisals. <i>Treaties</i> with, and <i>recognition or acquiescence of</i> , other international persons, e.g., protectorates, leased, mandated and trust territories		State jurisdiction over flag-craft and pirate vessels <i>jure gentium</i> . Right to flag under <i>international customary law</i> may be based on nationality of owner or charterer, other 'genuine link', and registration. It may also be derived from <i>consent, recognition or acquiescence of</i> other international persons		<i>International customary law</i> : State jurisdiction over nationals, including corporate bodies and business enterprises endowed with nationality, other persons owing allegiance, and pirates <i>jure gentium</i> . <i>Treaties</i> with, and <i>recognition or acquiescence of</i> , other international persons, e.g., jurisdiction over protected persons	
Element	Jurisdiction	Jurisdiction	Jurisdiction	Jurisdiction	Jurisdiction	Jurisdiction
Hierarchy and Precedence (<i>Jurisdiction</i>)	On a par with other types of jurisdiction		On a par with other types of jurisdiction		On a par with other types of jurisdiction	
Hierarchy (<i>Jurisdiction</i>)			First	Second	Third	
Precedence (<i>Jurisdiction</i>)			In case of conflict, overrides quasi-territorial and personal jurisdiction	In case of conflict, gives way to territorial jurisdiction but overrides personal jurisdiction	In case of conflict, gives way to both territorial and quasi-territorial jurisdiction	
Geographical Scope	Limitless (terrestrial and extra-terrestrial)	National territory of a State, other territory for the international relations of which it is responsible, and territory under its <i>occupatio pacifica</i> or <i>bellica</i>	Limitless (terrestrial and extraterrestrial)	Over flag-craft anywhere outside territories subject to the territorial jurisdiction of other recognized international persons	Limitless (terrestrial and extra-terrestrial)	Over all individuals, corporate bodies and business enterprises subject to a State's personal jurisdiction outside territories or craft subject to the territorial or quasi-territorial jurisdiction of other recognized international persons
Relevance to Space Law	Extraterrestrially applicable	Stresses the urgent need of clearly delimiting national space from outer space. Will also apply extraterrestrial territories, once sovereignty established and recognized in accordance with existing rules of international law	Extraterrestrially applicable	Applicable to national spacecraft in outer space	Extraterrestrially applicable	Applicable to nationals and other persons or entities subject to a State's personal jurisdiction even when they are in outer space