

In-Space Maneuvering, Servicing, and Resource Use: The Commercial Need for Legal Assurances

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Abstract

This paper will address legal approaches to a number of new ventures that will be carried out in outer space in the near future and that will likely require major changes to the way nations will approach space law. Today we tend to view activities in space from an individual program or project perspective and we tend to analyze the engineering, social, and legal issues very narrowly and separately for each proposed venture. However, four current government and commercial activities: active debris removal, satellite servicing, diverting near earth objects, and resource extraction and processing all raise similar major and unresolved legal issues. These issues should be considered together in a consistent, logical, and rational way, insuring that solutions are coordinated and uniform. All of these activities involve attaching to an orbiting natural or human object and then working on or with that object. Issues raised range from definitions to property rights to weaponization. All will require new approaches to regulatory areas such as safety, the environment, transparency, liability, indemnification, and dispute resolution. Our current legal system in space is oriented toward launch and satellite operations, not towards active private sector initiatives in space and on celestial bodies such as the Moon and asteroids. It is clear that a balance between governmental objectives and commercial assurances on financing and profits will have to be made. Similarly, the dual-use nature of space will have to balance national security with business risk-taking. An *ad hoc* national or international legal regime will not serve any nation or company well. This paper will suggest ways to approach these required changes in international space law that will be evolutionary and consistent with the current space treaties and international law.

Introduction

Times change and technology advances. What can be accomplished in outer space today far exceeds the accomplishments of the 1950s and 1960s. Additional major changes in future uses of space are on the threshold of being realized. Reaching beyond the technological capabilities alone, governments,

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once the only organizations capable of funding and performing in space, are being complemented by profit-seeking private sector entrepreneurs.

The law does not change as fast. The international framework of space treaties were negotiated and drafted over 50 years ago. Politics, governments, economies, and global dynamics now call for major changes to space law. However, the same motivating forces also make the prospect of implementing legal changes to the system very much more complex and difficult. It is unlikely that the current treaties will be redrafted or amended, mainly due to difficult threshold of one-half of those States party to the treaties need to approve amendments. This, coupled with today's very changed political environment makes it unlikely that any amendments or a new space treaty will be forthcoming any time soon.

Even more of concern to future progress in space exploration is that national laws and regulatory systems are also slow to change. The fragmentation of regulatory approaches (both within nations and among nations) and the lack of predictability and stability will make private funding difficult and profits even more elusive for space operations.

Space capabilities are changing as well. Although not yet operational, progress is being made rapidly on different activities that will occur in outer space itself—separate and quite different from almost all previous space activity. These include:

- In orbit satellite servicing of various types
- Active debris removal technologies
- Planetary defense such as moving Near Earth Objects
- Resource utilization and extraction from the Moon and asteroids

Each of these activities is being discussed separately. Each of these activities is usually, when structured by governments, done in a separate facility and program. And, the legal issues, if they are discussed at all, are also analyzed in a fragmented format.

Yet, no matter how different the technologies involved are, the legal issues, which are unresolved by most traditional space law interpretations of the current system, are not being discussed in a coordinated and useful way. Governments are concerned, but companies consider these legal issues as very serious barriers to financing and success.

I. The treaty framework

The five United Nations space treaties form the structure of the international space law system.¹ (And derivatively, they are also the basis of national space law.)

¹ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [Outer Space Treaty or OST].

These treaties reflect the technology and the space operations of the era they were created in. And, for about 50 years they have been remarkably successful in providing basic principles focused on peaceful uses of space and the obligation of nations to oversee all space activities and insure safety and financial responsibility for their space assets.

With the exception of the Moon Agreement, the treaties are oriented more toward issues with launching payloads than with issues of operations in space. Liability is clearly defined if a launch goes wrong and/or a space asset reenters the atmosphere and lands on Earth. And, that liability falls on the Launching State(s) and is absolute.² A space object is defined as a launch vehicle and its parts.³

But a satellite as a space object is defined as the object and its component parts;⁴ a much more vague definition for in-space and on-orbit assets, particularly when viewed in today's world of potential small particles that are "debris." Similarly, liability in-space is fault based with no clear definition of a duty of care, negligence, or other determinants of fault.⁵

The reason for clear rules for launches and less clear rules for in-space activities is simple—accidents and issues of in-space activities were not really important to the drafters of the treaties. They were of little risk and unlikely to be invoked 50 years ago. Satellites were only transmitting signals back and forth and when they reached the end of their lives, they remained in orbit and were harmless because there were few other satellites in the large emptiness of space.⁶ Governments owned and operated, or controlled any on-orbit assets and directly assumed any liabilities imposed by the treaties. Any other activities in space were not serious enough or imminent to be of concern and the few privately owned telecommunications satellites were heavily regulated.

Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, *opened for signature* Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [Rescue and Return Agreement]. Convention on International Liability for Damage caused by Space Objects, *opened for signature* Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [Liability Convention or Liability Convention]. Convention on the Registration of Objects Launched into Outer Space, *opened for signature* Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S.15 [Registration Convention]. Agreement Governing the Activities of States on the Moon and Outer Space, UN Doc. A/34/664, *opened for signature* Nov. 1979; UN Doc. A/34/20, Annex 2; UN Doc. A/RES/34/68; 1363 UNTS (1979) ILM 1434 [Moon Agreement].

² Liability Convention, Art. II

³ Liability Convention, Art. I

⁴ Liability Convention, Art I

⁵ Liability Convention, Art IV

⁶ An exception to this general practice was made for satellites in the geosynchronous orbit. They generally were lifted into "graveyard" higher orbits to make room for safely providing space for replacement satellites. It wasn't until 2004 when the FCC made that practice mandatory for U.S. licensed GEO satellites.

Even today most nations have not implemented any direct regulatory authority over commercial activities in-space and on-orbit, mainly because until now there was nothing to regulate. In the United States there are licensing regimes for launching (DOT/FAA), using spectrum (FCC) and remote sensing (DOC/NOAA). For anything else there is not designated authority to oversee safety and financial responsibility. Even insurance policies are not required for any operations other than launching.⁷

None of the proposed new commercial activities that involve much higher risk factors such as servicing satellites, moving NEOs, or extracting resources from celestial bodies are under the licensing jurisdiction of any U.S. federal agency.⁸

This paper does not argue that the treaties and basic principles of space law are outdated or obsolete. These principles are: using space for the benefit of all nations and peoples, having no sovereignty claimed in outer space by any nation, allowing the freedom of access to space by all nations, using space only for peaceful purposes, and prohibiting weapons of mass destruction to be used in space, continue to stand as important guiding tenants for space activity. The treaties themselves should not be changed.

But, the paper does advocate for the need to recognize the reality of today's world and to change the rules for those in-space and on-orbit activities that will be among the inevitable technological successes in space of the 21st Century and possibly also be commercially profitable at the same time.

Another major change from the past century is the fast growth of private sector for-profit companies developing capabilities of exploring and using space both in cooperation with governments and also independently. Space law will need to recognize the clear distinctions between government missions to space, public private partnerships, and government regulatory oversight of for-profit space activities.

Thus, both the technological and the market forces related to space activities are now different. Attempts by government agencies, regulators, or policy to ignore these changes could result in the eventual failure of our present space legal structure. In order to maintain the system, the implementation of treaty principles will have to adapt to these new conditions.

⁷ Even though the required launch insurance for a U.S. licensee does not extend to prolonged on-orbit activities, companies sometimes still buy policies to protect themselves from liability. It is also noteworthy that the U.S. Government remains responsible and liable under the treaties for all U.S. government and non-government space activities.

⁸ However, they still will require launch licenses (FAA), spectrum allocations (FCC), and, if performing remote sensing activities, a license from NOAA.

II. Changing Technology vs. Static Law
A. Technology and U.N. Treaties

The space treaties are purposely designed to be difficult to amend, as each requires a majority of the States party to a treaty to agree on any changes. Even then, if a State that is already party to a treaty does not accept the amendment, it is not bound by that amendment.⁹

However, three of the treaties, the Liability Convention, the Registration Convention, and the Moon Agreement do call for the U.N. General Assembly to consider a review of the treaties ten years after they have entered into force. This has never happened.

Also, each of the treaties allows States party to that treaty to withdraw from the treaty if they give one year’s notice. This, too, has never been done.

It is clearly evident that any major changes to international space law will not come directly from changes to these treaties.

The Vienna Convention on Treaties, Section 62, does specifically allow for a treaty interpretation to recognize a fundamental change of circumstances.¹⁰ But, neither technology nor market conditions are mentioned specifically. And, the effect of those conditions must radically transform the extent of obligations still to be performed under the treaty. Although it could be argued that this might apply to space law, these tests may be too stringent to easily invoke this provision of the treaty.

B. Government vs. Commercial Space

Government	Commercial
Mission success	Operational system
Longer-time frame but constrained by annual budget decisions	Short term focus: profit/cash flow Exception: private entrepreneur funding
Public welfare	Maximize profit
National security	Sustainable operations
Cost effectiveness	Least cost, maximum efficiency
Next engineering/science program	Next consumer/client product
Budget priorities	Private financing/ROI

⁹ Vienna Convention on the Law of Treaties, 1155 U.N.T.S. 331, 8 I.L.M. 679, entered into force Jan. 27, 1980, Article 40(b)(4).

¹⁰ Vienna Convention on Treaties, Section 62

Government	Commercial
Authorization/appropriations	Cash flow
Separate R&D, Construction, Operations budgets	Plan for life cycle funding
Treaties, Law, Regulations for the public good	Regulatory hurdles, compliance, taxes/user fees

Governments and private companies think differently. They have different objectives, financing potential, and management. The table below illustrates some of these differences.

Only when they are obligated to each other through a formal partnership agreement or through law and regulatory actions can they work together effectively and over a long period of time.

Commercial space cannot survive and prosper without significant changes to the current regulatory system. All space, including private operations proposed for in-space activities, is dual-use. Any operations in space will trigger potential unlimited government liabilities, whether the government performs these activities or not.¹¹

Commercial companies need investors. Investors need assurances that they can have the opportunity to earn a profit and a fair return on their investments.

This means that companies need to be assured that the national regulatory regime is predictable, stable, fair, and timely. These conditions only partially exist in most nations and, as mentioned above, do not currently exist for many in-space activities. This may have a serious destabilizing influence on commercial activities, particularly as they progress from R&D stages to operational stages. Within the next decade many of these commercial prospects will be squarely facing these financial and legal challenges.

The following sections will, using the United States regulatory system as an example, outline the pressure points and suggestions for improving this system to stimulate both new commercial space operations as well as better government/industry partnership arrangements.

III. Pressure Points: Legal and Economic

Working in space should be considered in a different category from the types of common space activities of the past 50 years: launching and data transmission from orbiting satellites. Of course some high visibility government programs like the Apollo moon landings, Skylab, the Space Shuttle, MIR, and various Mars landers led the way for today's proposed new efforts of working in space.

¹¹ OST, Art. VI and VII, Liability Convention, Art. IV.

But, those programs clearly involved governments taking all the responsibility, liability, and risks. They also were clearly space exploration aimed at better science, engineering, and learning. When they involved more than one nation, the cooperation was done by mutual consent.

Even with international acceptance of these major government space missions, today, decades later, there are still remaining open and unresolved legal issues concerning landing sites and the equipment that remains in space.¹²

A. Legal

The pressing legal issues of these new space activities are two-fold: honoring national responsibilities for international treaty obligations and developing a transparent and workable national regulatory process. The difficulty is balancing government mission needs and commercial interests with treaty requirements that were designed for a different era and with apparent ambiguities.

Space treaty issues such as sovereignty and property rights overlap economic and law through regulatory policies that inhibit private investments. In various formats, this involves the potential for a government to deny permission to perform commercial activities that might be deemed a violation of either government priorities (e.g. national security) or treaty principles. Given the general economic trends and market developments, governments should also recognize that they don't have the ability to "fix" or control international market dynamics with outdated regulatory actions.

Therefore, the crucial economic issues involve the management of risk, the right for a private entity to have an opportunity to make a profit (defined here as a fair return on investment), and an international recognition for governments to encourage companies to develop products and services performed in space for sales to governments and to private customers.

The most important international legal issues that will need clarification and better definition as commercial interests expand in space are:

- Defining and identifying a nation's responsibility under Article VI of the OST when assets in space are sold, transferred, or otherwise disturbed by the nation that is not the launching state nor state of registry,
- Distinguishing sovereignty from ownership, property rights, and liability, particularly with respect to using resources found on celestial bodies.
- Similarly, linking the registration of a space asset to true jurisdiction and control, not just the jurisdiction and control of the first launching state and/or the original state of registry,
- Identifying and defining the difference between a launch from earth and a launch from a space-based asset,
- Clearly defining a separate liability regime for in-space incidents that doesn't contradict or violate any provisions of the Liability Convention,

¹² Hertzfeld H. and Pace, S, *International Cooperation on Human Lunar Heritage*, *Science*, Vol. 342, 29 November 2013

- Provide for an international binding and enforceable system of dispute resolution for space incidents.

Essentially, the above issues revolve around three principles: (1) *state responsibility* being attached to the most logical state(s) associated with a space asset, and (2) the avoidance of performing an action that results in *harmful interference* with the assets of another state while in outer space, and (3) *resolving any disputes* in outer space peacefully, effectively, and in a fair and impartial manner.

Today, none of these legal principles are well defined. So far, luck has been in our favor and there have been no in-space incidents that have occurred that have (1) not been resolved by diplomatic negotiations, and (2) have created enough economic damage in space to warrant a test in a court of law.

The space community should not wait for the inevitable test case. If we do, any hasty solution will be too little, too late. And it would likely result in a patchwork of ineffective compromises, or so narrow that it is oriented toward one particular situation to insure that that particular type of incident won't occur again.

Governments may be able to settle disputes involving government assets, but when the mix includes valuable commercial assets, the need for a more formal set of definitions and rules will be necessary.

B. Economics

Economic policy should recognize the unmistakable changes in market trends in the space sector. The wave of smaller and less expensive satellites with marketable consumer products, servicing satellites that will someday extend the life of existing commercial satellites, and a potential business opportunity to extract and use the scarce resources found on other celestial bodies on Earth and/or provide resources and other services for use in orbit are examples of these business opportunities.¹³

The first lesson taught in Econ. 101 is the definition of economics. The essence of that definition is that economics is the study of how human beings make choices for the allocation of scarce resources to satisfy human wants and needs. Outer space is not a true "global commons." Space has no borders and its resources are not unlimited. The space treaties are written in a manner that can be interpreted as "res communis," (space is owned by all jointly and for the benefits of all humankind). All nations are free to access and use space. Some have extended this idea to even suggest that space is a public good.

¹³ Since this paper focuses on in-orbit activities, human space adventurism and hypersonic space travel proposals are not discussed, as they will operate either in airspace or in the gray areas between the atmosphere and outer space.

The reality is quite different. As soon as something human-created is placed in space, economic questions arise. And, they multiply along with the multiplication of different uses in space and different assets placed in space.

The GEO orbit provides a very illustrative example. It is a scarce resource. The allocation mechanism for those slots was developed by nations and administered by an international organization, the ITU. The system is based on limited rights granted on a first to use a GEO location. Since spectrum is also scarce, not only is the location of a satellite allocated but international negotiations and agreements also allocate the use of spectrum under principles of non-interference. And, as technology has changed, so have the rules. But the system is far more “res nullius” (not owned until first claimed) than “res communis.”¹⁴

Space is also not a public good. Economics defines a public good as one that is non-rivalous and one for which nobody can be excluded from using it. The use of outer space is a competitive endeavor, and more so today than ever where companies compete not only for government contracts but also for consumer purchases.¹⁵ It is also clear that people or nations can be excluded from space, either by policy, funding, or even through aggressive actions.

The economic changes affecting space activities over the past decade that are both technology and market driven and that are likely to not only continue, but also strengthen, are:

- Government budgets for space will be level or decreasing due to demographic trends and changing priorities, but
- More nations will devote resources to space applications and operations that enhance their ability to manage both civil infrastructure and security issues,
- Launches and access to space will become less expensive from the development of small-, cube-, and nano-satellites with advanced capabilities,
- Some space capabilities will be more cost-effective and affordable for venture capital investments,
- Private ventures in space, both directly and as suppliers to space-faring nations and companies, will compete internationally with government funded space assets and services,
- Space services will also be increasingly in competition with high altitude and alternative terrestrial technologies that offer more limited coverage but are less costly and less risky,

¹⁴ Christol, Carl Q., *Development of Current Outer Space Law*, Symposium on Commercial Opportunities in Space, Taipei, Taiwan, 21 April 1987, page 2.

¹⁵ It is important to note that competitive in this context is somewhat limited by notable barriers to entry. These include high up-front investment, significant technological and market risk, sovereign enterprises, and regulatory hurdles. As described in the text, these barriers are falling, but in reality outer space is a location that where the competition is mainly among a small number of very large firms and is focused on technological competence and success in addition to prices.

- The effective and efficient operation of various parts of a nation's critical infrastructure (electricity, water, geographic information systems, telecommunications, disaster warnings, etc.) will be increasingly dependent on space-based assets,
- Consumers will demand and use more products and services that are provided by satellite networks.

Both the supply of space-based services as well as the public and private demand for those services will continue to expand. In space, governments and private companies capabilities will become more coordinated, more combined, more international and more inter-dependent. These developments will greatly complicate the legal and regulatory framework needed for the safe, efficient, and productive use of space.

However, space will remain tied to nations and to Earth for economic and legal issues. No matter what is produced in outer space, or where the good or service is used—terrestrially or in space—the market is to satisfy human wants. There is no true economy originating in space or even law that can be governed separately from existing nation-states. Perhaps in the far future when human beings develop independent colonies in space there will be a true “space economy.”

IV. Role of National Law

The two examples below illustrate how these difficult issues may be approached. The first example is the regulatory structure for earth observations in the United States, which is one of three separate major regulatory space activities. (The others being telecommunications and launch activities). The second example is the new and future-looking commercial exploitation of space resources, or for short, mining in space.

The U.S. Department of Commerce, through NOAA is charged with regulatory authority on commercial earth observations satellites.¹⁶ Since 2000, fewer than 20 such licenses have been granted. Today, in spite of the many remote sensing satellites in orbit and selling/providing information to customers, only 4 are U.S. satellites. Those companies are in competition with both public and private entities worldwide.

With the recent launching of numerous very small satellites with remote sensing capabilities, there has been an upsurge in applications for NOAA licenses—so much so that the agency is ill equipped to handle those requests and there is a significant backlog of applications.

¹⁶ U.S. Code, Title 51, Chapter 601, Land Remote Sensing Policy, Subchapter III, Licensing of Private Remote Sensing Systems, Pub. L. 102–555, title II, § 201, Oct. 28, 1992, 106 Stat. 4171; Pub. L. 105–303, title I, § 107(f)(1), Oct. 28, 1998, 112 Stat. 2854.

Congress has mandated that NOAA issue a license within 120 days of the application.¹⁷ However, because each license needs clearance through an interagency process that includes reviews by the State Department, the Department of Defense, the Federal Communications Commission, the Federal Aviation Administration, and others, this process can take a long time. The clock stops ticking on the 120-day limit if this review cannot be accomplished as quickly as anticipated.

The result is an administrative delay, a lack of transparency in the review process, and an added risk to the company of meeting launch and operational time frames within financing and other corporate commitments. And, because of the national security sensitivity of some remote sensing operations, there is also a risk of a license being denied and/or modified so that the company cannot meet operational objectives.

While this process may have worked in the past, it is inherently flawed in today's environment where U.S. companies are delayed in offering services that foreign companies are able to offer faster. The technology has changed so rapidly that prior issues of image resolution and national security are not as important as timeliness and other factors.

In fact, remote sensing has evolved from a hardware and technology manufacturing focus to a very important and economically valuable part of the information industry. Software and the use of remote sensing information has become a "big data" issue and the control and marketing of applications based on locational awareness is a crucial part of the future of this industry. What began as a secret intelligence activity in the 1950s, then became a dual-use imagery and analysis tool in more recent years, is now moving quickly into freely available consumer information in "the cloud." Yet, the regulatory process in the United States has not adjusted to these changes.

Even some products that are available from non-U.S. suppliers on the open market such as radar satellite imagery are still prohibited as commercial products from U.S. operators. The U.S. Government is mired in a law and regulatory culture that needs to change to meet new market conditions. However, such changes, no matter how inevitable they may be over time, appear to be so difficult to make that the lack of responsiveness could undermine the civil remote sensing capabilities of the United States and encourage a shift in market leadership to non-U.S. competitors..

Another very difficult problem is presented by the new companies promoting technology developments to mine asteroids for resources to be sold to customers in space and possibly to be returned to Earth as marketable metals. In this case there is no regulatory authority. As discussed above, the Congress has not granted regulatory powers for in-space activities to any agency.¹⁸

¹⁷ Op. cit., §60121(c).

¹⁸ There are some powers granted to the FAA in launch licensing that enables that Agency to oversee a satellite until it is placed in its proper orbit and also for a space

And, even when it has, there are differences in the approaches to similar problems in the laws applied by each regulatory body.

Because of the void in regulatory authority, potential investors are concerned about the risks involved in working in-space. Even assuming that the eventual engineering, science, and technological unknowns will be solved, there remain open questions about a nation and a company's rights, obligations, and liability while performing activities in space that are very different than those that are analogous to operating an orbiting communications satellite for which there are well-defined rules.

Since there is no international precedent for these new operations, the first step for private entities will be to get approvals from their own nations to perform such activities. An example of this development is in the recently introduced bill to the U.S. Congress that would grant general approval for a company to proceed and to provide as much assurance as a nation can grant that the activities will be sheltered from harmful interference from other entities.¹⁹

The bill does not make any declaration of territorial sovereignty but does grant a company the rights to use the resources it may discover and extract from an asteroid—a position that historically has been taken separately by the United States, Russia, and Japan when they have returned space resources to the Earth.

However, the legislation, if passed by Congress and signed by the President, applies only to entities under the jurisdiction of the United States and cannot guarantee that another nation or a private company from another nation will adhere to these same rules.

This approach is an interesting first step in a new era of space exploration. It does not address all issues, nor does it solve any international issues. But, it is an indication of the types of activities that will have to be addressed by nations and the international legal community in the years ahead.

V. Recommendations

A full description of an on-orbit legal and regulatory system is beyond the limits of this short paper. Below is a set of recommendations for a selected group of important issues focused primarily on liability.

asset that is returning to Earth during its preparation for re-entry. NOAA has the authority to monitor earth observations and to revoke a license if a company violates the provisions of the license. Both the FCC and NOAA require companies to have a plan for the disposal of the satellite at the end of its lifetime (as do internal rules of NASA and the DOD), but each of those agencies imposes slightly different criteria. And NASA also issues and enforces strict safety and operational guidelines for non-governmental cargo vehicles that dock with the ISS.

¹⁹ U.S. Congress, House of Representatives, Subcommittee on Space, H.R. 5063, American Space Technology for Exploring Resource Opportunities in Deep Space (ASTEROIDS) Act of 2014.

These changes can be made at a national level; they do not require treaty amendments or a new treaty. However, it will be important that nations coordinate their laws and regulations.

Different technologies and programs with different on-orbit objectives are being developed. Most of them involve a physical connection with a man-made space object, and another object. The risks involved in performing these functions are far greater than those from most satellites that are simply orbiting around the Earth. The accompanying legal issues of State responsibility, ownership, and liability, need to be adjusted to these new commercial possibilities. The law should be uniform and as consistent as possible across all of these initiatives, and across all nations.

Recognizing that The Responsible State May Change

One objective of the OST is to make sure at least one nation is responsible for every space object. One aspect of State responsibility involves continuing supervision of that nation's space activities, both governmental and commercial. It also involves accepting liability for any damage to others.

Current interpretations of Articles VI and VII of the OST do not release the original Launching State from this responsibility and ultimate liability, even when that State has effectively no control or jurisdiction over the on-orbit activities of a particular space object resulting from the following examples:

A space asset is sold from a company in one nation to another company in another nation—the contract for the sale includes an agreement that the purchasing nation assumes all international treaty obligations for that asset.

A servicing satellite repairs a satellite owned by a different nation with a formal agreement from that nation covering future liability.

Although eventually courts of law would likely uphold the shift in responsibility of a launching State in the example above, it would be most logical to accept a rebuttable presumption in the law that the appropriate State to be responsible is the one that has jurisdiction and control over the company or companies that are operating a space asset.²⁰

It may be difficult to use the current U.N. Registration system for the purpose outline above. It would not be difficult for an international organization to recognize space objects and their owners that are not formally registered with a designation of “constructive registration” based on the nation(s) in which a company has its headquarters and/or operations center.

As long as there is at least a “constructive registration” (if not a formal one) assigned to a State of all space objects, the treaty objectives are fulfilled.

²⁰ Jurisdiction and control are terms used in Article VIII of the OST as well as the Registration Convention. Not all States that are parties to the OST have ratified the Registration Convention, and registration of space objects is at the discretion of each nation.

Redefining Liability for On-Orbit Accidents

This proposal suggests that each new accident or incident in outer space be considered as an entirely new accident. As technology for monitoring objects in space improves, the ability to predict conjunctions of space objects will also improve.

Assuming that proper and timely prior notification will be possible, any accident involving at least one active and maneuverable space object should be able to be avoided. If the owner of the maneuverable object does not take action to avoid the accident (i.e. had the last clear chance to avoid it), then liability attaches to the owner of that object.

Currently, the interpretation of the treaties suggests that if an accident in space occurs the Launching State(s) is responsible in perpetuity for any damage done by any space object it launches.²¹ Technically, that commits the Launching State to indefinite and unlimited liability, a situation is hard to enforce and potentially could discourage States from approving some proposed on-orbit activities.

In situations where both space objects are maneuverable, then traditional fault liability would apply based on the actions each party took when notified that a conjunction was possible.

In the situation where neither object is maneuverable, (and even the best conjunction analysis would be useless²²) most likely the damage would cause no immediate economic consequences, as the likely scenario in this case would involve inactive and essentially valueless space objects.²³

Establishing Liability Limits

Liability claims for on-orbit activities are likely to be minimal. Therefore States should consider setting caps on the amount of liability any owner or State may have to pay. This would make on-orbit insurance more affordable and at the same time offer innocent victims more assured recovery of losses.

Unlike an accident at launch or upon reentry of a large space object, there is virtually no likelihood of an on-orbit accident creating direct physical damage on the Earth.

If the accident on-orbit involves abandoned, or non-functioning space objects, then there is no economic loss to the launching states.

²¹ For purposes of simplicity, an assumption is being made that debris and small particles from a spacecraft will be considered as space objects, even though the formal definition is not clear that these would be deemed "component parts" of space assets.

²² It is recognized that there may be complicating factors such as the future ability to send a servicing satellite into space to deflect one of the space objects.

²³ If later debris from that accident was involved in an incident, it would, as suggested above, be considered yet again a new accident and there would be no need for a legal fault-based analysis of the prior incident.

If an active satellite were damaged or disabled, then the depreciated value of that asset would be the direct loss. Most satellites depreciate in value relatively fast.

An active satellite that was severely damaged would also possibly lose revenues from its operations. If not insured, that could amount to a large business loss. But, the example of the 12-year old Iridium satellite destroyed in the February 2009 collision with a defunct Russian Cosmos satellite, Iridium had a spare satellite already in orbit. There was no significant economic damage and there was also no lawsuit.

Finally, there could also be environmental damage in space. However, there are no good economic measures for this and a monetary valuation would be difficult or impossible.

Taken together, these arguments suggest that the total value of damage from an accident in space may not be catastrophic and would be insurable.

Changing the current liability regime for on-orbit activities from one of perpetual risk and open-ended liability to one of predictable and insurable caps on liability should be considered. There is precedent for these limits in other international legal domains such as maritime and civil nuclear treaties.

Clarify Existing Ambiguities and Contradictions in the Space Treaties

This recommendation focuses on reducing current ambiguities in the law. A full discussion of this cannot be summarized in a short paragraph. However, it is important to point out that property rights are different from sovereignty and liability. Property rights exist today in space—anything launched is owned by the entity purchasing the equipment and can be sold or transferred, even if it is space. National laws for space activities, similarly, can protect intellectual property. Liability can be assumed by anyone for anything in space, and insurance can be purchased. Real property on celestial bodies, however, cannot be claimed for ownership, as this would violate Article II of the Outer Space Treaty's prohibition on declarations of sovereignty.

The use of resources on a celestial body is permitted in the treaties. And, when the United States, the Soviet Union, and more recently, Japan returned rocks found on the Moon and on an asteroid and declared them the property of their nations, the international communities did not object.

The Moon Agreement has been ratified by only 19 nations. The Agreement contains some ambiguous language concerning the use and exploitation of resources on celestial bodies. On one hand, it is clear that the use of resources for scientific purposes is allowed. And, with certain caveats, even the exploitation of resources is also allowed. But, the "common heritage" provisions in that Agreement has been viewed as restricting commercial opportunities for using those resources.

If valuable resources are actually extracted from celestial bodies by commercial firms, the international community will have to resolve these issues. And, they will have to be resolved in a manner that does not conflict

with the prohibition of claims of sovereignty over territory and with adequate provisions to handle both harmful interference with other nation's rights as well as with liability and associated environmental issues.

Establish a Binding and Enforceable Dispute Resolution System

Currently, the principle mechanism for settling international disputes is through diplomatic negotiations. As commercial space develops, there will be a growing need for a more formal adjudication system. National courts are appropriate for disputes between citizens under their jurisdiction. International courts such as the International Court of Justice in The Hague are available for disputes between nations, but their decisions are not enforceable.

Arbitration has been used in international commercial disputes very effectively. Most cases involve contract provisions where the contract itself calls for arbitration. Through multilateral agreements, nations have agreed to enforce decisions of arbitration proceedings. It may also be possible to apply this type of dispute resolution system to other space situations where there is no contractual relationship among the parties. And, even governments may agree to arbitration under some circumstances.²⁴

Conclusion

The principles of the U.N. system of space treaties remain the basic framework of space law. These suggested changes do not violate either the spirit or provisions of the treaties. Instead, they recognize the important changes that are occurring in the use of outer space and work towards creating methods of continuing those basic ideals of into the future.

There are voids in the current legal system, and if they are not filled, there is a risk of a fragmented, chaotic, risky, and commercially unstable space investment atmosphere developing over time. It is now time to anticipate the future and create a legal atmosphere of encouraging private investment and exploration without sacrificing the principles of the past.

²⁴ Hertzfeld, H, and Nelson, T, *Binding Arbitration as an Effective Means of Dispute Settlement for Accidents in Outer Space*, IAC, Beijing, China, September 2013.