

DEVELOPMENT OF THE NATURAL RESOURCES OF THE MOON AND OTHER CELESTIAL BODIES: ECONOMIC AND LEGAL ASPECTS

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The path of gradual commercialization of current space applications, such as launch services, satellite communication services, direct broadcasting services, satellite remote sensing and navigation services, and satellite weather monitoring services, will most likely be followed by future activities of use of space resources. Ventures, like mining the natural resources of the Moon and asteroids, are likely to become technologically feasible in the near future. The question is what would be the most appropriate approach to address the future needs of exploitation of space resources: should it remain the exclusive province of state governments; should the private sector take over such space activities; or should a public-private partnership type of venture be encouraged? As state governments are becoming constrained by budget deficits, an increased reliance on private sector involvement in space activities involving the extraction and use of space resources is to be expected. When deciding whether to invest in commercial ventures of resource use exploitation, any potential private investor will be faced with the issues of economic costs, risks, and perceived regulatory barriers. This study argues that the perceived regulatory barriers, i.e., the licensing requirement, the “common heritage of mankind” principle of international space law, and protection of intellectual property rights, are not obstacles to economic development. Governments should provide both policy and regulatory incentives for private sector participation in the area of space natural resource use by funding basic research and development and by sponsoring liability insurance for private ventures among other incentives.

With the prospect of space missions to the Moon and other celestial bodies becoming a reality, the issue of finding ways to sustain such missions is important. Energy and economic sustainability are keys to this. At the same time, it is essential to define an adequate legal framework for the exploration and use of the resources available on the Moon and other celestial bodies. Space-resource utilization

issues are increasingly gaining the interest of policymakers and space industry representatives all over the world.

Natural resources discovered on the Moon include oxygen from the lunar soil, water from the ice poles, and numerous volatile gases that can be used to supply fuel and construction materials. All these resources can be exploited for permanent bases on the lunar surfaces and space missions to/from the Moon.¹ Perhaps, the most valuable resource on the Moon is Helium-3, a fuel that can be used to support a future development of nuclear fusion for energy. Helium-3 is considered by some experts as an ideal fuel because it is powerful and has the advantage of generating very little radioactive by-product.² While scarcely available on the Earth, Helium-3 is estimated to be plentiful on the Moon.³ Experts argue that this rare isotope could be extracted and transported to the Earth using existing terrestrial mining technology.⁴

The planet Mars also appears to host valuable resources. The National Aeronautics and Space Administration's (NASA's) Phoenix Mars lander found evidence of water on Mars.⁵ In addition, the discovery of relatively high concentrations of methane on Mars is another element that tends to suggest that there may be Martian life forms buried underground.⁶ Scientists are optimistic that more discoveries are waiting on Mars.⁷ However, the cost of exploring Mars by humans is controversial. One estimate puts a price tag at \$1 trillion for a mission that would use the Moon as a stop-over.⁸ This estimate was challenged by others as being a "completely inaccurate reading of historical data and deeply flawed mathematics."⁹ Even NASA officials called the price tag of \$1 trillion "preposterous,"¹⁰ without providing a more precise estimate.

Scientists believe that asteroids contain rare elements and water as well.¹¹ Some argue that mining the asteroids would involve lower costs than retrieving lunar resources and the quality of asteroidal material, such as free metal—iron-nickel—and volatiles—water, carbon, and others—is generally deemed superior to lunar material.¹² The technology to be applied in mining and basic processing of asteroidal material may soon be available.

It is undeniable that the use of space resources can contribute significantly to the exploration of space by providing new energy sources and reducing the need for the use of Earth's sources. Future large-scale activities in space will most likely require raw materials

obtained from in-space sources rather than from Earth to compensate for the high cost of space launch.¹³ Therefore, we can anticipate a future market for such resources of precious and Earthly-rare minerals from the Moon and other celestial bodies, including near Earth asteroids.¹⁴ Some experts caution that this market will only take off when cheaper launch technology is available and space tourism will constitute the driving factor for space development. Others suggest that space resources can be used to make permanent bases and fuel missions in a much less expensive way than having similar materials launched from Earth.¹⁵ As such, the idea of mining natural resources from outer space might be transformed into reality much sooner than expected.

In fact, in recent years, the exploration of natural resources on the Moon, Mars, and other celestial bodies received considerable and growing attention from spacefaring nations. For example, in February 2004, NASA released “The Vision for Space Exploration”¹⁶ based on United States (U.S.) President George W. Bush’s new space exploration policy, “A Renewed Spirit of Discovery: The President’s Vision for U.S. Space Exploration.”¹⁷ The new policy, now renamed the U.S. Space Exploration Policy, makes the human return to the Moon by the year 2020 a priority for human space missions as precursors for human exploration of Mars and other destinations.¹⁸ The main rationale is that a permanent lunar base on the Moon could lead to the development and testing of new sustainable exploration approaches, including space resource utilization.¹⁹ This is also the rationale for a number of other spacefaring states.

Russia, for example, announced more definite plans to mine the isotope Helium-3 on the Moon by 2020.²⁰ The project will involve building a permanent base on the Moon by 2015, and establishing a heavy-cargo transport link that would allow industrial-scale delivery of this rare isotope.²¹ The European Space Agency (ESA) undertook steps to explore the Moon as well by launching a spacecraft on 27 September 2003, which entered lunar orbit on 15 November 2004, carrying a set of miniaturized instruments that studied the chemical composition of the lunar surface.²² China expressed intentions to explore the Moon and is allegedly considering the prospect of lunar mining.²³ On 14 September 2007, Japan launched the Kaguya (SELENE) mission to explore the Moon from orbit.²⁴ In addition, the Japanese Space Agency (JAXA) is

planning a long-term space program that includes constructing a research base on the Moon starting around 2025.²⁵ The Indian Space Research Organization (ISRO) plans to launch a robotic mission to the Moon (Chandrayaan-1) in October or December 2008. This mission will involve the placing of a 525-kg spacecraft around the lunar orbit, with the purpose of collecting data that will allow for the chemical mapping of the entire lunar surface.²⁶ This new ISRO project reflects the views of the scientific community in India that advocate the need to seriously pursue the mining of Helium-3 from the lunar surface.²⁷

Various challenges arising out of government budgetary constraints, increased societal needs for resources, and the quest for major technological advances raise the question of what would be the best scenario to efficiently conduct the exploration and use of space natural resources. This study considers the economic and legal aspects of future initiatives to explore and possibly extract natural resources available on the Moon, Mars, and other celestial bodies.

Changing Roles of the Main Players in the Space Industry

From the beginning of the space age, states have been the main players in the space arena. They heavily invested public funds in new capital-intensive ventures, and carried out, as state activities, space exploration and operations primarily for the purposes of national prestige as well as security and strategic competition with rival states. Such rationales and the role of states are still true to a large extent. During the 1970s and 1980s, the world also witnessed the emergence of new space players in the form of intergovernmental operational organizations, like Intelsat, Inmarsat, Intersputnik, European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), Eutelsat, and Arabsat. These bodies were established by states, under international treaties, and were granted their own international legal personalities for the purposes of carrying on specific space operations. These organizations were designed to exploit space technology, in a businesslike manner, for telecommunication purposes.

In the 1990s, the global space sector welcomed the entry of the third group of space actors, i.e., private enterprises. Even though

private companies have been involved in the space arena from the dawn of the space age, their role was primarily to serve as contractors for government space activities. Concomitantly, the private sector played an independent role as it relates to the commercial exploitation of space applications. This transformation in the private sector's role in the space field has been strongly influenced by global political and economic trends towards privatization, commercialization, deregulation, and globalization of almost all human activities. Most of the aforementioned intergovernmental organizations have already been privatized. Presently, private companies are carrying out, as their own operations, commercial services for telecommunications, Earth observation, launch of space payloads, and navigation.

Recent developments in commercial space show the order of magnitude of the global space sector and the extent of the role played by various actors in this arena. The space industry has become an area of global economic activity. In 2007, for example, the global economic impact of space industry was estimated to be around \$251 billion.²⁸ According to *The Space Report 2008* of the Space Foundation, "Commercial satellite products and services continued to pace the market, accounting for 55 percent of space-economy activity worldwide, or \$138.8 billion That is an increase of 20 percent over 2006."²⁹

There is a dramatic shift going on in the space industry. While commercial space products and services are being increasingly utilized by military forces,³⁰ commercial enterprises have become users of military space assets.³¹ To illustrate, the U.S. military's Global Positioning System (GPS) is very important to civilian population uses, and it is estimated that 18,000 people worldwide were saved with the help of satellite-aided search and rescue with 5,000 of those in the U.S.³² GPS has also become a lucrative business for the civilian sector. The implication of this new relationship of interdependence, according to retired General Lance W. Lord, former Commander of U.S. Air Force Space Command, is that "Removing space capabilities from our [American military] way of life would not only cripple our combat forces, but it would have catastrophic consequences on our entire economy."³³

The scope and nature of space activities of the private sector is constantly changing. Private enterprises are no more confining their activities to the commercial exploitation of space applications. They have embarked upon the domain hitherto almost exclusively

dominated by governments; i.e., research and development of new space technologies and their applications, not only for Earth-based commercial operations, but also for space exploration. One example, in this regard, is that of the recent design, construction, and successful testing of the SpaceShipOne vehicle by a small private company called Scaled Composites for sub-orbital travel by ordinary human beings.³⁴ Also, funded entirely by private capital, SpaceX is developing a heavy lift launch vehicle, Falcon 9, that will be applied to support human spaceflight.³⁵

Scenarios for the Development of Natural Resources

As noted above, space activities were initially the exclusive domain of governments. Yet, the trend of increased involvement of the private sector in space applications has changed the economic and political landscape of space activities, and raises questions about the role that governments and commercial ventures could play in partnership in the exploration and use of space natural resources. The range of plausible scenarios include: governments should be exclusively responsible for executing space activities relating to the exploration and use of space natural resources; the private sector should be allowed to take over the area, with or without initial support from the government; or public private partnerships (PPPs) are established to balance the public obligation to provide safe services, and to find the most cost-effective means for achieving this objective.

Government's Changing Involvement

Nowadays, due to significant budgetary constraints, governments seem to have difficulties making space exploration a spending priority. Even in the U.S., where the government recently made a strong case for efforts to return to the Moon and the Mars, the budgetary realities show the sacrifices required in order to allocate monies to such a project, i.e., it had to postpone or eliminate several projects deemed important by various sectors, such as robotic missions to the icy moons of Jupiter, in particular Europa, which is thought to contain a subsurface sea of liquid water making it a potential candidate for harboring alien life.³⁶

In addition, it appears unlikely that taxpayers are in favor of funding a large-scale lunar or Mars mission that does not give direct economic payback.³⁷ The need to spare taxpayer money from being spent for Moon and Mars missions was pointed out by Citizens Against Government Waste (CAGW), a non-profit organization in the U.S.³⁸ According to this group's president, Tom Schatz,

Mankind's future in space no longer depends on politicized bureaucracies and tax-funded boondoggles. The success of SpaceShipOne, startup space companies, and the advent of space tourism have opened the door to an exciting future of private enterprise in space. Such endeavors are economical, realistic, and more likely to yield tangible benefits for mankind and taxpayers.³⁸

The group challenged the usefulness of a U.S. House of Representatives appropriation for NASA's budget of \$16.5 billion, including \$3.1 billion for the Moon/Mars initiative. The CAGW pointed out that the International Space Station (ISS) is "expected to be finished in 2010, 16 years behind schedule, \$92 billion over budget, with perhaps one-eighth of the capability that engineers had hoped." This group found a worrisome trend of wasteful government spending in the space arena: "The ISS is a glaring link in a continuous chain of space projects that are either abandoned, end in disaster, or deliver far less than promised."³⁹

In an era when governments are much more cost-conscious in order to reduce government deficits while not increasing taxes, more reliance on the private sector for funding new projects is the likely outcome. Moreover, there is an increasing worldwide trend towards relying on private investors rather than government for development in space.⁴⁰

Private Sector's Possible Involvement

Many experts argue that when private money becomes involved, the values become cost and efficiency, and thus, commercialization of this area of space applications should be encouraged.⁴¹ President Bush's "Vision for Space Exploration" called for a larger role for private industry in space exploration.⁴² The Commission on Implementation of U.S. Space Exploration Policy,⁴³ established

to formulate recommendations for implementing this new vision for space exploration, released a report⁴⁴ that stresses the need to transform NASA's relationship with the private sector to reflect the new space exploration vision. The goal is to ensure a large presence of private industry in space operations by allowing private companies to assume the primary role of providing services to NASA and giving preference in operational activities to competitively-awarded contracts with private and non-profit organizations.⁴⁵ In this context, "NASA's role must be limited to only those areas where there is irrefutable demonstration that only government can perform the proposed activity."⁴⁶ In addition, the report recommends that

... Congress increase the potential for commercial opportunities related to the national space exploration vision by providing incentives for entrepreneurial investment in space, by creating significant monetary prizes for the accomplishment of space missions and technology developments, and by assuring appropriate property rights for those who seek to develop space resources and infrastructure.⁴⁷

In view of such governmental policy, a private company, Lunar Transportation System (LTS), has undertaken to "design, build, ground test, flight test, and operate an Earth-Moon transportation system."⁴⁸ Although initially the U.S. government would be the major customer, it is expected that private sector customers might require future LTS services.⁴⁹ Explorations of the Moon and other celestial bodies and their natural resources are, undoubtedly, on the serious operational strategies of private enterprises and the potential success of "private" projects, like the one mentioned above, can serve as a stimulus to private sector space.⁵⁰

In order for the private sector to find the area of exploration and use of natural resources appealing from a business perspective, several requirements must be met.

- There must be a market for the products.
- There must be a reasonable payback time. It is estimated that the private sector will not invest much into technologies or products whose payback exceeds five years, especially if the front end capital cost is large or the risk is perceived as high.⁵¹

- Reasonable access to the resources, and reasonable launch and transportation costs.
- Readily available technology for extraction and processing of natural resources on the Moon and other celestial bodies.
- Manageable risks, such as an adequate insurance environment.
- Legal protection of property rights as to real property and intellectual property.

Regarding the market for the products, it appears that at least for some resources, such as Helium-3, there will be immediate customers. Although space projects undertaken by private sector utilization of resources are characterized by high front-end investment, long payback time, and high risk, relative to most other non-space business ventures, in the case of space natural resources utilization, it is estimated that the initial quantity of resource required until payback would be less than what was required in the case of the building a major transcontinental pipeline and approximately the same as for a large offshore oil exploration and production projects.⁵²

Even though the costs of getting to the Moon, Mars, and other celestial bodies and of returning to Earth are so high that the commercial exploitation of space natural resources is economically unfeasible at the present time,⁵³ costs should not halt commercial initiatives because of the following reasons.

- The cost of space resource utilization is comparable to large-scale terrestrial projects, and the actual launching cost will not be the main cost item in the project budget.⁵⁴
- The high cost of space launch drives up the market price and profitability of space resources. If space launch costs come down, the price of products and services from space resources will come down, and so will the profit.⁵⁵
- There is no reasonable expectation that space launch projects currently under development by governments will dramatically reduce the cost of launching from Earth. Instead, cost reductions will occur as a result of more private ventures entering into the market.⁵⁶
- Space resources utilization is estimated to have a shorter payback time than many projects of the same amount of investment on Earth, at current space launch costs.⁵⁷

One element that plays a major role in the future of commercialization of exploration and use of space resources is the issue of protection of property rights. A strong private property regime can encourage commercialization and settlement of outer space. A communitarian property system will inhibit economic development and leave exploration and settlement in the realm of governments, who cannot always afford to undertake such activities.⁵⁸ Experts anticipate an integrated system of lunar and asteroid mining, habitation in outer space, and space-based solar power generation. In such scenarios, the right to maintain a facility in a given location relative to another space object, or the right to exploit a given mineral deposit on a celestial body, may lead to conflicts. The institution of real property appears to be an efficient method of allocating limited resources, like materials and location.⁵⁹ According to Wayne White:

A regime of real property rights would provide legal and political certainty. Investors and settlers could predict the outcome of a conflict with greater certainty by analogizing to terrestrial property law. Settlers and developers would also be reassured knowing that other nations would respect their right to remain at a given location.⁶⁰

Mineral rights, spectrum rights, rights of way, orbital slots, intellectual property, and title deeds are essential factors in accomplishing an optimal development environment for space resource utilization.⁶¹ A private company would likely not invest in lunar or asteroid prospecting and mining until private property rights are guaranteed; investors prefer to be protected against unlawful interference from others.⁶² The provisions of international space law addressing the issue of property rights in outer space are discussed later in this paper.

To summarize this section, one can anticipate that the discussion over the need for a regime providing for property rights is likely to become increasingly debated as space develops. As mentioned above, in the U.S. the report published by the Commission on Implementation of U.S. Space Exploration Policy recommends that “Congress increase the potential for commercial opportunities related to the national space exploration vision by . . . *assuring appropriate property rights for those who seek to develop space resources and infrastructure* [emphasis added].”

The next section turns to the issue under debate as to whether the government should get involved in assisting large-scale development of the space field by the private sector, and if so, what are the ways in which governments can get involved.

Government Incentives to Promote Private Sector Involvement

Given the perceived difficulties that confront private companies from starting large-scale development of space applications related to natural resources from the Moon and other celestial bodies, governments should assist the private sector in several ways. It can be expected that the private sector might take over once the difficulties of covering the start-up costs and building initial infrastructure are overcome. Assistance can take on different arrangements discussed below.

1. Funding Basic Research and Development (R&D). Especially in those areas where R&D costs are high, the payback times are long, and the perceived risks are high, governments could provide funding for R&D.⁶³ The results of government-funded R&D should be made available to all competing private companies, thus ensuring a basis for fair competition.⁶⁴
2. Funding Deployment of Initial Infrastructure. Governments should fund the initial infrastructure, for example, a space station and interorbital vehicles.⁶⁵ The services provided by such infrastructure should be auctioned to the highest bidder, however, the private sector should be allowed to provide additional services. Once the private sector starts providing the same services, the government should let the private sector take over that market.⁶⁶
3. Providing a Guaranteed Market/Initial Customer. Here, the government should not fund any development, but simply guarantee a minimum market for the products resulting from the extraction and use of space resources. The private sector needs to be sure that if they produce, for example, fuel propellants or radiation shielding from lunar materials, these products not only will be marketable, but that there is an immediate customer for them and there is a guaranteed price for products and services from space materials.⁶⁷ Governments could guarantee that they would buy a certain quantity of such

products at a certain price in case no other customer made a similar offer. Obviously, if a private customer offers a higher price, the government is relieved of the obligation to buy the products.⁶⁸

4. Providing Government-sponsored Insurance. Since space based activities are high risk, the insurance costs to cover such endeavors are also very high.⁶⁹ Buying sufficient insurance is, in many instances, an obstacle for start-up companies to get into the space business. Governments could cover partially the insurance associated with carrying out exploration and extraction of resources on the Moon or other celestial bodies.⁷⁰ In this way, the start-up costs and the risk for interested private companies would be reduced.
5. Enacting Legislation Providing the Necessary Regulatory Framework for Promotion and Liberalization of Commercial Space Activities. Governments should adopt laws and regulations that would clarify issues of private property and intellectual property related to exploration and use of space natural resources consistent with their international responsibilities. Also, a proper regulatory framework needs to address issues of public interest and safety. Steve Doyle summarized the role of governments: "The function of governments is to protect the public interest by licensing or otherwise regulating the use of resources and ensuring that commercial operations are safe and environmentally acceptable."⁷¹
6. Granting Tax Incentives and Loans at Preferred Interest Rates. Following the same rationale as above, it is suggested that governments should provide interested private companies with tax incentives and loans at lower interest rates than high-risk loans.
7. Sponsorship of Development of Appropriate Technology and Systems Development. Such initiative is undertaken in the U.S. where NASA's Centennial Challenge program co-sponsors with the X-Prize Foundation a competition offering \$2 million to the private company that designs a Lunar Lander Analog. This challenge aims to stimulate the development of the kinds of "rockets and landing systems that NASA needs to return to the Moon, while also accelerating the development of the private sub-orbital space flight industry."⁷²

Public Private Partnerships (PPP)

The concept or model of PPP is generally defined as “partnerships between the public sector and the private sector (industry), for the purpose of delivering a project or a service traditionally provided by the public sector.”⁷³ In most instances, the public sector contracts for infrastructure development and deployment as well as for management and operations where risks are allocated between the public and private sector.⁷⁴ The procurement of a service under a PPP opens a wide range of options for public entities that do not have the skills to carry out a particular project or have budgetary constraints.

PPPs are likely to generate substantial benefits for customers and taxpayers if the appropriate allocation of responsibilities between the private customer and the public contractor is achieved. In terms of risk allocation, the controlling principle for PPPs is that a risk should be transferred to the party best able to manage or control it.⁷⁵ Typically, the private sector assumes the design, development and construction risks, the operational and maintenance risks, the performance risks, inflation risks, and other financial risks. On the other hand, the market risks and residual value risks, dependent on the duration of the contract and the nature of the assets, are shared between the private and public sector. The policy and legislative risks are allocated to the public sector.⁷⁶

In the space sector, relevant examples of PPPs include the Skynet 5 project, undertaken in the United Kingdom (UK), and the Galileo concession. In the former instance, the British Ministry of Defense (MOD) selected the PPP model to conceive a military satellite communications system destined to replace the MOD's Skynet 4 satellites. It was estimated that the PPP model would save the UK government £500m over the lifetime of the contract.⁷⁷ Under the 15-year concession contract, a private company delivers core military satellite communications to the UK armed forces, also having the permission to commercialize spare capacity to third parties. The arrangement involves taking over the ownership and operation of the existing Skynet 4 infrastructure and incorporating two new Skynet 5 satellites and the associated ground segment. Full service availability is expected in 2008.⁷⁸

The Galileo project started in 1998 when the European Commission (EC) announced plans to develop a European Global Navigation Satellite System (GNSS) in coordination with ESA. For the deployment and operation of Galileo, a 20-year PPP scheme was proposed as what was believed to be the most cost-effective way to meet the public sector's objectives, while attracting private investment. In this particular PPP scheme, the public sector represented by the EC and ESA were to be responsible for the definition and development and in-orbit validation phases, which will include the launch and testing of four satellites. The deployment and operation phases were to be managed under a PPP with a private Galileo concessionaire, who should have completed the 30-satellite constellation, the afferent ground segment, and provide the users with Galileo services. The involvement of private finance was expected to reduce the need for public contributions over the 20-year concession period. However, due to failure to agree on how to organize the public consortium, the EN decided in June 2007 to abandon the idea of a partnership with the private sector and opt for an exclusive public funding of the project.⁷⁹

PPP projects are one way to provide win-win situations for both the public and the private sector.⁸⁰ However, not all states have the required legal framework to allow for implementing PPP models. In any event, it is clear that private companies are becoming active players in the global space industry. For this to be fully realized, the shortage of public funds and inherent inefficiencies of government operations and undertakings are important to be addressed. As such, the role of the state might not diminish, but would change from the developers and operators of space systems to the regulators of space activities. To expand and flourish, private entities need minimum interference from the government. Unfortunately, primarily due to the dual purpose character of space technology and operations, state control over private companies is not likely to be lessened.

We will next assess the applicable international space regulatory regime to determine to what extent it serves as a roadblock or stimulus for the space activities of private companies. We will also outline some important steps that governments need to take to stimulate and sustain space activities of private actors. It must be kept in mind that this is an inventory of important issues

relevant to the participation of private entities in the exploration and exploitation of natural resources of the Moon and other celestial bodies. We do not intend to provide answers to all questions, but to raise them so that they may be discussed in depth by others.

Regulatory Issues Relating to Participation by Private Entities

Primarily due to the physical nature of outer space, including the Moon and other celestial bodies, the international community has been creating an international legal regime of outer space primarily through the United Nations' Committee on the Peaceful Uses of Outer Space (UNCOPUOS). The most fundamental agreement within this regime is the 1967 Outer Space Treaty that has been ratified or signed by 125 States.⁸¹ Some of the provisions of this Treaty have been further elaborated in four separate agreements.⁸² In addition to the general application of a few other important treaties,⁸³ these five agreements are the nucleus of current international legal regime governing outer space and the natural resources therein. As noted earlier, during the 1960s and 1970s when the foundations of this international regime were laid, states were the only players in the space arena. Therefore, this legal framework was perceptibly adopted largely and essentially from the perspective of states. However, the emergence of private entities as new players with growing importance gives rise to legal implications and posits challenges that were unknown earlier. In this part of the paper, we will analyze the current international regime with a view to critically determine the relevance and viability of its principles and rules pertinent to the activities of private entities in the exploration, use, and exploitation of natural resources of the Moon and other celestial bodies.

We should keep in mind that irrespective of the increasing significance of the private entities in the space sector, states remain almost exclusively the subjects of international law. Peter Malanczuk correctly asserts that, "even much more than in general international law, there is no doubt that states are still the primary and predominant actors in space law. Legally speaking, this is a clear consequence of the fact that it is states which create space law in the form of treaties, custom or other international instruments

and which provide for rights and duties of other entities. States also create international organizations active in outer space and regulate, supervise and license private operators within their national jurisdiction who must conform to the international treaty obligations which states have accepted.”⁸⁴ There should be no doubt that, at least in the near future, states will remain the main actors in the creation and implementation of law respecting space activities, including those that relate to space resource utilization. In other words, the scope, nature, and extent of participation by private entities in space are, and would be, determined by their respective states according to their national policies and regulatory mechanisms.

Government Regulation of Private Space Entities

Current advocates for space commercialization focus almost exclusively on technological and economic aspects of resource exploration and use, and not sufficiently on the legal environment, especially under the international law.⁸⁵ The following legal principles must be taken into account while considering private sector space resource utilization.

1. Freedom of Exploration and Use. Article I (2) of the Outer Space Treaty recognizes the freedom of exploration and use of outer space by all states. Similarly, Article 6 (1) of the Moon Agreement reiterates the “freedom of scientific investigation on the Moon (and other celestial bodies) by all states parties” to the Agreement. It should be noted that the right of such freedom can be exercised by states alone or by authorizing their private entities, or by participating in intergovernmental organizations. Under international space law, private entities do not enjoy the right of freedom of exploration and use of outer space, the Moon and other celestial bodies, but they can be granted a privilege, under applicable national laws, by their respective states to undertake such activities.

The freedom to explore and use the Moon and other celestial bodies by states, and consequently by their private entities, is not absolute and must be exercised only within the limitations prescribed by law; i.e., *inter alia* “without discrimination of any kind,” “on a basis of equality,” and “in accordance with

international law.” It is the responsibility of an appropriate state to ensure that activities of its private entities are in accordance with applicable international law, including the provisions of the Outer Space Treaty, and the Moon Agreement, if applicable.

2. **State Responsibility.** Unlike the rules of general international law under which a state can be held responsible only if there is a “genuine link” between that state and the activity concerned,⁸⁶ Article VI of the Outer Space Treaty imposes comprehensive international responsibility on the concerned states party to the Treaty to ensure that the activities of its private entities would remain in accordance with the provisions of the Treaty and international law. For carrying out this responsibility, an ‘appropriate’ state is obligated to exercise “continuous supervision” of its private entities engaged in space activities. Under Article VI, there is a possibility of existence of multiple “appropriate” states. An appropriate state may be the state of registration of the spacecraft as determined under the Registration Convention.⁸⁷ With expanded private sector space activities, including multinational alliances, confusion about the appropriate state will increase, and this must be resolved, preferably through an additional protocol to the Outer Space Treaty.
3. **Liability for Damage.** Under Article VII of the Outer Space Treaty, each launching state⁸⁸ is internationally liable for damage to another state or to its natural or juridical persons caused by a space object or its component parts. This principle has been expanded under the 1972 Liability Convention, according to which 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.”⁸⁹ The Outer Space Treaty and the Liability Convention may seem to impose burden on a spacefaring nation, however, no state has suffered any serious financial losses as a result of any accident. On the other hand, assumption of such liability by the launching state is a form of positive state support to its private entities engaged in space activities.

It may be noted that space and nuclear activities are similarly hazardous in nature and, thus, their liability regimes are comparable too. The 1963 Vienna Convention on Civil Liability for Nuclear Damage imposes absolute liability not only on the

operator of a concerned nuclear plant, but also on the state of installation of the nuclear facility.⁹⁰ The U.S. is not party to any international nuclear accident liability treaty. However, the 1957 U.S. Price Anderson Act,⁹¹ which has been renewed up to 2025, provides for \$10 billion in compensation for absolute liability. It “requires individual operators to be responsible for two layers of insurance cover. The first layer is where each nuclear site is required to purchase \$300 million cover from private insurers. The second layer is jointly provided by all U.S. reactor operators. It is funded through retrospective payments, if required of up to \$96 million per reactor collected in annual installments of \$15 million and adjusted for inflation. Combined, the total provision comes to over \$10 billion paid for by the utilities. The U.S. Department of Energy also provides \$10 billion for its nuclear activities. Beyond this cover and irrespective of fault, Congress, as insurer of last resort, must decide how compensation is provided in the event of a major accident.”⁹²

The U.S. follows a similar approach with respect to possible space-related liability. Under the U.S. Commercial Space Launch Act of 1984 as amended,⁹³ a licensee of a space launch is required to have insurance in place or to demonstrate financial responsibility to a level or amount of a maximum probable loss (MPL) determined by the Office of Associate Administrator of Space Transportation (AST) within the U.S. Federal Aviation Administration (FAA). Licensees are required to obtain insurance for the amount of \$100 million to cover potential losses sustained by the U.S. government and not greater than \$500 million for third party claims.⁹⁴ In case a claim exceeds these amounts, the U.S. government has undertaken to provide compensation up to \$1.5 billion.⁹⁵ In addition, risk allocation-sharing among a licensee, its customers, and their respective contractors and subcontractors is provided for under U.S. law, which imposes mandatory reciprocal waivers of liability.⁹⁶ Such regulatory support undoubtedly serves an important stimulus to private entities involved in space activities.

4. Licensing of Private Space Entities. Article VI of the Outer Space Treaty specifies that the “activities of nongovernmental entities in outer space, including the Moon and other celestial

bodies, shall require authorization and continuing supervision by the appropriate state party to the Treaty.” The aforementioned international responsibility and possible liability of states have become the main basis for making the activities of their private entities subject to national regulation, which is normally initiated and exercised through the administrative process of licensing. It may be noted that such requirements of national authorization or licensing of private entities is not unique. In the field of radio communications, including space communications, international law requires all states to ensure that the activities of their private operators are carried out in accordance with applicable rules of international law⁹⁷ and that these operators procure appropriate national licenses.⁹⁸ Therefore, no state allows the use of radio frequencies by private entities without a prior national license.

Is this requirement of “authorization” or licensing a hindrance or barrier to the undertaking of space activities by private entities? Yes, it may be seen this way, but only at the national level, and only if licensing is a cumbersome, time-consuming and expensive process. International space law, as expressed in Article VI, does not stipulate any specific form or condition of “authorization” and continuous “supervision.” States remain free to impose flexible or rigid conditions or procedures on their private entities. Entry into the space arena and continuous operation of space activities by private entities are exclusively determined by national policies, laws, and regulations.

Private Property Rights and Sharing of Benefits

In order to facilitate commercialization in space, there needs to be a well-defined property rights regime. By ensuring companies exclusive rights to resources, they would have the incentives to invest and develop a business enterprise. Legal uncertainties regarding resource appropriation and protection of real property rights are barriers to private sector involvement in natural resource utilization. According to current international space law, there are some impediments to private property in space, but they are not insurmountable.

Private Property Rights in International Space Law

Article II of the Outer Space Treaty specifies, "Outer Space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." Appropriation implies the exercise of exclusive control or use and denial of use by others. The term "national appropriation" has intentionally been designed to be comprehensive and is understood to include all forms of appropriation, whether governmental, public, private, or otherwise. However, Gorove is of the view that Article II prohibits only "national appropriation," and thus, appropriation by a private individual or company is allowed.¹⁰⁰ This view cannot be fully justified since letting private entities to appropriate outer space would defeat the very purpose of Article II, and consequently, the Treaty itself. Article II is also understood to negate appropriation in the form of public or private property rights in space.¹⁰¹

In response to a growing concern with the proliferation of sale of "real property" space deeds, the International Institute of Space Law (IISL) issued in 2004 a statement addressing the validity of claims on property rights regarding the Moon and other celestial bodies.¹⁰² According to this position paper, the Outer Space Treaty prohibits all territorial claims to outer space (Article II), including claims by private entities (whether individuals or corporations). This argument is drawn from the text of Article VI, which provides that "states bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by nongovernmental entities," meaning private parties, and "for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty."

In addition, Article VI provides that "the activities of nongovernmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate state party to the Treaty." The IISL Statement draws the conclusion that the prohibition of national appropriation by Article II includes, therefore, appropriation by nongovernmental entities, i.e., private entities whether individuals or corporations, since that would be a national activity.¹⁰³ Such

prohibition also applies to enacting legislation “on a territorial basis to validate a private claim.”¹⁰⁴ In the IISL’s view, “sellers of such deeds are unable to acquire legal title to their claims. Accordingly, the deeds they sell have no legal value or significance, and convey no recognized rights whatsoever.”¹⁰⁵ Finally, the position paper points out that “to comply with their obligations under Articles II and VI of the Outer Space Treaty, state parties are under a duty to ensure that, in their legal systems, transactions regarding claims to property rights to the Moon and other celestial bodies or parts thereof, have no legal significance or recognized legal effect.”¹⁰⁶

The provisions of Article II of the Outer Space Treaty have been reiterated in Article 11(2) of the Moon Agreement.¹⁰⁷ However, Article 11(3) of the Moon Agreement contains more specific wording to the effect that the surface, the subsurface of the Moon (and other celestial bodies) and any part thereof or their natural resources *in place* cannot become property of any one.¹⁰⁸ In other words, once these resources are removed, they may be considered to have become the exclusive property of the entity that caused them to be removed. Moreover, under Article 6(2) of the Agreement,¹⁰⁹ both public and private entities are entitled to collect and remove Moon’s minerals and other substances for scientific investigations and exploration purposes and also use them for the support of their space missions. If one considers that there is a contradiction between Article 11(2) and Article 11(3), the latter shall prevail according to a well-accepted rule of international law; i.e., *lex specialis derogat generali*. The Moon Agreement, being later in adoption, should be considered to have modified the meaning of the terms used in the 1967 Outer Space Treaty,¹¹⁰ whose Article II on broad nonappropriation would seem to prohibit such an exclusive use. We, therefore, conclude that the Moon Agreement, as an improvement over the provisions of the Outer Space Treaty, is more conducive to the interests of private entities.

This point of view was reflected in an interesting case concerning a claim of property over an asteroid that came in 2003 before the Federal District Court for the District of Nevada.¹¹¹ Gregory William Nemitz registered on the Archimedes Institute’s website a property claim to Asteroid 433 Eros.¹¹² Subsequently, NASA landed the Near Earth Asteroid Rendezvous (NEAR) mission spacecraft on Eros, and Nemitz submitted an invoice to NASA

for “parking” or “storage” fees. After NASA denied his claim, Nemitz filed a complaint with the court alleging that NEAR’s landing violated his property rights and that he is entitled to be compensated for such infringement. The U.S. Government filed a motion to dismiss, and the Federal District Court for the District of Nevada granted the motion. The court concluded that Nemitz has failed to demonstrate a legal basis for his claim of a private property rights on an asteroid. The court ruled that “neither the failure to...the United States to ratify the...Moon Treaty, nor...the Outer Space Treaty, created any rights in Nemitz to appropriate private property rights on asteroids.”¹¹³

Current Attempts to Claim Property Rights in Outer Space

In ignorance of the international legal regime, some have already “claimed” celestial bodies, merely by announcing their claim. Pursuant to such claims, some are even selling “title” to areas of outer space.¹¹⁴ In 1980, being possibly the first to take the initiative of selling lunar property, Dennis Hope filed with a U.S. governmental office for claim registries in San Francisco a property claim over the Moon, Mars, and all other celestial bodies, except the Sun and the Earth.¹¹⁵ Subsequently, he informed the General Assembly of the United Nations and the governments of Russia and the U.S. Their failure to respond to his notification was interpreted by Hope as an acknowledgment of the validity of his property rights. This claim is based on what Hope considered to be a loophole of the 1967 Outer Space Treaty that prohibits governments from ownership of extraterrestrial property, but failed to mention the same prohibition for individuals or corporations.

Although many legal experts have voiced their views that such legal claims are null and void under the Outer Space Treaty¹¹⁶ or that such claims of property are useless without the protection of a government authority, Hope’s business initiative is alleged to be a successful enterprise, currently numbering almost 3,500,000 so-called “proud owners of their extraterrestrial property,”¹¹⁷ though no independent confirmation of this number exists. According to the Hope’s Lunar Embassy site, among the buyers of extraterrestrial property are not only individuals, but companies as well.¹¹⁸

This initiative's alleged success has triggered increased competition from similar websites.¹¹⁹ Such is, for example, the Lunar Republic, organized as an international business company and, according to its website, authorized to operate in more than 200 countries around the world.¹²⁰ Recognizing that under the current international law, no government nor private entity could own property on the Moon and that the Moon Agreement calls for the establishment of an "international regime" to govern the Moon, the proponents of this initiative came up with the idea of establishing "an independent and sovereign Lunar Republic, with a government *sine terra* elected by its citizen-partners and empowered to create a long-term plan for the exploration and settlement of the Moon and the development of its resources."¹²¹ The Government of the Lunar Republic will be entrusted to guide the "peaceful occupation and exploration of the Moon and management of its resources," while "allowing individual property ownership in certain areas."¹²² A Lunar Registry¹²³ is established with the main role "to protect and uphold the private property rights of Lunar land owners, while also working with other agencies and the Lunar Republic in developing plans for the settlement of the Moon, the construction of scientific centers, the promotion of Lunar tourism, the development of mineral and other resources on the Moon, and the respectful preservation of the environment, in accordance with international treaties."¹²⁴

The sales of land are conducted by the Lunar Republic in compliance with what is called the "Lunar Settlement Initiative,"¹²⁵ which has the aim to provide a "framework for private development of the Moon" and to "promote privately funded exploration and settlement of Luna." This initiative proposes an international public-private partnership with the commercial space industry and centers around the idea that any organization, whether operating for profit or not for profit, should be allowed to offer for sale to any private entity¹²⁶ a "legal and valid claim to property on Luna in exchange for payment that shall be directly utilized to fund a program that will result in the human settlement of Luna."¹²⁷ Land claims are to be offered in individual parcels of one acre and no single organization can offer claims to more than 10% of the total land available on the Moon.¹²⁸ The condition for granting "legal recognition and certification"

to a land claim is the establishment of a human-based settlement and its permanent and continuous inhabitation.¹²⁹ According to this initiative, any such settlements are to be recognized as legal under public international law. As will be argued below, the terms of the initiative violates the terms of the Outer Space Treaty and it cannot expect that the regime it tends to establish will enjoy protection under the international law which it ignores otherwise.

Proposed Solutions to Overcome the Prohibition Against Claims of Real Property

Several theories are suggested by various experts to overcome what is generally perceived to be a prohibition of claims of real property *stricto sensu* under the existing international treaties. These theories are explained below.

1. The Theory of “Pseudo Property Rights.” While acknowledging that the Outer Space Treaty prohibits states from making sovereign claims over portions of outer space, while requiring the signatories to closely monitor activities carried out by nongovernmental entities over which they have jurisdiction, this theory proposes the recognition of a property right that would translate to the right to exclude others from interfering with one’s right.¹³⁰ As states are required to monitor nongovernmental activities, they would be entitled to establish a “pseudo-property” regime applicable only to their nationals. Such a regime would be similar to the one governing patents under the U.S. legal system. By filing a patent, a company can exclude all other companies from using a certain technology. Similarly, an outer space pseudo property right would be the equivalent of a title deed to a house based on which the “owner” has the right to exclude others from using the house. National entities would have to apply to their government for authorization to operate on a certain location. Individual states would have the task of registering such rights and ensuring that other nongovernmental entities from that particular state do not interfere with them. Although not a full fledged property right, such arrangement would give certain guarantees of state

enforcement against violators from the same state. Problems would arise, however, when entities from different states claim “pseudo-rights” over the same resources. The theory suggests that this is not likely to happen, given the increased evidence of respect for others’ property among spacefaring states. Even if it does happen, bilateral agreements between the concerned states would be a solution. Although doubting the true enforcement power of the Outer Space Treaty, the proponents of this theory recommend, as a last resort, the withdrawal of the state concerned from the Outer Space Treaty.¹³¹

2. **The Theory of Designated Zones of Functional Jurisdiction.** Based on an analogy to the regime governing the continental shelf, this theory proposes an international agreement that would define certain specific cases when a state, being able to show a “particular and distinctive interest,” would be entitled to claim the right to exercise “functional jurisdiction,” as opposed to territorial jurisdiction, in a designated area of outer space or on a celestial body. States would have to enact unilateral legislation that creates such “designated areas” of functional sovereignty in outer space.¹³²
3. **Functional Property Rights.** This theory is based on the principles of civil law, as opposed to common law, which distinguish between property and sovereignty. Under this theory, conferral of title would not depend upon the government’s sovereignty over a specific area, but rather on the state’s control over the space objects and personnel at that location. States may require private entities to maintain a facility and/or conduct certain activities in a fixed location for a specified period of time, e.g., one to five years, to perfect such property rights.¹³³ These rights would be limited to the area occupied by the space object, and to a reasonable safety area around the facility.¹³⁴ The proponents of this theory also suggest that states, which establish such property rights regimes, could insert a reciprocity provision in their property laws that recognize property rights of entities under the jurisdiction of other states that enact similar property regime. Once several states have implemented similar property regimes, an international registry would be necessary. In addition, states could negotiate a multilateral treaty to coordinate property rights.¹³⁵

4. Natural Law of "Use and Occupation" Theory. This theory is reflected in a draft for an Act to Promote Privately Funded Space Settlement, proposed by the so-called Space Settlement Initiative, under the name "The Space Settlement Prize Act."¹³⁶ According to the authors of this draft legislation, "the ratification failure of the Moon Treaty means there is no legal prohibition in force against private ownership of land on the Moon, Mars, etc., as long as the ownership is not derived from a claim of national appropriation or sovereignty, which is prohibited by the Outer Space Treaty."¹³⁷ In order to circumvent the prohibition of claiming sovereignty over extraterrestrial property, the draft Act proposes that, for property rights on the Moon, Mars, and other celestial bodies, the U.S. will have to recognize natural law's "use and occupation" standard and not the common law standard of "gift of the sovereign."¹³⁸ According to the Space Settlement Prize Act, a private entity that establishes the first lunar settlement on the Moon would be granted the ownership of up to 600,000 square miles in a contiguous, reasonably compact shape that includes its base,¹³⁹ the private entity that establishes the first settlement on Mars would be entitled to receive the ownership of up to 3,600,000 square miles in a contiguous, reasonably compact shape that includes its base,¹⁴⁰ and the private entity that establishes a permanently inhabited base on an asteroid will be entitled to receive ownership of up to 600,000 square miles in a contiguous, reasonably compact shape that includes its base, or the entire asteroid if its surface area is smaller than 1,000,000 square miles.¹⁴¹
5. The Theory of Tele-Possession. A relatively new concept to overcome issues of ownership of resources, at least with regard to asteroids, is "tele-possession" that entails the use of robot emissaries that perform tasks that a hands-on asteroid miner could do at a remote site, and thus, gain legal domain over the asteroid and establish a form of legal possession.¹⁴² This concept is based on the Roman law of *pedis possession*, which is the foundation for Western law of ownership. It means that the first entity to set foot (*pedis*) upon and occupy an area in outer space can claim possession. Modern law has already established precedent for robotic tele-possession in the legal model applied to maritime salvage of a shipwreck by using underwater telerobots. The proponents of this theory agreed

that this theory is more likely to be acceptable with regard to asteroids, which are not an intrinsically unique and environmentally fragile medium, nor are perceived as a limited resource.¹⁴³

6. Creating a New Nation out of a Colony in Outer Space. Another theory that was suggested was that a group of people that will go to a celestial body and colonize or settle it, will declare themselves a new state that would not be a signatory of the Outer Space Treaty, and thus, not bound by its prohibition of ownership. In this way, the new celestial based state could claim territorial sovereignty over the local resources.¹⁴⁴
7. Adopting a System Similar to the one Established by the Law of the Sea Convention. The Law of the Sea Convention¹⁴⁵ provides for a regime designed to govern appropriation of ocean resources beyond the limits of national jurisdiction that is very similar in nature to the regime proposed by the Moon Agreement to govern use of space resources. This Convention establishes an "Authority" entitled to grant mining rights to corporations, and an "Enterprise" which competes with these corporations and is responsible for distributing its mining profits to developing nations.¹⁴⁶ Hence, corporations have an incentive to invest in mining activities, while the Enterprise ensures that the benefits are shared by all states, since the resources belong to all of them.¹⁴⁷
8. Amendment of or Withdrawal from the Outer Space Treaty. State parties can amend or even withdraw from the Outer Space Treaty and subsequently assert territorial claims over areas of outer space. The Treaty provides that parties can withdraw by giving one year's notice.¹⁴⁸ It is doubtful that states will take this course of action. First, withdrawal, followed by territorial claims, will likely lead to strong political opposition from non-spacefaring states and possibly lead to military conflict with competing spacefaring states.¹⁴⁹ Second, for the most part, the Treaty allows states to govern their own space activities, subject only to principles of international law, including non-appropriation of outer space principles, which have already become a part of customary international law, and *jus cogens*, and thus, binding upon all states.

If one agrees that there is a need for a property rights system, the next question is whether or not such a system should be established before, or after, extensive development of technology to extract and use such resources has taken place. The "Positivist School" of space law argues that the current air or sea law cannot be applied to an area of exploration that is virtually unknown. Consequently, space law addressing property rights must evolve gradually as the realities and needs require.¹⁵⁰ More specifically, it is advocated that, with the exception of environmental laws in near-Earth space, governments should not be allowed to implement laws applicable to the use of space resources until "the field matures further, i.e., until the field defines itself through actual operations and demonstrations."¹⁵¹

On the other hand, the "Natural Law School" of space law adopts an approach guided by the principles of equity and morality. According to this school, it would be important to plan for the future uses of space resources to make certain not only of an equitable distribution of resources, but also to prevent conflicts among states as history shows they are possible whenever competing states get involved in exploring and exploiting new resources.¹⁵²

Sharing of Benefits

Article I(1) of the Outer Space Treaty declares that, "The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development." This legal principle ensures that outer space, the Moon, and other celestial bodies are a "global commons" to be explored, used and exploited as a "public good," in contradistinction to possible exclusive control or claim by individual states.¹⁵³ The negotiating history of the Treaty shows that it clearly established a fair balance of interests among all states.¹⁵⁴ This "common interest" principle is the basis for other principles that ensure "freedom of outer space," "non-appropriation of outer space," and respect for the corresponding interests of all players in the exploration and use of outer space, the Moon, and other celestial bodies, so that space activities may be carried out without any international conflict and in an orderly manner. Though pursuant to Article I(1), all space activities must be such that they

contribute somehow to the well-being of all countries, it does not impose any specific obligation on a state to share with others the benefits acquired with the exploration and use of outer space. The nature, scope, manner, and process for such distribution are left to be determined by each state party to the Treaty. This understanding of the provisions of Article I(1) has consistently been maintained by both space powers and non-space powers.

Article 11 of the Moon Agreement, according to which the Moon, other celestial bodies, and their natural resources are the “common heritage of mankind” (CHM), is said to be the most controversial legal principle from the perspective of the private industry, because it is considered by some to require the sharing of benefits derived from those resources. However, the CHM principle of the Moon Agreement has often been misinterpreted and misunderstood. For example, the U.S. Army Space Reference Text on Space Policy and Law mentions that under the 1979 Moon Agreement, that was “signed by five countries but not the United States or the Soviet Union . . . the Moon is a common heritage for all mankind which implies that all nations would share equally in any benefits derived from Moon exploration. If the U.S. signed this treaty it would be hard to get private firms to invest in future Moon projects if they had to divide the profits.”¹⁵⁵ Such contention is not valid. The Moon Agreement does not require “equal” sharing but “equitable” sharing, and that too would be implemented only through an international regime, which needs to be negotiated and established at a later date.

The negotiating history of the Moon Agreement shows that while the developing states and the U.S. supported the inclusion of CHM principle in the Moon Agreement, the Soviet Union had opposite views.¹⁵⁶ Yet, during the last session of the Legal Subcommittee of UNCOPUOS in 1979, the Soviet Union withdrew its opposition when the meaning of the CHM was tied to the provisions of the Moon Agreement itself. The finally adopted wording of Article 11(1) states that: “The Moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this Agreement and in particular in paragraph 5 of this article [i.e., Article 11],” which in turn, specifies that “states parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon as such

exploitation is about to become feasible.” Therefore, the meaning and scope of the CHM principle will be clarified and elaborated in the envisioned international regime, if and when established, and no reference to the principles and rules under any other treaty, including the 1982 UN Law of the Sea Convention, is supposed to be made.

Moreover, attempts to understand the meaning of the CHM principle, as included in the Moon Agreement, with the use of or by heavy reliance upon, analogies and traditional international law concepts, like *res nullius*, *terra nullius*, *terra communis*, *res communis*, *res extra commercium*, etc., is not only unwarranted, but could also prove to be counterproductive. None of these concepts has been incorporated into the text of the Moon Agreement. Their meaning and scope have evolved according to the needs, interests, preferences, policies and circumstances of various members of the international community. The physical characteristics of each of “*terra*” or “*res*,” its situation or location, and its subjection or non-subjection to the legal principle of national sovereignty have also played a significant role in determining the scope of each of these concepts. Nevertheless, these concepts could, or perhaps should, be considered when assigning a precise scope to the CHM principle during the negotiations of the envisioned international regime.

Under the Moon Agreement, an international regime needs to be established only when the exploitation of the natural resources of the Moon “is about to become feasible.” Here, the term exploitation should be understood to mean regular extraction and refinement of natural resources for commercial purposes. It is not research, scientific investigation, and exploration as such activities are only precursors of exploitation.

The envisioned international regime should be based upon several principles enumerated in Article 11(7),¹⁵⁷ one of which deals with “equitable sharing by all state parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration.” The requirement of an equitable sharing is not currently applicable. Its specific scope, implications, and methodology would be ascertained by the state parties only when negotiating the envisioned international regime.

The U.S. and other industrialized states, whose private entities would be engaged in research and exploration of the natural resources of the Moon, cannot be expected to remain inactive participants during the negotiations of the envisioned international regime. It is unthinkable that the interests of the private industry would be compromised under any envisioned regime.

According to Arthur Dula, "If the United States becomes a party to the Moon Treaty, the opportunities and prospects for private enterprise development of the resources of the Moon and other celestial bodies will be negligible if not non-existent. Specifically, the draft treaty would . . . create a moratorium on the commercial exploitation of the resources of the Moon and other celestial bodies, until a second, much more comprehensive treaty for regulating resources activities is concluded."¹⁵⁸ The text of the Moon Agreement does not support such an interpretation. There is no moratorium on the exploitation of the natural resources of the Moon and other celestial bodies before the creation of the envisioned international regime. At its July 1979 session, the UNCOPUOS added, under paragraph 65 of its report, a clarification to the effect that, "Article 7 is not intended to result in prohibiting the exploitation of natural resources which may be found on celestial bodies other than Earth."¹⁵⁹ The UN General Assembly, when adopting a resolution containing the text of the Moon Agreement, has asserted that Paragraph 65 should be taken into consideration for a proper interpretation of the Moon Agreement.

Before the establishment of the envisioned international regime, the provisions of Article 6(2) shall remain applicable.¹⁶⁰ As noted earlier, private entities of those states that are parties to the Moon Agreement can legally collect, remove, and use the Moon's minerals and other substances for scientific investigation and exploration purposes and also use them for the support of their space missions. States that wish their public and private entities to use natural resources of the Moon and other celestial bodies are better off by being parties to the Moon Agreement.

In our legal opinion, under the Moon Agreement, the private entities carrying out exploration and use of the natural resources of the Moon and other celestial bodies are not required to share the benefits of such exploration and use. They may also legally collect, remove, and use the Moon's minerals and other substances for

investigations and for the support of their space missions. Such legal entitlement should encourage private investment and result in the expansion of capabilities to ascertain the exploitation viability of the natural resources of the Moon and other celestial bodies. The Moon Agreement is more favorable to the interests of private entities than the Outer Space Treaty and the Agreement avoids the need for determination of a legal regime to protect private property rights before the establishment of the envisioned international regime.

Intellectual Property Rights and Use of Space Technology

Intellectual property, e.g., patents, copyrights, etc.,¹⁶¹ is protected in order to encourage creativity and development. However, in providing legal protection of a creator's rights, the interest of the society in knowledge is also taken into consideration. The fundamental principles of intellectual property law are highlighted below.

- Intellectual property rights (IPRs) are acquired and protected in the territory in which they are granted. Intellectual property law is fundamentally national and territorial in nature.
- IPRs are not protected unless properly granted by an appropriate national body after following an administrative procedure.
- For proper and effective transfer of IPRs, it is imperative that the concerned technology must be sufficiently and effectively protected by law.
- IPRs are limited in scope, time, and space.
- In all countries, except the U.S., patent rights are granted on the first-to-file basis. In the U.S., the rule of first-to-invent is followed.

IPRs are protected under national laws only. To some extent, protection in other states could be secured through intergovernmental bilateral and multilateral agreements. For example, the Contracting States of the Paris Convention for the Protection of Industrial Property¹⁶² constitute a union for the purpose of protection of industrial property. Article 2(1) of the Convention provides that:

Nationals of any country of the union shall, as regard to the protection of industrial property, enjoy in all the other countries of the union the

advantages that their respective laws now grant, or may hereafter grant, to nationals; all without prejudice to the rights specially provided for by this Convention. Consequently, they shall have the same protection as the latter, and the same legal remedy against any infringement of their rights, provided that the conditions and formalities imposed upon nationals are complied with.¹⁶²

Since 1 June 1978, under the European Patent Convention (1973), the European Patent Office has instituted a procedure for a single application for patent, which will be valid in all the European countries that are Parties to the Convention. The Convention attempts to make the patent protection simpler, cheaper, and more reliable.

There is no possibility of acquiring protection for inventions made on space objects registered by international organizations since such space objects cannot be treated as the territory of these organizations. In case of inventions made on a space station, which operates in international space, it becomes imperative to determine its "territoriality," i.e., the legal status of that space station. Therefore, the determination of the legal status of a space station is necessary. Article 21(2) of the 1998 Intergovernmental Agreement for the International Space Station, specifies that "for purposes of intellectual property law, an activity occurring in or on a Space Station flight element shall be *deemed* to have occurred *only in* the territory of the partner state of that element's registry [*emphasis added*]." However, "for ESA-registered elements any European Partner State may deem the activity to have occurred in its territory."

There is only one example of a specific national law of intellectual property rights in outer space and that is in the U.S. The U.S. patent law provides that "any invention made, used, or sold in outer space on an aeronautical and space vehicle [as defined in section 103(2) of the NASA Act] under the jurisdiction or control of the United States shall be considered to be made, used, or sold within the United States for the purposes of this title with respect to any space vehicle or component thereof that is specifically identified and otherwise provided for by an international agreement to which the United States is a party."¹⁶³

Bradford-Lee Smith, in his paper on "Recent Developments in Patents for Outer Space Activities,"¹⁶⁴ raises the following

questions with respect to the application of current intellectual property laws to outer space activities:

- U.S. patent law and the International Space Station Intergovernmental Agreement make explicit reference to the state of registry to determine the applicable law. What if the state of registry changes in time?
- Since IPR law is territorial, which state's law applies in outer space? Which jurisdiction will be applicable in the case of space activities of multinational corporations and multinational co-operations?
- What about transfers of IPRs between entities belonging to different states? Due to the limited number of players and programs, competitors on one program could be partners on another program, customers on another, and/or subcontractors still on another.

Legal certainty is indispensable for the success of private space ventures. In order to achieve such certainty, Bradford-Lee Smith suggests the "globalization" of the jurisdiction in outer space activities, i.e., the adoption of a single worldwide IPR law for space activities and creating a single territory for IPR in space activities, including space access (launch sites and vehicles), space objects (UN registry), and space settlements (Moon and other celestial bodies).¹⁶⁵

Barriers Related to the Use of Space Technology

Simply possessing know-how serves no purpose unless it is put to some use. Normally, law encourages the development of useful know-how so that it serves society. Therefore, law grants exclusive right to exploit that knowledge. The inventor or innovator of any technology can exploit it directly or authorize others to do so. Such authorization is called an act of transfer of technology. Technology, in simple terms, means specific information or data that is required for the development, production, or use of a product. Technology transfer implies transfer of knowledge or know-how. The knowledge, as we have mentioned, is intellectual property, which has been granted legal protection in various forms, such as patent, copyright, industrial design, trade mark, etc.

Technology transfer could occur through many methods or channels, i.e., outright sale or licensing for compensation. Licenses

are legal instruments or contracts that contain several clauses dealing with various terms and conditions for the transfer of technology. One must also be careful about the retransfer of technology by the licensee to anyone else without the permission of the licensor. Other legal matters need to be taken into consideration: (1) the level of legal protection under the legal system of the state where the transferee is located; and (2) the compliance with applicable laws, especially those that prohibit the transfer of certain kinds of technology to certain states.

Transfer of technology across national borders is controlled mainly for security and economic reasons. There is no internationally binding treaty that requires or restricts the transfer of space technology. However, several international efforts to control the proliferation of space technology, weapons, and missiles has resulted in the adoption of international policy guidelines or understandings, such as the Missile Technology Control Regime (MTCR) and the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies. The MTCR was adopted on 16 April 1987 by the G7 countries (Canada, West Germany, France, Italy, Japan, the UK, and the U.S.) for the purposes of coordinating their respective national regulations directed at the control of proliferation of missile technology.¹⁶⁶ The term "missile" includes ballistic missiles, space launch vehicles, and sounding rockets. The MTCR, currently subscribed by 33 states, attempts to restrict the export of missile systems, and related technology, capable of carrying a 500 kilogram payload at least 300 kilometers as well as systems intended for the delivery of weapons. The Wassenaar Arrangement was agreed upon in 1996 to deny the trade in dangerous arms and dual-use goods and technologies to regions and states that are perceived to pose security threats.¹⁶⁷ Forty participating states¹⁶⁸ share a common control list and a common set of objectives, but each state implements its control list and objectives independently.

Controls or barriers to transfer of space technology are imposed by states at the national level. The most important examples of such restrictions are the U.S. Arms Control Act and Export Control Act, and the regulations, known as the International Traffic in Arms Regulations (ITAR) that have been adopted pursuant to the Arms Control Act.¹⁶⁹ From the U.S. government

perspective, the rationale for the imposition of such regulatory mechanisms is the control of proliferation of arms and sensitive technologies; e.g., the Wassenaar Arrangement “is designed to prevent destabilizing accumulations of arms and dual-use goods and technologies.”¹⁷⁰ Through the U.S. Export Administration Act, whose provisions are elaborated in the U.S. Export Administration Regulations, the U.S. Office of Export Licensing exercises control of the re-export of the goods and technologies of U.S. origin.¹⁷¹

While the U.S. laws are the most extensive ones, similar laws exist in almost all Western European countries. The thrust of these laws is that they prohibit and, in certain cases, restrict the sale of goods and transfer of technology to certain states. There are a number of lists enumerating the prohibited or restricted goods and technology, and satellites and launch vehicles and their subsystems are invariably on these lists. In practical terms, when a company from these countries wants to transfer technology related to these items, it needs a special export license from an officially designated authority. Generally, it is a very cumbersome procedure because a number of ministries or government offices may be involved in the assessment of that license application; e.g., ministry of foreign affairs, ministry of defense, ministry dealing with international trade, etc. The rigidity and the manner in which the ITAR is implemented (it includes export controls on all goods, technology, and data related to satellites and launch vehicles and their subsystems) has become a serious impediment in conducting global space business not only by U.S. private companies, but also foreign entities. A study by the International Space Business Council on the *State of the Space Industry* calls U.S. export regulations under ITAR ‘the industry’s most serious issue’ and states, “what initially was a nuisance to businesses has evolved into a serious problem for U.S. industry.”¹⁷² It is therefore obvious that, in order to encourage the use of space technology by private entities of various states, national export control regulations might need to be relaxed to the maximum possible extent.

Conclusion

We witness that governments around the world are opening the space industry for private investment. Various space application sectors witnessed significant developments with the active involvement

of the private sector. Commercialization appears to be a natural sequel to the initial phase of space exploration of space resources. This process will bring efficiency in operation and will encourage effective use of space systems and it is likely to lead to a reduction in the government subsidies and the burden on taxpayers. Albeit there is a fair level of confidence in the potential of commercial uses of space, governments need to place a growing emphasis on encouraging private sector's involvement in the exploration and use of space resources.

The often cited regulatory barriers under the current international legal regime, such as the licensing requirement, the "common heritage of mankind" principle and the protection of real property and intellectual property rights are not in fact insurmountable obstacles to the development by private entities of natural resources of the Moon and other celestial bodies.

Notes

1. NASA, Johnson Space Center, "Mining and Manufacturing on the Moon" <<http://aerospacescholars.jsc.nasa.gov/HAS/cirr/em/6/6.cfm>> (accessed 28 May 2006).
2. Former NASA Astronaut Harrison Schmitt, in his book *Return to the Moon: Exploration, Enterprise, and Energy in the Human Settlement of Space* (New York, NY: Copernicus Books in association with Praxis Publishing, LTD, 2006) makes an argument for industrial use of the Moon based on the utility of Helium-3 fusion.
3. It is estimated that Helium-3 on the Moon is sufficient to accommodate Earth's energy needs for at least 1,000 years. See NASA, "Mining and Manufacturing," (note 1).
4. See Harrison H. Schmitt, "Mining the Moon," *Popular Mechanics*, 12 October 2004, <<http://www.popularmechanics.com/science/space/1283056.html>>? Page=4&c=y> (accessed 28 May 2006).
5. *SPACE.com*, "NASA Announces Discovery of Evidence of Water on Mars," 25 June 2008, <http://www.space.com/scienceastronomy/solarsystem/mars_water_000620.html> (accessed 12 September 2008).
6. *Space Daily*, "The Martian Methane Surprise," 7 December 2004, <<http://www.spacedaily.com/news/mars-life-04y.html>> (accessed 6 June 2006).
7. NASA, Press Release 04-385, "Reports Detail Rover Discoveries of Wet Martian History," 2 December 2004, <http://www.nasa.gov/home/hqnews/2004/dec/HQ_04385_MER_science.html> (accessed 6 June 2006), citing

- Michael Meyer, chief scientist for Mars Exploration at NASA Headquarters, Washington, DC.
8. Gregg Easterbrook, "Bush's Goofy Mars Proposal: Red Scare," 2 February 2004, <<http://www.tnr.com/doc.mhtml?>?> I=20040202&s=easterbrook020204>> (accessed 31 May 2006).
 9. Dwayne Day, "Whispers in the Echo Chamber: Why the Media Says the Space Plan Costs a trillion Dollars," *The Space Review*, 22 March 2004, <<http://www.thespacereview.com/article/119/1>> (accessed 1 June 2006).
 10. NASA Administrator Sean O'Keefe during a press conference on 21 January 2004, cited in Day (note 9).
 11. Schmitt, "Mining the Moon," (note 4).
 12. See "Asteroidal vs. Lunar Materials Utilization," <<http://www.permanent.com/ep-a-v-l.html>> (accessed 26 May 2006).
 13. M. J. Sonter, "The Technical and Economic Feasibility of Mining the Near-Earth Asteroids," Paper presented at the 49th International Astronautical Congress, 28 September-2 October 1998, Melbourne, Australia, <http://www.spacefuture.com/archive/the_technical_and_economic_feasibility_of_mining_the_near_earth_asteroids.shtml> (accessed 28 May 2006).
 14. A study done in 1998, estimated that the size and rate of development of this future in-orbit market for materials could exceed 1000 metric tons per year by 2010, with a subsequent exponential growth to tens of thousands of metric tons per year once large-scale space activities commence. See Sonter, (note 13).
 15. "Don't Wait for Cheap Earth Launch," <<http://www.permanent.com/ep-cheap.html>> (accessed 29 May 2006).
 16. NASA, "The Vision for Space Exploration," February 2004, <http://www.nasa.gov/pdf/55583main_vision_space_exploration2.pdf> (accessed 24 May 2006).
 17. White House, "A Renewed Spirit of Discovery: The President's Vision for U.S. Space Exploration" <<http://www.whitehouse.gov/space/background.html>> (accessed 24 May 2006).
 18. Ibid.
 19. President Bush advocated spending a total of \$12 billion over five years on the plan.
 20. *Space Daily*, "Russia Plans Mine on the Moon by 2020," 25 January 2006 <http://www.spacedaily.com/reports/Russia_Plans_Mine_On_The_Moon_By_2020.html> (accessed: 6 June 2006).
 21. K. S. Parthasarathy, "Mining the Moon," *The Tribune* (Chandigarh, India) 3 February 2006, <<http://www.tribuneindia.com/2006/20060203/science.html>> (accessed 6 June 2006).
 22. "Europe Goes to the Moon," 16 November 2004, <<http://www.euractiv.com/en/science/europe-goes-moon/article-132324>> (accessed 6 June 2006).
 23. Walter Derzko, "Mining the Moon: Will China Become the New Saudi Arabia of the 21st Century?" 2 November 2005, <http://smarteconomy.typepad.com/smart_economy/2005/11/mining_the_moon.html> (accessed

- 6 June 2006). Chinese officials have denied reports that China's exploration plan of the Moon is aimed at exploring Helium-3 resources for potential mining. See Hu Hao, Director of the Chinese Lunar Exploration Project, quoted in *People's Daily Online*, "China's lunar exploration is not for Helium-3," 5 November 2004.
24. "Japan Investigates the Moon," 2005, <<http://www.spacetoday.org/Japan/Japan/Moon.html>> (accessed 6 June 2006).
 25. Citing the Japanese daily newspaper, *Mainichi Shimbun*, 28 February 2005.
 26. Radhakrishna Rao, "India Aims for the Moon" *The-South-Asian.com*, September 2004, <http://www.the-south-asian.com/Sep2004/indias_moon_mission.html> (accessed 6 June 2006).
 27. *Ibid.*
 28. "Worldwide Space Economy Passes \$250 billion," <http://www.aviation-week.com/aw/generic/story_channel.jsp?channel=busav & id=news/ECON04078.xml&show=us> (accessed 19 April 2008); and Louis A. Arana-Barradas, "Civilian Sector Biggest Space Customer," San Antonio TX (SPX), 20 February 2006, <http://www.spacedaily.com/reports/Civilian_Sector_Biggest_Space_Customer.html> (accessed 22 February 2006). Also, see General Lance W. Lord, Former Commander of Air Force Space Command, "Space Capabilities Integral to Economic Livelihood Central To Defense Structure," Colorado Springs CO (SPX), 23 February 2006, <http://www.spacewar.com/reports/Space_Capabilities_Integral_To_Economic_Livelihood_Central_To_Defense_Structure.html> (accessed 28 February 2006).
 29. *The Space Report 2008*, Space Foundation, 2008.
 30. "Government and Military Remain Key To Commercial Satellite Revenues," Cambridge MS (SPX), 29 May 2006, <http://www.spacemart.com/reports/Government_and_Military_Remain_Key_To_Commercial_Satellite_Revenues.html> (accessed 29 May 2006).
 31. Louis A. Arana-Barradas, "Civilian Sector Biggest Space Customer," San Antonio TX (SPX), 20 February 2006, <http://www.spacedaily.com/reports/Civilian_Sector_Biggest_Space_Customer.html> (accessed 22 February 2006). Also, see General Lance W. Lord (Commander of Air Force Space Command), "Space Capabilities Integral to Economic Livelihood Central to Defense Structure," Colorado Springs CO (SPX) 23 February 2006, <http://www.spacewar.com/reports/Space_Capabilities_Integral_To_Economic_Livelihood_Central_To_Defense_Structure.html> (accessed 28 February 2006).
 32. *Ibid.*
 33. *Ibid.*
 34. "SpaceShipOne Wins Big Prize, Opens New Frontier of Private Space Travel," Mojave, CA (AFP), 4 October 2004, <<http://www.spacedaily.com/news/xprize-04zh.html>> (accessed 12 October 2004).
 35. For details, visit SpaceX website at <<http://www.spacex.com/>> (accessed 22 February 2006). Also, see Frederic Garlan, "Despite Risks and Pitfalls Entrepreneurs Explore the Final Frontier," Paris (AFP), 7 February 2006,

- <http://www.spacedaily.com/reports/Despite_Risks_And_Pitfalls_Entrepreneurs_Explore_The_Final_Frontier.html> (accessed 08 February 2006); and “Falcon 1 Lost In First Launch Attempt,” Washington DC (SPX), 24 March 2006, <http://www.spacedaily.com/reports/Falcon_1_Lost_In_First_Launch_Attempt.html>(accessed 02 April 2006). As of August 2008, the Falcon 1 has failed on three separate launch attempts.
36. *Space Daily*, “NASA Budget Shuts Out Icy Moon Mission,” 8 February 2006, <http://www.spacedaily.com/reports/NASA_Budget_Shuts_Out_Icy_Moons_Mission.html> (accessed 3 June 2006).
 37. “Asteroidal vs. Lunar Materials Utilization,” (note 12).
 38. Citizens Against Government Waste (CAGW), “Moon, Mars Missions Not a Priority for Taxpayers,” 16 June 2005 <<http://www.cagw.org/site/News2?id=8992&page=NewsArticle>> (accessed: 27 May 2006).
 39. Ibid.
 40. “Overview of Economic and Political Issues” <<http://www.permanent.com/ep-overv.html>> (accessed: 29 May 2006).
 41. “Asteroidal vs. Lunar,” (note 12).
 42. *Report of the President’s Commission on Implementation of United States: Space Exploration Policy A Journey to Inspire, Innovate, and Discover*, 16 June 2004, <<http://www.marstoday.com/viewsr.html?pid=13136>> (accessed: 25 January 2006).
 43. White House, Executive Order: President’s Commission on Implementation of United States Space Exploration Policy, 30 January 2004, <<http://www.whitehouse.gov/news/releases/2004/01/20040130-7.html>> (accessed 24 May 2006).
 44. “Report of the President’s Commission,” (note 42).
 45. Ibid.
 46. Ibid.
 47. Ibid.
 48. See Lunar Transportation System <<http://www.lunartransportationsystems.com/>> (accessed 25 January 2006); and “Lunar Transportation Systems - A New Private Commercial Space Venture,” Bellevue, WA (SPX), 2 February 2005, <<http://www.spacedaily.com/news/rocketscience-05d.html>> (accessed 8 January 2006).
 49. Lunar Transportation System, <<http://www.lunartransportationsystems.com/>> (accessed 6 June 2006). Lunar Transportation Systems’ website introduces its “concept to create the equivalent of a two-way highway to the Moon as part of NASA’s new space exploration plans.”
 50. “First ‘Private’ Lunar Mission Succeeded Despite NASA Roadblocks,” Tucson AZ (SPX), 4 April 2005, <<http://www.space-travel//lunar-05p.html>> (accessed 18 April 2005); and “New Book Reveals That Private Lunar Mission Succeeded Despite NASA Roadblocks,” Press Release, 2 April 2005, <<http://www.moontoday.net//viewpr.html?pid=16541>> (accessed 25 January 2006).
 51. “Overview of Economic,” (note 40).
 52. Ibid.

53. Stephen Doyle, "Legal Aspects of Space Commercialization" in Nandasiri Jasentuliyana, ed., *Space Law. Development and Scope* (Westport, CT: Praeger, 1992).
54. "Don't Wait," (note 15).
55. Ibid.
56. Ibid.
57. "Overview of Economic," (note 40).
58. Sam Dinkin, "Property Rights and Space Commercialization," *The Space Review*, 10 May 2004, <<http://www.thespacereview.com/article/141/1> > (accessed 28 May 2006).
59. Wayne White, "Real Property Rights in Outer Space" (1997), Proceedings, 40th Colloquium on the Law of Outer Space, International Institute of Space Law, 1998 (Published by American Institute of Aeronautics and Astronautics, Reston, VA) <http://www.spacefuture.com/archive/real_property_rights_in_outer_space.shtml > (accessed 28 May 2006).
60. Ibid.
61. Sam Dinkin, "Don't Wait for Property Rights," *The Space Review*, 12 July 2004, <<http://www.thespacereview.com/article/179/1> > (accessed 28 May 2006).
62. "Legal History and Issues," <<http://www.permanent.com/ep-legal.html> > (accessed 29 May 2006).
63. "How the Government Can Help the Private Sector," <<http://www.permanent.com/ep-ghelp.html> > (accessed 23 May 2006).
64. "Private Sector History and Issues," <<http://www.permanent.com/ep-pvt.html> > (accessed 26 May 2006).
65. "How the Government," (note 63).
66. "Private Sector History and Issues," (note 64).
67. Ibid.
68. "How the Government," 1 (note 63).
69. For example, insurance for satellite and rocket launches accounts sometimes for a third of the total cost.
70. "How the Government," (note 63).
71. Doyle, (note 53).
72. Shana Dale, Deputy Administrator, NASA, quoted by *Space Daily*, "NASA Announces Lunar Lander Analog Competition Agreement," 8 May 2006, <http://www.spacedaily.com/reports/NASA_Announces_Lunar_Lander_Analog_Competition_Agreement.html > (accessed 29 May 2006). On 4 October 2004, the Ansari X PRIZE showed that offering such an award for ground breaking research and development is an effective impetus for technological growth.
73. Xavier Bertran and Alexis Vidal, "The Implementation of a Public-Private Partnership for Galileo," Proceedings of the 18th International Technical Meeting of the Satellite Division of The Institute of Navigation, 13 – 16 September 2005, Long Beach, CA, <http://72.14.207.104/search?q=cache:7OIS3VoY2ikJ:satjournal.tcom.ohiou.edu/issue9/PDF/Implement_Public-Private.pdf+the+implementation+of+a+public+private+partnership+for+galileo&hl=en&gl=ca&ct=clnk&cd=1 > (accessed 8 June 2006).

74. Ibid.
75. Ibid.
76. Ibid.
77. Ibid.
78. Ibid.
79. Paul Meller, "EU Scraps Galileo PPP," IDG News Service, 11 June 2007, < http://www.cio.co.uk/industry/manufacturing/news/index.cfm?articleID=1440&pagtype=same_chandate > (accessed 12 September 2008).
80. Ibid.
81. *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies* (hereinafter referred to as the Outer Space Treaty); opened for signature on 27 January 1967, entered into force on 10 October 1967; 98 ratifications and 27 signatures, 610 UNTS 205.
82. *The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, opened for signature on 22 April 1968, entered into force on 3 December 1968; 90 ratifications, 24 signatures, and 1 acceptance of rights and obligations, 672 UNTS 119; *The Convention on International Liability for Damage Caused by Space Objects*, opened for signature on 29 March 1972, entered into force on 1 September 1972; 86 ratifications, 24 signatures, and 3 acceptances of rights and obligations, 961 UNTS 187; *The Convention on Registration of Objects Launched into Outer Space* <, opened for signature on 14 January 1975, entered into force on 15 September 1976; 51 ratifications, 4 signatures, and 2 acceptances of rights and obligations, 1023 UNTS 15; and *The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (hereinafter referred to as the "Moon Agreement")*, opened for signature on 18 December 1979, entered into force on 11 July 1984; 13 ratifications and 4 signatures, 1363 UNTS 3.
83. For example, the *Charter of the United Nations*, 26 June 1945 (191 ratifications); *Constitution and Convention of the International Telecommunication Union with Annex*, 1994 (as amended in Marrakesh in 2004) and *ITU Radio Regulations*, Edition of 2004 (189 ratifications); and *Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water*, 5 August 1963 (125 ratifications and 10 signatures), 480 UNTS 43.
84. Peter Malanczuk, "Actors: States, International Organizations, Private Entities," in Gabriel Lafferranderie and Daphne Crowther (eds.), *Outlook on Space Law over the Next 30 Years* (The Hague: Kluwer Law International, 1997).
85. Dinkin, "Property Rights," (note 58).
86. See, United Nations, *Report of the International Law Commission*, Fifty-third session (23 April-1 June and 2 July-10 August 2001), General Assembly, Official Records, Fifty-sixth session, Supplement No. 10 (A/56/10), United Nations, New York, 2001, Chapter IV: State Responsibility.
87. Article II of the Registration Convention obliges the launching state to "register the [launched] space object by means of an entry in an appropriate registry which it shall maintain." And Article VIII of the Outer Space Treaty (note 81) entitles the state "on whose registry an object launched

- into outer space is carried [to] retain jurisdiction and control over such object.”
88. According to Article VII of the Outer Space Treaty (note 81), a launching state is a state “that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each state party from whose territory or facility an object is launched.”
 89. *The Liability Convention*, (note 82), Article II.
 90. Article VII of the 1963 *Vienna Convention on Civil Liability for Nuclear Damage*. As of 13 May 2005, there are 33 States Parties and 14 Signatories to the Convention. The Convention has been amended and strengthened in 1997 by a Protocol to Amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage and Convention on Supplementary Compensation for Nuclear Damage <<http://www.iaea.org/Publications/Documents/Conventions/liability.html>> (accessed: 25 January 2006). Under the Convention, term “Installation State,” in relation to a nuclear installation, means the “Contracting Party within whose territory that installation is situated or, if it is not situated within the territory of any State, the Contracting Party by which or under the authority of which the nuclear installation is operated.” Under Article VII (1) of the Convention: “The operator shall be required to maintain insurance or other financial security covering his liability for nuclear damage in such amount, of such type and in such terms as the Installation State shall specify. The Installation State shall ensure the payment of claims for compensation for nuclear damage which have been established against the operator by providing the necessary funds to the extent that the yield of insurance or other financial security is inadequate to satisfy such claims.”
 91. Atomic Energy Act of 1954, 42 United States Code 2210 et., seq. (as amended).
 92. *Civil Liability for Nuclear Damage*, UIC Nuclear Issues Briefing Paper # 70, May 2006, <<http://www.uic.com.au/nip70.htm>> (accessed 1 June 2006). For a detailed description of the *Price-Anderson Act*, see U.S. Department of Energy, Report to Congress: Price-Anderson Act 1999 <<http://www.gc.doe.gov/price-anderson/public-comments/Nuclear%20Energy%20Agency/paa-rep.pdf>> (accessed: 1 June 2006).
 93. 49 United States Code, Subtitle IX. Commercial Space Transportation, 701.
 94. 49 United States Code, (note 93), 701, Section 70112 (a) (1).
 95. 49 United States Code, (note 93), 701, Section 70113 (a) (1) (B).
 96. 49 United States Code, (note 93), 701, Section 70112 (b).
 97. Article 45(2), Constitution of the International Telecommunication Union (note 83).
 98. Article 18(1) of ITU Radio Regulations (note 83).
 99. Dinkin, “Property Rights,” (note 58). The example of former Communist countries in Eastern Europe where property rights were poor is given as example of what are the consequences of giving little incentive for economic development.
 100. S. Gorove, “Interpreting Article II of the Outer Space Treaty” *Fordham Law Review* 37, (1969).

101. The French representative, speaking to the First Committee of the UN General Assembly on 17 December 1967, stated that the basic principle of the Outer Space Treaty (note 81) was that there was a “prohibition of any claim to sovereignty or property rights in space,” cited in Carl Christol, “Article 2 of the 1967 Principles Treaty Revisited” (1984) IX *Annals of Air and Space Law* 217 at 218. Manfred Lachs asserted that, “Appropriation’ in the wider sense is involved [in Article II of Outer Space Treaty (note 81)]. States are thus barred from establishing proprietary links in regard to the new dimension,” in *Ibid.*
102. International Institute of Space Law, “Statement by the Board of Directors of the International Institute of Space Law on Claims to Property Rights Regarding the Moon and Other Celestial Bodies,” <http://www.iafastroisil/additional%20pages/Statement_Moon.htm> (accessed 26 May 2006).
103. *Ibid.*
104. *Ibid.*
105. *Ibid.*
106. *Ibid.*
107. Article 11(2) of the Moon Agreement: “The Moon is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means.”
108. Article 11(3) of the Moon Agreement: “Neither the surface nor the subsurface of the Moon, nor any part thereof or natural resources in place, shall become property of any state, international intergovernmental or nongovernmental organization, national organization or nongovernmental entity or of any natural person. The placement of personnel, space vehicles, equipment, facilities, stations and installations on or below the surface of the moon, including structures connected with its surface or subsurface, shall not create a right of ownership over the surface or the subsurface of the moon or any areas thereof. The foregoing provisions are without prejudice to the international régime referred to in paragraph 5 of this article.”
109. Article 6(2) of the Moon Agreement specifies that: “In carrying out scientific investigations and in furtherance of the provisions of this Agreement, the state parties shall have the right to collect on and remove from the moon samples of its mineral and other substances. Such samples shall remain at the disposal of those state parties which caused them to be collected and may be used by them for scientific purposes. State parties shall have regard to the desirability of making a portion of such samples available to other interested state parties and the international scientific community for scientific investigation. States parties may in the course of scientific investigations also use mineral and other substances of the Moon in quantities appropriate for the support of their missions.”
110. According to Article 31 of the 1969, Vienna Convention on the Law of Treaties (United Nations, *Treaty Series* 1155 (1969): 331), the provisions or terms of an international treaty should be interpreted “in their context” and there “shall be taken into account, together with the context (a) any subsequent agreement between the parties regarding the interpretation of the treaty or the application of its provisions.”

111. *Nemitz v. US*, Slip Copy, 2004 WL 316704, D. Nev., April 26, 2004.
112. Note that Archimedes Institute maintains a registry of such claims as part of its mission to inform the public about space law but acknowledges that such claims do not “have the advantage of being protected by treaty or domestic statute.” The Archimedes Institute, Space Property Registry, <<http://www.permanent/Archimedes/PropertyRegistry.html>> (accessed 27 May 2006).
113. *Nemitz* (note 111). *Nemitz* appealed the case to the Ninth Circuit Court of Appeals, and the lower court’s dismissal of the case was upheld “for the reasons stated by the district court.” *Nemitz v. NASA*, 126 Fed. Appx. 343 (9th Cir. (Nev.) Feb. 10, 2005) (Not selected for publication in the Federal Reporter, NO. 04-16223). As may be noted, the decision was not selected for publication in the Federal Register meaning that the ruling does not establish a binding legal precedent for future cases.
114. “Legal History and Issues,” (note 62).
115. Robert Roy Britt, “Lunar Land Grab: Celestial Real Estate Sales Soar,” 2 February 2004, <http://www.space/scienceastronomy/mystery_monday_040202.html> (accessed 24 May 2006).
116. See International Institute of Space Law Position Paper, (note 102).
117. The Lunar Embassy, “So Who on Earth Buys Extraterritorial Property?” <<http://www.lunarembassy.com>> (accessed 24 May 2006). Most sought after properties on the Moon (most recent count: 2,524,728 customers), followed by properties on Mars (most recent count: 945,344 customers). Note that China revoked the license of the Chinese branch of Lunar Embassy by assessing that to own a piece of land on the Moon, although a “beautiful dream,” was fraudulent and illegal. *Space Daily*, “Chinese Lunar Land Sale A Great Idea but Illegal Says Government,” 28 January 2005, <<http://www.spacedaily//lunar-05zzzb.html>> (accessed 29 May 2006).
118. *Ibid.* Although the names of the customers are confidential, the Lunar Embassy website mentions that among its customers are approximately 250 very well known celebrities as well as two former U.S. presidents. Also, the site mentions that approximately 30 NASA employees are among the “owners of extraterrestrial property.”
119. The Lunar Embassy, <http://www.lunarembassy.com>, acknowledges the increased competition from what they call “copycats,” but points out that “We the Lunar Embassy are the only recognized world authority for the sale of lunar and other planetary real estate (including Mars) in the known solar system. Please be advised that any others are copy cat companies without authority, soliciting your money for unauthorized products. As the Lunar Embassy are the sole holders of the property claim to all planets in the solar system and their Moons (with the exceptions of the Sun and the Earth), we of course, also intend to offer properties for sale on all of these stellar bodies in the foreseeable future.” Dennis Hope allegedly spent thousands of dollars in legal fees to defend his company and challenge his competition. Some of the competing web sites were forced to shut down based mostly on copyright violations, not on property ownership claims. Britt, “Lunar Land Grab,” (note 115).

120. Lunar Registry, "Lunar Property Ownership: Is It Legal to Own Land on the Moon?," <<http://www.lunarregistry/info/legal.shtml>> (accessed 27 May 2006). Among these countries, the website mentions United States, Japan, Russia, China, India, Great Britain, Australia, France, Germany, The Netherlands, Switzerland, Denmark, and Sweden.
121. Ibid. See the text of the Proclamation of establishment of the Lunar Republic, <<http://www.lunarregistry/info/proclamation.shtml>> (accessed 26 May 2006).
122. Lunar Registry, (note 120). According to the website: "Of the nine-billion acres of land that encompass Luna, only about 100-million acres will be offered for sale, approximately 2% of the total land available."
123. Lunar Registry, (note 120). According to the website, Lunar Registry has "a program through which you, your family, or your business enterprise can legally claim ownership of property on the Moon." "In much the same way that major corporations, such as IBM or General Electric, offer shares of stock to raise capital, we are offering a limited number of shares in lunar property to fund privatized exploration, settlement, and development of the Moon. Proceeds will be pooled to create the investment capital required to occupy and develop the Moon. Your property ownership is permanently registered by the International Lunar Lands Registry in its annual publication, which is copyrighted and deposited in the United States Library of Congress and with international patent and trademark offices, including the United Kingdom (UK Patent Office), Japan (Japan Copyright Office), Russia (Rospatent) and with the United Nations (UN Depository Library), in compliance with the Berne Convention."
124. Lunar Registry, (note 120).
125. The Lunar Settlement Initiative, An Initiative to Promote Privately Funded Exploration and Settlement of Luna (Opened for comment on 20 July 2003), <http://www.lunarsettlement./Lunar_Settlement_Initiative.pdf> (accessed 23 May 2006).
126. A "private entity" is defined as "an individual, corporation or consortium of companies, which is not controlled by a sovereign state or government." The Lunar Settlement Initiative (note 125).
127. Ibid.
128. Ibid. Note that, for the purposes of this document, it is established that Luna comprises nine billion (9,000,000,000) total acres of land.
129. Ibid.
130. Dinkin, "Don't Wait," (note 61).
131. Ibid.
132. Imre Csabafi, *The Concept of State Jurisdiction in International Space Law* (The Hague: Nijhoff, 1971).
133. Wayne N. White, "Implications of a Proposal for Real Property Rights in Outer Space," 1999, Proceedings, 42nd Colloquium on the Law of Outer Space, International Institute of Space Law 2000 (Published by American Institute of Aeronautics and Astronautics), <http://www.spacefuture/archive/implications_of_a_proposal_for_real_property_rights_in_outer_space.

- shtml > (accessed 29 May 2006).
134. White, "Real Property," (note 59).
 135. White, "Implications," (note 133).
 136. "An Act to Promote Privately Funded Space Settlement," <<http://www.spacesettlement./law/> > (accessed 28 May 2006).
 137. *Ibid.*, Sec. 2 (10).
 138. *Ibid.*, Sec. 2 (12).
 139. *Ibid.*, Sec. 6 (1).
 140. *Ibid.*, Sec. 6 (2).
 141. *Ibid.*, Sec. 6 (3).
 142. Leonard David, "Extraterrestrial Resources: 'Living off the Land,'" 14 November 2003, <http://www.space/businesstechnology/technology/space_resources_031114.html > (accessed: 24 May 2006).
 143. "Legal History and Issues," (note 62).
 144. "Legal History and Issues," (note 62).
 145. *United Nations Convention on the Law of the Sea*, Nov. 1982, 21 ILM 1261.
 146. *Ibid.*
 147. Harminderpal Singh Rana, "The 'Common Heritage of Mankind' and the Final Frontier: A Revaluation of Values Constituting the International Legal Regime for Outer Space Activities," *Rutgers L. J.* 225 (1994): 233-234.
 148. *Outer Space Treaty*, (note 81) Art. XVI.
 149. White, "Implications," (note 133).
 150. Kim Alaine Rathman, "Sharing the Harvest of the Skies: Outer Space Commercialization and Third World Development," *Philosophy and Technology*, Summer 1998 3(4).
 151. "Legal History and Issues," (note 62). Bruce S. Marks, a lawyer in the field of space resources, is quoted as saying: "... those miners themselves who are active should first devise practical regulation upon which they would consensually rely. As has been the situation previously, from the time of the California Gold Rush through the recent negotiations surrounding the seabed treaty and hard mineral extraction projections for the seabed, extra-legal regimes, followed by eventual codification of consensual law, appear to be the most workable solutions for humankind's advance into new frontier resource regions." *Ibid.*
 152. Rathman, (note 150).
 153. According to Carl Christol, "Exclusive rights may not exist even though the practical capabilities of some explorers, users, and exploiters may be greater than others." Carl Christol, *The Modern International Law of Outer Space* (New York, NY: Pergamon Press, 1982).
 154. After the completion of the draft treaty in UNCOPUOS, the U.S. delegate stressed that the "spirit of compromise shown by the space powers and the other powers had produced a treaty which established a fair balance between the interests and obligations of all concerned, including the countries which had as yet undertaken no space activities" : Official Records of the UN General Assembly, Twenty-First Session, First Committee, Summary Records of Meetings, 20 September -17 December 1966, U.N., New

- York. Similarly, the Soviet delegate stated that Article I, Paragraph 1, was not “a mere statement of the rights of States” but was designed “to guarantee that the interests, not only of individual States, but of all countries and of the international community as a whole, would be protected” : UN Document A/AC.105/C.2/SR.57, 20 October 1966.
155. Chapter 3, Space Policy and Law, [US] Army Space Reference Text, <http://www.fas.spp/military/docops/army/ref_text/chap3im.htm> (accessed 25 January 2006). The purpose of this Reference Text is “to provide information on space systems and their use as they relate to U.S. Army operations. The intended users are U.S. Army commanders, staff officers, and Noncommissioned Officers, students attending Army courses of instruction and their instructors. The format and contents are intended to provide the reader a central reference as to the environment of space, the capabilities of U.S. and foreign space systems and how they can impact on U.S. Army operations at strategic, operational and tactical levels,” <http://www.fas.spp/military/docops/army/ref_text/chap1_im.htm> (accessed 25 January 2006).
 156. For details, see Agreement Governing the Activities of States on the Moon and other Celestial Bodies, Prepared by Eilene Galloway at the request of Hon. Howard W. Cannon, Chairman, Committee on Commerce, Science, and Transportation, United States Senate, May 1980.
 157. They are specified in the Moon Agreement, Article 11, paragraph 7, as: “(a) the orderly and safe development of the natural resources of the Moon; (b) the rational management of those resources; (c) the expansion of opportunities in the use of those resources; (d) an equitable sharing by all state parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration.”
 158. Arthur Dula, “Free Enterprise and the Proposed Moon Treaty” *Houston Journal of International Law* 3 (1979), cited in Glenn H. Reynolds and Robert P. Merges, *Outer Space: Problems of Law and Policy* (Boulder, CO: Westview Press, 1989).
 159. Report of the Committee on the Peaceful Uses of Outer Space, United Nations General Assembly, Official Records: Thirty-Fourth Session, Supplement No. 20, 1979, Un Document No. A/34/20.
 160. Article 6 (2) of the Moon Agreement specifies that: “In carrying out scientific investigations and in furtherance of the provisions of this Agreement, the state parties shall have the right to collect on and remove from the Moon samples of its mineral and other substances. Such samples shall remain at the disposal of those state parties which caused them to be collected and may be used by them for scientific purposes. State parties shall have regard to the desirability of making a portion of such samples available to other interested states parties and the international scientific community for scientific investigation. State parties may in the course of scientific investigations also use mineral and other substances of the moon in quantities appropriate for the support of their missions.”

161. According to Article 2 of the Convention Establishing the World Intellectual Property Organization, intellectual property shall include rights relating to: literary, artistic and scientific works; performances of performing artists, phonograms, and broadcast; inventions in all fields of human endeavors; scientific discoveries; industrial designs; trademarks, service marks, and commercial names and designations; protection against unfair competition; and all other rights resulting from intellectual activity in the industrial, scientific, literary, or artistic fields.” See <http://www.wipo.int/treaties/en/convention/pdf/trtdocs_wo029.pdf> (accessed 1 June 2006).
162. Paris Convention for the Protection of Industrial Property of 20 March 1883, as revised on 14 July 1967 and as amended on 14 September 1979.
163. U.S. Congress, H. R. 1510 Congressional Record. 5 October 1988, P. H. 9669, “Patents in Space Act,” Chapter 10, Title 35, par. 105.
164. Bradford-Lee Smith, “Recent Developments in Patents for Outer Space Activities,” a paper presented at the United Nations/Nigeria Workshop on Space Law entitled “Meeting international responsibilities and addressing domestic needs,” 21–24 November 2005, Abuja, Nigeria.
165. *Ibid.*
166. For details, see “Missile Technology Control Regime (MTCR) Questions and Answers,” <<http://www.state.gov/t/np/rls/fs/27517.htm>> (accessed 6 June 2006). Argentina (1993), Australia (1990), Austria (1991), Belgium (1990), Brazil (1995), Canada (1987), Czech Republic (1998), Denmark (1990), Finland (1991), France (1987), Germany (1987), Greece (1992), Hungary (1993), Iceland (1993), Ireland (1992), Italy (1987), Japan (1987), Luxembourg (1990), Netherlands(1990), New Zealand (1991), Norway (1990), Poland (1998), Portugal (1992), Republic of Korea (2001), Russian Federation (1995), South Africa (1995), Spain (1990), Sweden (1991), Switzerland (1992), Turkey (1997), Ukraine (1998), United Kingdom (1987), and United States of America (1987).
167. For details, visit the official website of the Wassenaar Arrangement, <<http://www.wassenaar.org/>> (accessed 3 June 2006). For the U.S. perspective on the Arrangement, see <<http://www.state.gov/t/isn/rls/fs/2001/5285.htm>> (accessed 3 June 2006).
168. Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Romania, Russian Federation, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom.
169. CFR Title 22, §120.29 Missile Technology Control Regime. For a detailed analysis, see Ram Jakhu and Joseph Wilson, “The New United States Export Control Regime: Its Impact on the Communications Satellite Industry” (2000) XXV *Annals of Air and Space Law* 157 *et seq.*
170. Department of State, <<http://www.state.gov/t/isn/rls/fs/2001/5285.htm>> (accessed 1 June 2006).

171. Section 774.1 of the Regulations provides that: "Unless the re-export of commodity previously exported from the United States has been specifically authorized in writing by the Office of Export Licensing prior to its export No person in a foreign country (including Canada) or in the United States may a) re-export such commodity directly or indirectly, in whole or in part, from the authorized countries. . . ." Parts, components, materials, or other commodities from the United States and incorporated abroad into a manufactured or produced foreign product are subject to US export controls" (Sec. 774.12). Only if the U.S. content value is both 10% and less than \$10,000 or less, they may be exempted from control.
172. "Space and Satellite Market Surpasses \$103B, To Reach \$158B By 2010," Bethesda, MD (SPX), 10 August 2005, <<http://www.spacedaily//industry-05zg.html>> (accessed 10 August 2005).