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A Limited International Agreement on Property Rights

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Wayne N. White's 2001 proposed "Convention on Jurisdiction and Real Property Rights in Outer Space" would codify the limited property rights he construes from the Outer Space Treaty, and would add specificity. A number of changes are proposed, and issues pertaining to such a convention are discussed.

Given the longstanding opposition of the United States to any definition or delimitation of outer space, and given the tangential nature of this contentious issue to property rights, the inclusion of this provision in an outer space property rights convention is counterproductive. A delimitation of outer space based on an arbitrary altitude is especially problematic.

More technically precise legal definitions of orbits are required as orbits become more crowded. The orbital parameters period, inclination, apogee, and perigee, also used in earlier space treaties, are replaced by the six technical parameters used in astrodynamics: semimajor axis, eccentricity, inclination, longitude of ascending node, longitude of periapsis, and longitude at epoch. The deviation from published orbital parameters necessary to declare a space vehicle "derelict" and void property rights is discussed.

Also discussed is the problem of "scarce natural resource" orbits and international governance. Historically, the International Telecommunications Union (ITU) has managed the geostationary orbit (GSO), which has been characterized as a "scarce natural resource;" however, other types of orbits might acquire that character in the future: Earth-Moon L_2 halo orbits for lunar communications, the areostationary orbit for Mars communications, the semidiurnal NAVSTAR-type orbit for both Earth and Mars navigation, an analogous orbit type for lunar navigation, and other halo orbits as transportation hubs along low-energy interplanetary transfer routes. The question arises as to whether the ITU should continue to manage the GSO, or whether at some point a space regime, one more broadly cognizant of the uses for "scarce natural resource" orbits other than telecommunications, should manage all such orbits.

I. Introduction

Since the collapse of the Moon Agreement, commentators have raised criticisms of the process of making new international space law.

> The world community cannot, at this point, meaningfully participate on an egalitarian basis in the initial space law negotiations. It is important that the drafting of space treaties be limited to as few participants as possible in order to conclude workable conventions in a minimum amount of time.
>
> In a situation where the majority is tempted to use its numerical strength, the influential minority may resort to a number of tactics which will eventually frustrate the multilateral law-making process.... [T]he dissatisfied minority may resort to limited international agreements negotiated within closed state groupings (Danilenko 1989).

Thus, those launching powers most likely to acquire an early capability to exploit extraterrestrial resources might conclude an agreement among themselves, excluding other states from the negotiation.

> Given the universal character of space activities, limited agreements among the major space powers regarding outer space probably cannot offer a viable solution to problems calling for essentially global management. At the same time, serious

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> thought should be given to the need to secure the support of the most directly interested states for future space legislation. A realistic assessment of the situation should proceed from the undeniable fact that all states do not have the same level of interest in outer space. While many members of the international community may remain unaffected by a particular decision concerning outer space, others are deeply concerned. Therefore it seems reasonable that the law-making process should reflect the various levels of interest of the space powers and of other states (Danilenko 1989).

However, so long as an agreement among a limited number of states does not violate existing international law, there is not necessarily a problem. It is not suggested that there be a celestial analogue to the 1939 Molotov-Ribbentrop Pact's secret protocol that divided the territories of Finland, Estonia, Latvia, Lithuania, Poland, and Romania between the Soviet Union and the German Third Reich. Several principles should be considered in exploring the prospect of a limited agreement. To begin with, the maxim *lex specialis derogat generali* must be applied. Treaties that contain specific language to regulate the behavior of states carry more weight than declarations of principles. Also, since international custom and the general principles of law develop over time, a newly adopted custom might provide the basis for a challenge to provisions in an older treaty. Finally, a custom may be accepted among relatively more important or powerful states than the parties to a more broadly-accepted treaty; this gives considerable weight to the custom, and were the custom to be codified in a treaty concluded among the relatively more important or powerful states, the weight of the new agreement against the old would be greater still.

> ...[I]n the framework of comprehensive settlements, states advancing far-reaching claims may easily form special pressure groups and negotiating alliances that multiply their original negotiating strength. Consequently, there is a danger that normative results of negotiations on a comprehensive space convention may not reflect the actual balance of interests of different groups of states as regards the exploration and use of outer space. In particular, space powers may find it difficult to preserve the existing principles of space law, such as the freedom of exploration and use of outer space, which have been criticized by a number of developing countries. It is clear that comprehensive negotiations will provide states pressing for radical reforms of the existing space law an ideal opportunity to reopen negotiations on these basic principles of space law which have been codified in the Outer Space Treaty. It is highly unlikely that the relevant global conference would adopt rules of procedure reflecting the idea that the opinions of those states who are most actively involved in space activities should carry more weight than others (Danilenko 1989).

These problems might be alleviated were the consensus rule in COPUOS to be modified. For instance, consensus might be required only among launching states, effectively giving each of them veto power, while a simple majority might be required among the entire COPUOS membership. This would be analogous to the method of voting in the UN Security Council, where each of the five permanent members holds a veto. However, as Danilenko points out, the adoption of such rules "is highly unlikely."

> In space law-making there is also no established tradition of requiring qualitative participation in the proposed space treaties. Consequently, from this perspective it is also reasonable to assume that the resulting compromises would tend to reflect the preferences of the numerical majority. As a result, there is a substantial risk that the negotiated convention would be resisted by the space powers. In the absence of their support, the envisioned ambitious legislative project might remain a dead letter. Far from achieving the desired coherence in space law, such a development would only destabilize the already existing legal regime for outer space (Danilenko 1989).

It would seem that the failure of the Moon Agreement is case in point, although it is certainly true that domestic American political interests played their part.

In any case, in the vein of a limited agreement, Wayne N. White (2001) proposes that the major launching states conclude a "mini-treaty" to explicitly provide for functional property rights. Arguably, this right is implicit in the Outer Space Treaty; however, a new agreement would add specificity. The idea of a "mini-treaty" is meant to circumvent the forum of COPUOS, which includes many non-launching states that have sought to limit the rights of launching states to appropriate extraterrestrial resources. Bearing in mind Danilenko's concerns regarding the development of a broad consensus including both launching and non-launching states, it might be more practical to conclude a "mini-treaty" between the major space powers, which, after all, is how the Outer Space Treaty itself began.

White's proposed Convention on Jurisdiction and Real Property Rights in Outer Space (see Appendix 1) has merit, but it also has some deficiencies. First of all, it mentions some, but not all, of the provisions in the Outer Space Treaty which establish the basis of legal principles for the proposed Property Rights Convention (PRC); obviously, the preamble of the convention should establish the strongest possible legal basis by citing all pertinent provisions of the Outer Space Treaty.

The PRC should apply only to the Solar System and not to the entire universe, so as not to prejudice the property rights of other sentient species in other star systems. Interspecies relations is a field whose development can be deferred to a later treaty as the need arises.

II. Analysis of the Convention Text

The PRC blunders into a space mine in paragraph 1(b):

The term “outer space” means all areas other than celestial bodies which are _____ kilometers or more above the level of the seas on the planet Earth.

White comments:

A treaty on jurisdiction is an appropriate place to finally resolve the issue of delimitation of outer space.

While this may be a good theoretical point, it is a political poison pill. Given the longstanding opposition of the United States to any definition or delimitation of outer space, and given the tangential nature of this contentious issue to property rights, the inclusion of this paragraph is counterproductive. A delimitation of outer space based on an arbitrary altitude is especially problematic. On the other hand, existing treaties imply a functional definition of outer space as the region where space objects are in orbit.

Paragraph 1(c) of the PRC states:

The term “space facility” means a physical structure or device located in outer space or on a celestial body which remains in one location and is used for any peaceful purpose. A structure or device which is located in outer space and orbits around a celestial body or a point in space shall be considered as “remaining in one location” so long as it remains within certain orbital parameters, as set forth below.

White comments:

The lagrangian points which are located between the Earth and the Moon are examples of equilibrium points in space around which humans may someday orbit space objects.

Paragraph 1(l) of the PRC states:

The term “Owner” means the legal owner(s) as defined and determined by any treaties, laws and regulations of the State of registry.

White comments:

The term “Owner” would include natural persons, sole proprietorships, partnerships, limited liability companies, corporations, non-profit and not-for-profit organizations, and governmental entities.

Paragraph 1(o) of the PRC states:

The term “Geosynchronous Orbit” means the orbit described by the following parameters: period 1436.1 minutes, inclination 0, Apogee = Perogee [sic] = 35,786 kilometers.

White uses the term “geosynchronous orbit” where the specifications actually define the narrower case of the geostationary orbit. A more general comment should be made here. The PRC borrows language from Article IV, paragraph 1(4) of the 1975 Convention on Registration of Objects Launched into Outer Space. This introduces several problems that require correction. To begin with, there are the terms “apogee” and “perigee,” which, technically speaking, refer specifically to the highest and lowest points in an orbit around the Earth (the suffix “-gee” is a shortened form of *geos;* other body specific suffixes are shown in Table 1 below), rather than the generic

Table 1: Body-Specific Apsides

Body	Closest approach	Farthest approach
Galaxy	Perigalacticon	Apogalacticon
Star	Periastron	Apastron
Black hole	Perinigricon	Aponigricon
Sun	Perihelion	Aphelion
Mercury	Perihermion	Apohermion
Venus	Pericytherion	Apocytherion
Earth	Perigee	Apogee
Moon	Periselene/Pericynthion/Perilune	Aposelene/Apocynthion/Apolune
Earth	Perigee	Apogee
Mars	Periareion	Apoareion
Jupiter	Perijove	Apojove
Saturn	Perisaturnium	Aposaturnium
Uranus	Periuranion	Apuranion
Neptune	Periposeidion	Apoposeidion
Pluto	Perihadion	Aphadion

Source: en.wikipedia.org/wiki/apsis

"apoapsis" and "periapsis," which apply to orbits around any body. The daunting prospect of having to maintain a different suffix for every orbitable body in the Solar System (and beyond) is the main reason why the generic '-apsis' has become the norm. Presumably, the PRC is meant to apply orbits around other bodies in addition to Earth. This language problem can be solved by attacking the larger technical issue, which is that the orbital parameters White specifies (again derived from the Registration Convention) provide an incomplete characterization of an orbit, and except for inclination, they are not the part of the basic set of orbital elements used in astrodynamics to technically characterize orbits (see Table 2 below). Period, apoapsis, and periapsis can be derived from the semimajor axis and eccentricity (together with the gravitational constant for the body being orbited). In the case of the geostationary orbit, whose value is directly tied to the synchronization of its period to the rotational period of the Earth, it does no harm, and may be legally helpful, to include the period in the specifications, although, technically speaking, it may be redundant.

Table 2: Basic Orbital Elements

Parameter	Symbol
Semimajor axis	a
Eccentricity	e
Inclination	i
Longitude of ascending node	Ω
Longitude of periapsis	ω
Longitude at epoch	L

Paragraph 2 of the PRC states:

> A State Party to this Treaty shall retain jurisdiction and control over: (i) the space objects on its registry, (ii) a safety zone of 500 meters around the residential or scientific space facilities on its registry, (iii) a safety zone of 1000 meters around commercial, industrial and mining facilities on its registry, and (iv) any natural persons within said space objects and safety zones. A State Party to this Treaty shall exercise jurisdiction and control over space objects on other States' registries which are within its safety zones, and the natural persons within said objects, only to the extent necessary to protect the safety of space objects and natural persons.

White specifies numbers here, but not for the delimitation of outer space in paragraph 1(b) or for deviations from orbital parameters in paragraph 12(c), which are subject to negotiation. Likewise, the specification of safety zones is more properly the subject of negotiation. Furthermore, just as there might be zones of different extents for residential or scientific space facilities versus commercial, industrial, and mining facilities, it is foreseeable that different extents might apply on different celestial bodies, and that any of these might require adjustment from time to time as the character and density of use and occupation changes. For these reasons, there should be no hard numbers in the body of the convention; rather it should reference annexes that contain such variable technical specifications (see Appendix 2 and Appendix 3). Subsequent protocols to the convention could amend and create these technical annexes without changing the language in the body of the convention.

Paragraph 11 of the PRC states:

> Private, non-governmental Owners who or which inhabit, maintain and/or operate a space facility for a period of at least one year shall be entitled to formal recognition and registration of the following rights, which shall be designated "real property rights:"

White comments:

> The terms of this Treaty in the section entitled "JURISDICTION" apply to all Owners, including governmental entities; the terms of this Treaty in the section entitled "REAL PROPERTY RIGHTS" apply only to private, non-governmental entities. Pursuant to Article VIII of the Outer Space Treaty, governmental entities will still have all of the same rights as private Owners, but in a less formal sense. States are prohibited by Article II of the Outer Space Treaty from appropriating areas of outer space and celestial bodies, and therefore, in the author's opinion, cannot confer real property rights on governmental entities.

Paragraph 11(e) of the PRC states:

> The exclusive right to appropriate resources within the space facility and its related safety zone.

White comments:

> Although entities may not claim ownership of mineral resources "in place," once they have been removed (i.e. mined) then they are subject to ownership.

Paragraph 12(a) of the PRC states:

> If the Owner of a space facility stops using the space facility for peaceful purposes, the Owner's real property rights shall immediately terminate.

White comments:

> See Article IV of Outer Space Treaty, which says, among other things: "The moon and other celestial bodies shall be used by all States Party to the Treaty exclusively for peaceful purposes."

Paragraph 12(c) of the PRC states:

> If the Owner of a space facility which is in orbit around a celestial body or point in space allows the space facility to deviate, for a period of one month or more, more than ___% from any of the orbital parameters of period, inclination, apogee and perogee [sic] which are listed in the real property rights registry, the real property rights shall immediately terminate.

From a technical standpoint, there are a number of problems with this paragraph. First of all, the four parameters listed in the paragraph should be replaced by the six parameters listed in Table 2. Secondly, inclination is an angular measurement, and since the percentage of a degree is a confusing concept at best, deviation from inclination should be specified in degrees. The last three parameters listed in Table 2 are angular measurements as well, thus deviation from these also should be specified in degrees. Next, as a practical matter no single percentage can serve as a measure of deviation from several different orbital parameters; indeed, regarding any one parameter, specification by percentage is inappropriate. For example, in low Earth orbit (LEO), a ten percent change in apoapsis or periapsis would be on the order of 20 to 50 km; in low orbits this occurs fairly rapidly due to atmospheric drag. In contrast, at geosynchronous altitude, a ten percent deviation in apogee or perigee would represent a change of 3,500 km; such a change, as result of only natural forces acting on the space object, could only occur over an extended period of time, and the object would have become unusable (as a geostationary platform) and a hazard to other geostationary objects well before then. Finally, another issue is that different tolerances may need to be specified for different regions of space. For instance, since the geostationary orbit is a scarce natural resource, tighter than normal tolerances should apply in this increasingly crowded region. As Mars is developed, the areostationary orbit may likewise become a scarce resource, along with lunar halo orbits as the Moon is developed. The various orbit regimes that the PRC might address include:

- Low Earth orbit: defined as an orbit around Earth whose semimajor axis is up to 8,000 kilometers.
  Utility: communications, science, intelligence.
  See Figure 1 through Figure 6

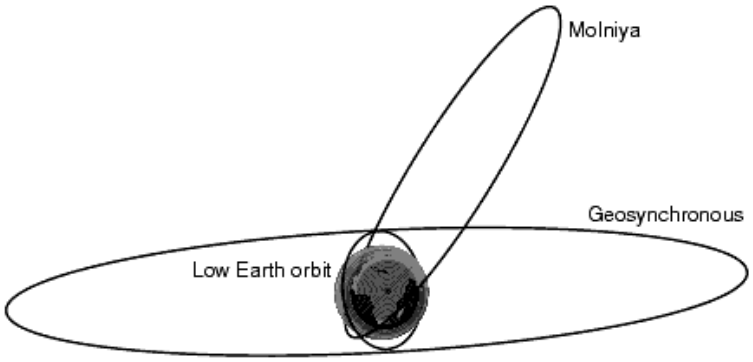

Figure 1. Low Earth Orbit, Geosynchronous, and Highly Elliptical Orbits

Source: www.aero.org/publications/gilmore/gilmore-1.html

- Medium Earth orbit, defined as an orbit around Earth whose semimajor axis is between 8,000 kilometers and 26,500 kilometers.
  Utility: communications, science.
- Semidiurnal Earth orbit, defined as an orbit around Earth whose period is 11 hours, 58 minutes, 2.1 seconds (semimajor axis of 26,561 kilometers).
  Utility: navigation (e.g., Navstar).
  See Figure 7 and Figure 8.
- Geosynchronous orbit, defined as an orbit around Earth whose period is 23 hours, 56 minutes, 4.2 seconds (semimajor axis of 42,163 kilometers; geostationary orbit is a restricted case, where inclination and eccentricity are 0).
  Utility: communications, meteorology, intelligence.
  See Figure 1.

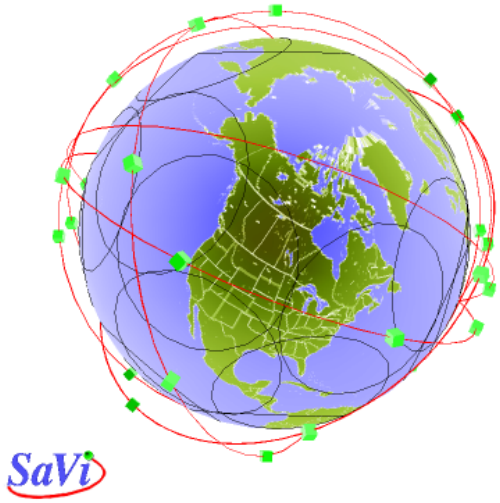

Figure 2. Orbcomm Constellation

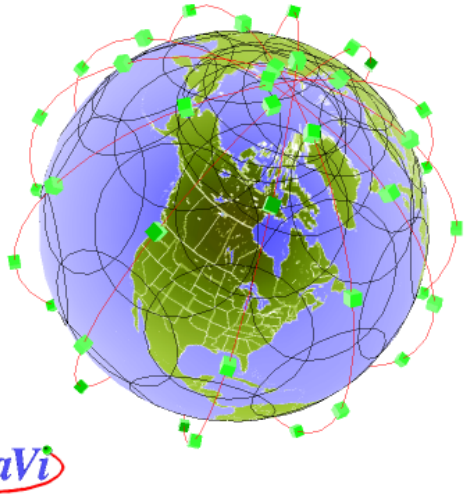

Figure 3. Iridium Constellation

Source: www.ee.surrey.ac.uk/Personal/L.Wood/constellations/overview.html

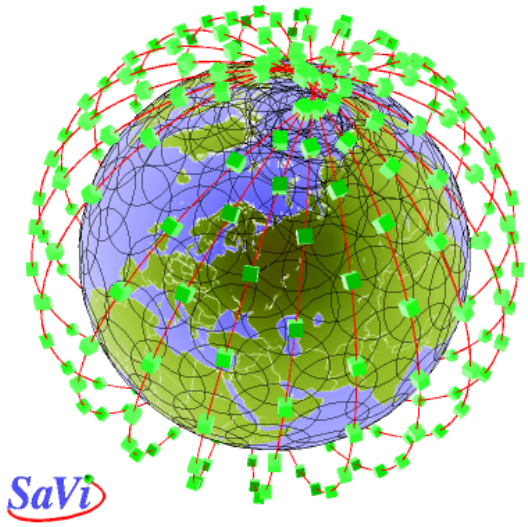

Figure 4. Teledesic Constellation

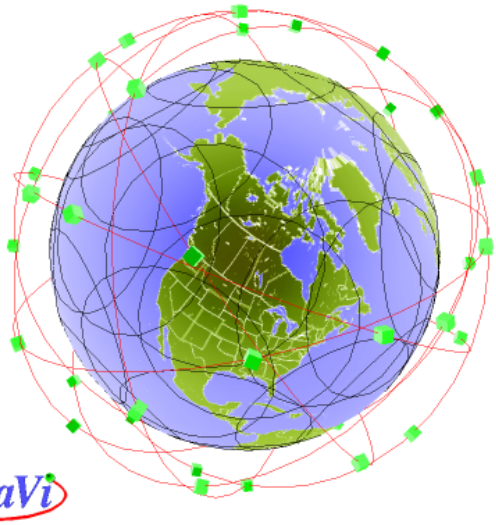

Figure 5 Globalstar Constellation

Source: www.ee.surrey.ac.uk/Personal/L.Wood/constellations/overview.html

- Highly elliptical orbit, defined as an orbit around Earth whose semimajor axis is greater than 42,200 kilometers. Utility: communications.
  See Figure 1.

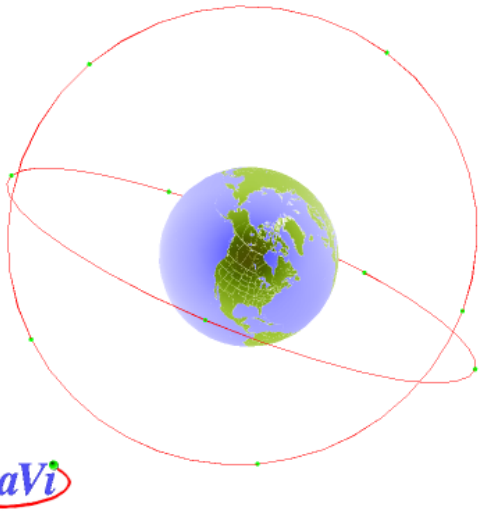

Figure 6. ICO Constellation

Source: www.ee.surrey.ac.uk/Personal/L.Wood/constellations/overview.html

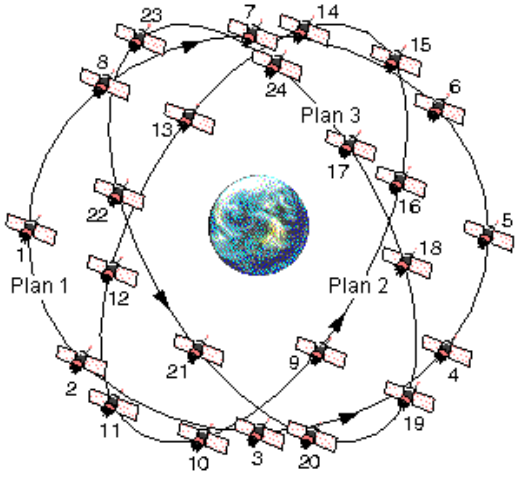

Figure 7. GLONASS Constellation

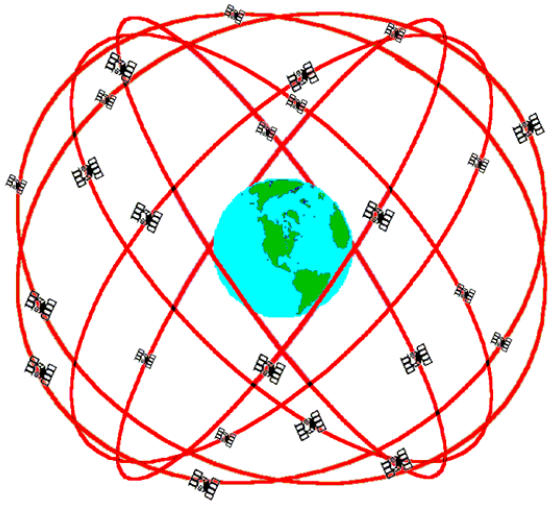

Figure 8. Navstar Constellation

Sources: www.pwsz.chelm.pl/gps/glonass.html
www.educnet.education.fr/localisation/pedago/geologie/GPS.htm

- Earth-Moon L_1 halo orbit*, defined as an orbit around the Earth-Moon L_1 Lagrange point.
  Utility: lunar near side communication, staging point for the Moon and beyond, and station to defend Earth

* Lagrange point halo orbits are open due to the disturbing effects of other bodies and even solar radiation in some cases. Unlike more conventional orbits, where we can let Newton be our autopilot a lot of the time, it may be that Lagrange point halo orbits, being more difficult to define quantitatively, will require a more active traffic control regime, more like the air traffic control system, where controllers would be responsible for ensuring separation between spacecraft and would issue maneuvering instructions to spacecraft operators as needed.

against massive impacts (Maccone 2004).
See Figure 9.

- Earth-Moon L_2 halo orbit, defined as an orbit around the Earth-Moon L_2 Lagrange point.
  Utility: communication between Earth and the far side of the Moon (Farquhar 1972).
  See Figure 9 and Figure 10.
- Earth-Moon L_3 halo orbit, defined as an orbit around the Earth-Moon L_3 Lagrange point.
  Utility: station to defend Earth against massive impacts (Maccone 2004).
  See Figure 9.

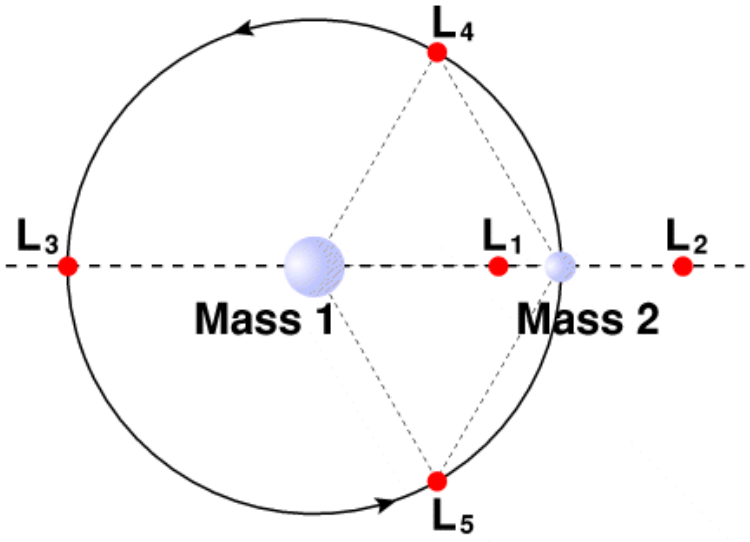

Figure 9: Lagrange Points

Source: NASA

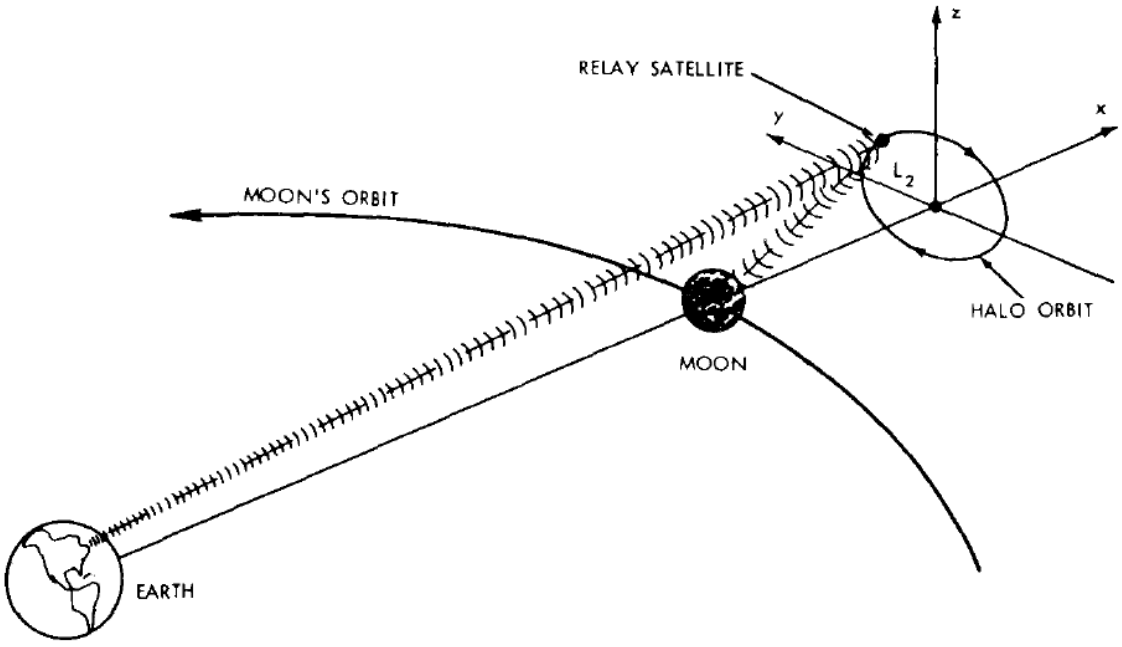

Figure 10: Earth-Moon L_2 Halo Orbit

Source: Farquhar 1972

- Earth-Moon L_4 and L_5 halo orbits, defined as an orbit around the Earth-Moon L_4 or L_5 Lagrange points.
  Utility: possible sites for space colonies (O'Neill 1977).
  See Figure 9.
- Sun-Earth L_1 halo orbit, defined as an orbit around the Sun-Earth L_1 Lagrange point.
  Utility: continuous view of daylight side of Earth.
  See Figure 9.
- Lunar orbit, defined as an orbit around the Moon.
  Utility: science and communications.
- Low Mars orbit: defined as an orbit around Mars whose semimajor axis is up to 4,500 kilometers.
  Utility: science.
- Medium Mars orbit, defined as an orbit around Mars whose semimajor axis is between 4,500 kilometers and 12,800 kilometers.
  Utility: science.
- Semi-sol orbit, defined as an orbit around Mars whose period is 12 hours, 18 minutes, 41.2 seconds (semimajor axis of 12,868 kilometers).
  Utility: navigation.
- Areosynchronous orbit, defined as an orbit around Mars whose period is 24 hours, 37 minutes, 22.4 seconds (semimajor axis of 20,427 kilometers; areostationary orbit is a restricted case, where inclination and eccentricity are 0) (Adams 2000; Edwards *et al.* 2000).
  Utility: communications.
- Highly elliptical Mars orbit, defined as an orbit around Mars whose semimajor axis is greater than 20,500 kilometers.
  Utility: communications, science.
- Earth-Mars solar outage orbit, defined as an orbit around the sun whose period is 686.9797 days (semimajor axis of 227.9 million kilometers).
  Utility: communication between Earth and Mars during solar conjunctions and oppositions (Gangale 2006).
  See Figure 11.

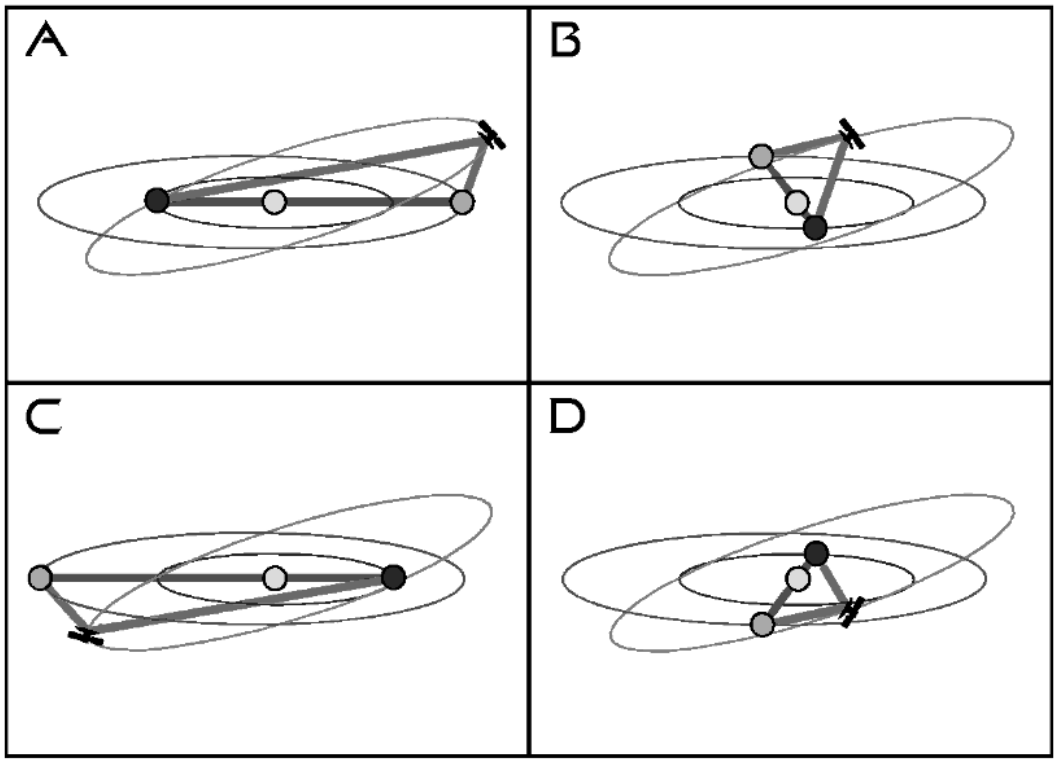

Figure 11. Earth-Mars Solar Outage Orbit

Source: Gangale 2006

Given the complexities of specifying tolerances for different orbital parameters in different regions of space, it would be better for paragraph 12(c) to refer to an annex that would address these issues in appropriate detail.

It may be that the way orbits are specified in the Registration Convention has to do with national security concerns that the US and USSR had during the Cold War. With the full set of current elements listed in Table 2, one would know the position of a space object at any time. However, White's proposed convention establishes real property rights for "private, non-governmental Owners" of space objects, so it would be difficult to raise the issue of national security in this context.

Specifying the full set of six orbital elements may become increasingly necessary for traffic control as space becomes more crowded, especially in certain highly-valued regions of space. The four parameters specified in the Registration Convention and White's proposed Property Rights Convention are insufficient for determining the position of objects in relation to one another. It is possible for two satellites to have exactly the same orbital parameters of period, inclination, apogee, and perigee, and either be thousands of kilometers apart or right on top of each other. In fact, there is an orbit that is occupied by hundreds of space objects: the period is 23 hours 56 minutes (a sidereal day), the inclination is zero, and both the apogee and perigee are 35,785 kilometers. It is the geostationary orbit. The distinguishing characteristic between all of these satellites is the longitude at epoch, and obviously the distinction is of vital importance. The International Telecommunications Union allocates positions in the GSO by specifying longitude. Other orbits beside the GSO are inhabited by multiple objects. The Navstar Global Positioning System (GPS) consists of 24 satellites orbiting the earth in circular orbits at an altitude (both apogee and perigee) of 20,200 km, an inclination of 55 degrees, and with a period of 11 hours 58 minutes (half of a sidereal day). The Navstar constellation is organized into 6 orbital planes, 60 degrees apart in the longitude of their ascending nodes. There are four satellites in each orbital plane, 90 degrees apart in their longitude at epoch. Again, these distinctions are important, just as hundreds of airliners can fly along the same jet routes every day... as long as they are adequately separated in time. Examples of highly-populated orbits are listed in Table 3 below. With an annex specifying different orbit regimes and requiring better reporting of orbital elements over the requirements of the Registration Convention, the Property Rights Convention could provide the initial structure for a future space traffic control system.

Paragraph 12(d): of the PRC states:

> Owners may not establish property rights over an area which would prevent other natural persons or legal entities from having free access to outer space and celestial bodies.

White comments:

> See Article I of Outer Space Treaty, which says, among other things: "Outer Space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on the basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."

Table 3: Populous Orbits

Constellation	FCC Class	Sats	Period	Apogee	Perigee	Inc.	Planes
Orbcomm	Little LEO	36	01:36	775	775	45.0	4
Iridium	Big LEO MSS	66	01:40	780	780	86.4	6
E-Sat	Little LEO	6	01:42	894	894	99.0	6
Leo One	Little LEO	48	01:44	950	950	80.0	8
Teledesic	Broadband	288	01:53	1,375	1,375	84.0	12
Globalstar	Big LEO MSS	48	01:54	1,414	1,414	52.0	8
SkyBridge Con. 1	Broadband	40	01:55	1,469	1,469	54.0	4
SkyBridge Con. 2	Broadband	40	01:55	1,469	1,469	54.0	4
Ellipso-Borealis	Big LEO	10	02:58	7,605	633	116.6	2
Ellipso-Concordia	Big LEO	6	04:46	8,040	8,040	0	1
ICO	MEO MSS	10	05:59	10,390	10,390	45.0	2
GLONASS	Navigation	24	11:15	19,100	19,100	64.8	3
Navstar	Navigation	24	11:58	20,200	20,200	55.0	6
Various GSO Sats	GEO	>1000	23:56	35,785	35,785	0	1

Source: Sushko 1999.

Paragraph 12(g) of the PRC states:

> Any State Party to this Treaty may terminate the property rights of an Owner whose space facility is carried on said State's registry, provided said State terminates the property rights pursuant to duly enacted laws or regulations, or duly ratified treaties, and the Owner has received due process of law including the right to be heard.

White comments:

> The term "due process of law" is a term with a very well defined meaning under United States law. The author assumes that most other nations' laws have a similar concept, although the term "due process of law" may not be the language which will be clearly understood by the majority of States. The author is therefore open to suggestions regarding better terminology.

Paragraph 16 of the PRC states:

> States Party to this Treaty are prohibited from conferring property rights upon Owners of space facilities which are located in the Geosynchronous Orbit.

White comments:

> The Geosynchronous orbit has become crowded with communications satellites in certain areas, and presents unique technical problems with respect to satellite spacing and radio frequency interference. The International Telecommunications Union addresses these issues by allocating orbital positions and frequencies. Therefore real property rights are inappropriate in this orbit.

In fact, the ITU exercises jurisdiction over the geostationary orbit only, which is a restricted case of the geosynchronous orbit. In any case, although from the viewpoint of institutional continuity, retaining ITU jurisdiction over the geostationary orbit might make for more ready acceptance of the PRC, look to a future in which other types of orbits—possibly nowhere near Earth—may become scarce resources and require a comparable level of regulation, one must ask whether these too should come under the purview of the ITU, or whether a new agency dedicated specifically to managing the scarce resources of outer space should be formed, and if so, whether the geostationary orbit should continue to fall under the jurisdiction of the ITU or be transferred to the new agency. Therefore, it is an open question as to whether "real property rights are inappropriate in this orbit." Were the geostationary orbit to be subsumed under the new agency, it should be able to exercise jurisdiction over property right cases in this orbit, as with any other type of orbit. For that matter, the paragraph rescinds ownership rights provided under Article VIII of the Outer Space Treaty:

> Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth.

There is no mention of the geostationary orbit in that treaty, therefore ownership of objects in that orbit has never been prohibited. Why should such rights be excluded now? It is only necessary to provide for the regulation of the scarce resource represented by the geostationary orbit. Historically, such regulation has been provided by the ITU; in the future, this may or may not be handed off to an international space authority.

III. Conclusion

Specifying the full set of six orbital elements may become increasingly necessary for traffic control as space becomes more crowded, especially in certain highly-valued regions of space. With an annex specifying different orbit regimes and requiring better reporting of orbital elements over the requirements of the Registration Convention, the Property Rights Convention could provide the initial structure for a future space traffic control system. Chaotic orbits will require a more active traffic control regime, more like the air traffic control system, where controllers would be responsible for ensuring separation between spacecraft and would issue maneuvering instructions to spacecraft operators as needed. In the future types of orbits other that the geostationary orbit—possibly nowhere near Earth—may become scarce resources and require a comparable level of regulation; thus, the purview of the ITU may expand to include these other orbits, or a new agency dedicated specifically to managing the scarce resources of outer space should may be formed, which may or may not include the geostationary orbit in its jurisdiction.

Appendix 1

Convention on Jurisdiction and Real Property Rights in Outer Space

PREAMBLE

Recognizing the common interest of all mankind in furthering the exploration, settlement and economic development of outer space for peaceful purposes,

Noting the great importance of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, which is commonly known as the Outer Space Treaty, and which

Provides in Article I that outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States, and which

Provides *in Article II* that 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, and which

Provides *in Article VIII* that a State Party to the Treaty on whose registry an object launched into Outer Space is carried shall retain jurisdiction and control over such Object, and over any personnel thereof, while in outer space or on a celestial body, *and which*

Provides in Article IX that States Parties to the Treaty undertake to not cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies,

Recognizing that the Outer Space Treaty permits exploitation and private appropriation of *extracted* resources,

Desiring to further define the extent of States' jurisdiction with respect to outer space and celestial bodies, and

Desiring to protect the interests of those who risk their lives and their investments in the settlement and economic development of outer space, including the Moon and other celestial bodies,

Have agreed on the following:

DEFINITIONS

1. For the purposes of this Convention:
    a. The term "celestial bodies" means all natural bodies in the ~~Universe~~ *Solar System* other than the planet Earth;
    b. The term "outer space" means all ~~areas~~ *regions* other than celestial bodies *in* which ~~are _____ kilometers or more above the level of the seas on the planet Earth~~ *it is possible for a space object to complete at least one revolution of a celestial body without propulsion and by virtue of the inertia of its mass;*
    c. The term "space facility" means a physical structure or device located in outer space or on a celestial body which remains in one location and is used for any peaceful purpose. A structure or device which is located in outer space and orbits around a celestial body or a point in space shall

be considered as "remaining in one location" so long as it remains within certain orbital parameters, as set forth below;

d. The term "residential space facility" means a structure located in outer space or on a celestial body whose primary purpose is to provide shelter, life support and living space for natural persons;
e. The term "scientific space facility" means a structure located in outer space or on a celestial body whose primary purpose is to further the purposes of scientific investigation and/or exploration of the Universe;
f. The term "commercial space facility" means a structure located in outer space or on a celestial body whose primary purpose is the sale of goods or services to other entities;
g. The term "industrial space facility" means a structure located in outer space or on a celestial body whose primary purpose is the production of products for use or consumption by other entities;
h. The term "mining space facility" means a structure located in outer space or on a celestial body whose primary purpose is to facilitate the removal and processing of material resources;
i. The term "space vehicle" means a device which is designed to transport people and material: (i) from celestial bodies to outer space, (ii) through outer space, (iii) from one point to another on the surface of a celestial body, (iv) from outer space to the surface of a celestial body; or any combination thereof;
j. The term "space object" means any device or structure which does not remain in one location, or a space facility or a space vehicle, as defined above;
k. The term "State of registry" means a State on whose registry a space object is carried;
l. The term "Owner" means the legal owner(s) as defined and determined by any treaties, laws and regulations of the State of registry;
m. The term "foreign national" means a citizen of a State other than the State of registry;
n. The term "abandonment" means:

(i) Cessation of regular or periodical use of a structure, or

(ii) Cessation of operation and/or loss of control of a device without taking prompt, overt action to re-establish operation and/or control over said device, or

(iii) An Owner's express public declaration that the Owner has abandoned a structure or device;

o. The term "~~Geosynchronous~~ *Geostationary* Orbit" means the orbit described by the following parameters: ~~period 1436.1 minutes, inclination 0, Apogee = Perogee = 35,786 kilometers.~~

(i) Period: 23 hours, 56 minutes, 4.2 seconds;

(ii) Semimajor axis: 42,163 kilometers;

(iii) Eccentricity: 0;

(iv) Inclination: 0 degrees.

JURISDICTION

2. A State Party to this ~~Treaty~~ *Convention* shall retain jurisdiction and control over:
   a. The space objects on its registry,
   b. A safety zone ~~of 500 meters~~ around the residential or scientific space facilities on its registry, *as specified in the appropriate annex to this convention that references this paragraph,*
   c. A safety zone ~~of 1000 meters~~ around commercial, industrial and mining facilities on its registry, *as specified in the appropriate annex to this convention that references this paragraph,* and
   d. Any natural persons within said space objects and safety zones. A State Party to this ~~Treaty~~ *Convention* shall exercise jurisdiction and control over space objects on other States' registries which are within its safety zones, and the natural persons within said objects, only to the extent necessary to protect the safety of space objects and natural persons.

3. States may enact and enforce laws and regulations which govern their citizens while they are in outer space, and space objects on their registry, so long as said laws and regulations do not violate any treaties or other agreements to which the State is a party, or any principles of customary or general international law.
4. Entities may occupy and use locations in outer space on a first-come, first-served basis, so long as said occupation and use will not interfere with other entities activities.
5. The Owner of a newly constructed space object shall promptly register said space object with an appropriate State in accordance with any treaties, laws and regulations which govern the Owner.
6. Owners of space objects may transfer ownership of their space objects at any time, so long as they comply with any applicable treaties, laws and regulations of the State of registry. Any Owner who or which transfers ownership of a space object shall promptly notify the State of registry that ownership of the space object has been transferred, and shall provide said State with the information necessary to identify and contact the purchaser.
7. The purchaser of a space object shall promptly register said object with an appropriate State in accordance with any treaties, laws and regulations which govern the purchaser. In the event that the purchaser registers the space object with a State which is different from the State of registry of the seller of the space object, the purchaser shall promptly notify the seller's State of registry that registration of the object has been transferred, and the identity of the State on whose registry the space object will be carried in the future.
8. The State of registry shall retain jurisdiction and control over a space object after the Owner of a space object abandons said space object, and until such time as an entity either purchases or otherwise legally assumes control and/or occupation of the space object and registers said object with another State, or advises the State of registry that the space object has been dismantled.
9. Abandonment of a space object by its Owner shall not negate or affect any international liability to which the State of registry may be subject, pursuant to the terms of the Outer Space Treaty, the Convention on International Liability for Damage Caused by Space Objects, general principles of international law, or any other applicable treaties, laws or regulations.
10. In the event that a natural person allegedly commits an act in a space object or in a safety zone which constitutes a crime under the laws of the State of registry, and said natural person is a foreign national, the State of registry shall consult with the foreign national's government. If the foreign national's government does not provide assurances that it will prosecute the natural person on charges commensurate to those which are justified under the laws and regulations of the State of registry, then the State of registry may prosecute the natural person in its court(s) pursuant to its own laws and procedures.

REAL PROPERTY RIGHTS

11. Private, non-governmental Owners who or which inhabit, maintain and/or operate a space facility for a period of at least one year shall be entitled to formal recognition and registration of the following rights, which shall be designated "real property rights:"
    a. The right to exclude natural persons and legal entities from the space facility and its related safety zone;
    b. The right to be free of interference from others;
    c. The right to control the activities of all natural persons and legal entities within the space facility and its related safety zone;
    d. The right to direct the activities of space vehicles and the natural persons inside such vehicles within the space facility and its related safety zone;
    e. The exclusive right to appropriate resources within the space facility and its related safety zone;
    f. The right to sell real property rights to other natural persons or legal entities.
12. The real property rights which States confer upon Owners shall be subject to the following limitations:
    a. If the Owner of a space facility stops using the space facility for peaceful purposes, the Owner's real property rights shall immediately terminate;
    b. If the Owner of a space facility abandons the space facility for a period of 2 years or more, the Owner's real property rights shall immediately terminate;
    c. If the Owner of a space facility ~~which~~ *that* is in orbit around a celestial body or point in space allows the space facility to deviate, for a period of one month or more, ~~more than ___%~~ *beyond the tolerances specified in the appropriate annex to this Convention that references this paragraph,* from any of the orbital parameters of ~~period~~ *semimajor axis, eccentricity,* inclination,

~~apogee~~ *longitude of ascending node, longitude of periapsis,* and ~~perogee~~ *longitude at epoch* ~~which~~ that are listed in the real property rights registry, the real property rights shall immediately terminate;

d. Owners may not establish property rights over an area which would prevent other natural persons or legal entities from having free access to outer space and celestial bodies;
e. The Owner of a space facility shall only have the right to direct the activities of space vehicles which are carried on the registry of a State other than the State of registry of the space facility, and the natural persons inside such vehicles, to the extent necessary to protect the safety of other space objects and natural persons within the space facility and its related safety zone;
f. Owners shall not have the right to exclude from the space facility and its related safety zone natural persons who come to inspect the space facility, on the basis of reciprocity, pursuant to Article XII of the Outer Space Treaty;
g. Any State Party to this ~~Treaty~~ *Convention* may terminate the property rights of an Owner whose space facility is carried on said State's registry, provided said State terminates the property rights pursuant to duly enacted laws or regulations, or duly ratified treaties, and the Owner has received due process of law including the right to be heard.

13. Each State Party to this ~~Treaty~~ *Convention* shall establish a registry of real property rights, and shall enact laws and, if deemed necessary, regulations which set forth the procedures which Owners of space facilities must follow in order to establish, register, and obtain documentation of real property rights. States shall require Owners of a space facilities which orbit around celestial bodies or points in space to provide the registry with the orbital parameters of the space facility, including ~~period~~ *semimajor axis, eccentricity,* inclination, ~~apogee~~ *longitude of ascending node, longitude of periapsis,* and ~~perogee~~ *longitude at epoch.* States' registries of real property rights shall be openly and easily available to other States and to the general public, free of charge.
14. States ~~Party~~ *Parties* to this ~~Treaty~~ *Convention* shall not confer real property rights upon an Owner which would prevent other natural persons or legal entities from having free access to outer space or celestial bodies.
15. Real property rights which States confer pursuant to this ~~Treaty~~ *Convention* shall not provide the basis for any claims of territorial sovereignty. States are prohibited from exercising territorial sovereignty in outer space and on celestial bodies.
~~16. States Party to this Treaty are prohibited from conferring property rights upon Owners of space facilities which are located in the Geosynchronous Orbit.~~

RESOLUTION OF LEGAL ISSUES

17. In order to provide Owners with greater certainty and less risk when legal issues arise, and to permit Owners to avoid legal disputes whenever possible, States ~~Party~~ *Parties* to this ~~Treaty~~ *Convention* are encouraged to resolve legal issues which arise in outer space or on celestial bodies by first considering analogous terrestrial treaties, laws, regulations and case law precedents before enacting new national laws. For example:
    a. Resolve legal issues regarding real property rights by first looking to terrestrial real property law;
    b. Resolve legal issues regarding space vehicles which travel in outer space by first looking to terrestrial maritime law;
    c. Resolve legal issues regarding space vehicles which travel only on the surface of celestial bodies by first looking to the law governing terrestrial ground transportation;
    d. Resolve legal issues regarding overflight of space facilities by first looking to terrestrial air law;
    e. Resolve legal issues regarding safety zones by first looking to terrestrial law which governs safety zones around facilities on continental shelves;
    f. Resolve legal issues regarding criminal jurisdiction by first looking to terrestrial laws which govern international criminal jurisdiction, extradition, and conflict of laws;
    g. Resolve legal issues regarding personal injury and damage to space objects by first looking to terrestrial laws which govern those issues.

CONSULTATION

18. States ~~Party~~ *Parties* to the ~~Treaty~~ *Convention* shall confer 5 years from the date this Convention enters into force, and every 5 years thereafter, to determine whether the following quantitative provisions of this ~~Treaty~~ *Convention* need to be revised pursuant to ~~Treaty~~ *Convention* amendment:
    a. The physical extent of safety zones for residential and scientific, and commercial, industrial and mining space facilities;
    b. The period of habitation, operation or maintenance of a space facility which is necessary to establish and register real property rights;
    c. The period of abandonment of a space facility necessary to terminate real property rights;
    d. The percentage of deviation from orbital parameters necessary to terminate real property rights.
19. The Parties may consult via a secure form of electronic communication.
20. In the event that a simple majority agree that one or more of the quantitative provisions need to be revised, the Parties shall convene a meeting to determine the revised quantitative figures. Each State Party to the ~~Treaty~~ *Convention* shall be permitted to send one voting representative to such a meeting. After full and complete discussion of relevant facts and issues, the States' voting representatives shall determine the revised quantitative figures by simple majority vote. Each State shall bear the cost of sending their representative(s) to such a meeting. The States participating in the meeting shall equally share the cost of the meeting, regardless of which State hosts the meeting, unless the host State voluntarily agrees to bear such costs.
21. In the event that States' representatives vote to change one or more quantitative provisions of this ~~Treaty~~ *Convention*, such changes shall take effect one year from the date of the vote, or at such later time as the parties may agree. Any changes in the quantitative provisions may serve to increase the rights of entities that already have property rights which have been conferred in accordance with this ~~Treaty~~ *Convention*, but such changes shall not under any circumstances diminish or abrogate the rights of entities that own property rights on the date when States' representatives vote to change the quantitative provisions.

DISPUTE RESOLUTION

22. In the event of a dispute between two or more Owners of space facilities who have registered real property rights with different States pursuant to this ~~Treaty~~ *Convention*, the Owners are first encouraged to seek resolution of their disputes through alternative dispute resolution methods such as international conciliation, mediation or arbitration. If such Owners are unwilling to or cannot resolve their disputes through private dispute resolution, the Owners may ask their respective States of registry to convene an arbitration panel to resolve the dispute. Each State of registry shall select one arbitrator. Those arbitrators shall then select one or two additional arbitrators by simple majority vote, such that the total number of arbitrators constitutes an uneven number. The arbitration panel shall then hear the facts and issues presented by the Owners and their legal counsel and shall decide the outcome of the dispute within a reasonable time.

GENERAL PROVISIONS

23. This ~~Treaty~~ *Convention* shall not provide the basis for the formation of any organization, either temporary or permanent, which would administer the terms of the ~~Treaty~~ *Convention* and/or determine the quantitative figures set forth in the ~~Treaty~~ *Convention*. It is the intention of States ~~Party~~ *Parties* to this ~~Treaty~~ *Convention* that the costs of administering the real property regime shall always remain minimal, so that no State will be prevented from becoming a party to the ~~Treaty~~ *Convention* because of prohibitive costs.
24. This ~~Treaty~~ *Convention* shall be open to all States for signature. Any State which does not sign this ~~Treaty~~ *Convention* before its entry into force in accordance with article 23 of this Convention may accede to it at any time.
25. This ~~Treaty~~ *Convention* shall be subject to ratification by signatory States.
26. This ~~Treaty~~ *Convention* shall enter into force upon the deposit of instruments of ratification by three States.

Appendix 2

Convention on Jurisdiction and Real Property Rights in Outer Space
Annex 1
Safety Zones

1. Pursuant to Paragraph 2(b) of the Convention, a State Party shall retain jurisdiction and control over a safety zone of _____ meters around the residential or scientific space facilities on its registry.
2. Pursuant to Paragraph 2(c) of the Convention, a State Party shall retain jurisdiction and control over a safety zone of _____ meters around the around commercial, industrial and mining facilities on its registry.

Appendix 3

Convention on Jurisdiction and Real Property Rights in Outer Space
Annex 2
Deviation From Published Orbital Parameters

Pursuant to Paragraph 12(c) of the Convention, if the Owner of a space facility that is in orbit around a celestial body or point in space allows the space facility to deviate, for a period of one month or more, beyond the tolerances for a specific type of orbit as defined in this annex, from any of the orbital parameters that are listed in the real property rights registry, the real property rights shall immediately terminate:

Section 1: Earth Orbits

1. Low Earth orbit, defined as an orbit around Earth whose semimajor axis is up to 8,000 kilometers:
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch [year]: _____ degrees.
2. Medium Earth orbit, defined as an orbit around Earth whose semimajor axis is between 8,000 kilometers and 26,500 kilometers:
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.
3. Semidiurnal Earth orbit, defined as an orbit around Earth whose period is 11 hours, 58 minutes, 2.1 seconds (semimajor axis of 26,561 kilometers):
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.
4. Geosynchronous orbit, defined as an orbit around Earth whose period is 23 hours, 56 minutes, 4.2 seconds (semimajor axis of 42,163 kilometers; geostationary orbit is a restricted case, where inclination and eccentricity are 0):
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;

c. Inclination: _____ degrees;
d. Longitude of ascending node: _____ degrees;
e. Longitude of periapsis: _____ degrees;
f. Longitude at epoch (year): _____ degrees.

5. Highly elliptical orbit, defined as an orbit around Earth whose semimajor axis is greater than 42,200 kilometers:
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.

Section 2: Earth-Moon Lagrange Point Halo Orbits

1. Earth-Moon halo orbits, defined as an orbit around Earth-Moon Lagrange points, shall be subject to active traffic control as such an authority is established.

Section 3: Sun-Earth Lagrange Point Halo Orbits

1. Sun-Earth L_1 halo orbit, defined as an orbit around the Sun-Earth L_1 Lagrange point, shall be subject to active traffic control as such an authority is established.

Section 4: Lunar Orbits

1. Lunar orbit, defined as an orbit around the Moon:
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.

Section 5: Mars Orbits

1. Semi-sol orbit, defined as an orbit around Mars whose period is 12 hours, 18 minutes, 41.2 seconds (semimajor axis of 12,868 kilometers):
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.
2. Low Mars orbit: defined as an orbit around Mars whose semimajor axis is up to 4,500 kilometers:
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.
3. Medium Mars orbit, defined as an orbit around Mars whose semimajor axis is between 4,500 kilometers and 12,800 kilometers:
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;

c. Inclination: _____ degrees;
d. Longitude of ascending node: _____ degrees;
e. Longitude of periapsis: _____ degrees;
f. Longitude at epoch (year): _____ degrees.

4. Areosynchronous orbit, defined as an orbit around Mars whose period is 24 hours, 37 minutes, 22.4 seconds (semimajor axis of 20,427 kilometers; areostationary orbit is a restricted case, where inclination and eccentricity are 0):
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.
5. Highly elliptical Mars orbit, defined as an orbit around Mars whose semimajor axis is greater than 20,500 kilometers:
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.

Section 6: Solar Orbits

1. Earth-Mars solar outage orbit, defined as an orbit around the sun whose period is 686.9797 days (semimajor axis of 227.9 million kilometers):
    a. Semimajor axis: _____ kilometers;
    b. Eccentricity: _____;
    c. Inclination: _____ degrees;
    d. Longitude of ascending node: _____ degrees;
    e. Longitude of periapsis: _____ degrees;
    f. Longitude at epoch (year): _____ degrees.

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