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# ARTICLE

## EFFICIENT ALLOCATION OF REAL PROPERTY RIGHTS ON THE PLANET MARS

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### I. INTRODUCTION

In August 2007 NASA successfully launched the \$90.5 million Phoenix Spacecraft which is scheduled to land on the surface of the planet Mars in the spring of 2008. The planned Mars Science Laboratory, another robotic spacecraft that should land on Mars in 2010, will cost an estimated \$347 million in 2007, with further operating expenses each year.<sup>1</sup> Should these new missions be completed as envisioned, they will be the sixth and seventh devices to land on the surface of Mars sent by the United States.<sup>2</sup> Yet, despite these significant achievements in space exploration and their enormous cost, the existing regime of space law tells us that Mars belongs to the “common

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<sup>1</sup> NAT'L AERONAUTICS AND SPACE ADMIN., FY 2007 BUDGET REQUEST SUMMARY 5 (2007).

<sup>2</sup> The others were Opportunity Rover (arrived 2004), Spirit Rover (arrived 2004), Mars Pathfinder (arrived 1997), Viking 2 (arrived 1976) and Viking 1 (arrived 1976). Nat'l Aeronautics and Space Admin. Chronology of Mars Exploration, <http://history.nasa.gov/marschro.htm>. (last visited March 3, 2008).

heritage of mankind.”<sup>3</sup> Common ownership of Mars (and the other planets as well as the Moon) and the resulting sharing of benefits derived from its exploration and development disregard the unequal cost burdens and associated risks that discourage investment and productive use. As a number of authors have argued, the opportunity for private profit, in one form or another, is an essential incentive for the advancement of space exploration,<sup>4</sup> especially as the expected gains are of high uncertainty. This article will further develop this view by challenging the idea of common property with respect to real property on the planet Mars and by evaluating specific ways in which such property rights can be allocated on the basis of efficiency. Accordingly, the current hypothetical of human exploration and colonization of Mars, although not improbable, will be considered from the perspective of a cost-benefit analysis. The article concludes that a present and definite legal regime that recognizes geographically limited and privately controlled claims to land on Mars will ensure timely and productive development of our neighboring world.

## II. THE FUTURE OF MARS EXPLORATION

Although numerous spacecraft have landed successfully on the planet, or achieved orbit around it, a manned mission to the planet Mars is several decades away and colonization is unlikely for centuries. However, there is little doubt that it will eventually occur because humans cannot expect to remain on Earth indefinitely; be it the result of our obviously degrading climate and depleted resources, or more dubious dangers such as global nuclear war, an asteroid collision, or radiation from the demise of our sun in the distant future.<sup>5</sup> President Bush indicated in his 2004 “Vision for Space Exploration” that robotic and manned missions to Mars are an important aspect

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<sup>3</sup> The Moon Treaty Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, art. 11, opened for signature Dec 18, 1979, 1363 U.N.T.S. 21 (entered into force July 11, 1984) [hereinafter *The Moon Treaty*].

<sup>4</sup> E.g., Brian Hoffstadt, *Moving the Heavens: Lunar Mining and the Common Heritage of Mankind in the Moon Treaty*, 42 *UCLA L. REV.* 575 (1994); James J. Trimble, *International Law of Outer Space and Its Effect on Commercial Space Activity*, 11 *PEPPERDINE L. REV.* 521 (1983-84); Andrew H. Pontious, *A Proposed Regime and Its Ramifications on the Commercialization of Outer Space* 7 *SANTA CLARA COMPUTER & HIGH TECH. L.J.* 157 (1991); Jeremy Zell, *Putting a Mine on the Moon: Creating an International Authority to Regulate Mining Rights in Outer Space* 15 *MINN. J. INT’L L.* 489 (2006).

<sup>5</sup> See Corey S. Powell, *Twenty Ways the World Could End Suddenly*, *DISCOVER*, Oct. 2000), GERRIL; GERRIT L. VERSCHUUR, *IMPACT: THE THREAT OF COMETS AND ASTEROIDS* 166 (Oxford University Press 1996); and See generally MARTIN SCHRAM, *AVOIDING ARMAGEDDON: OUR FUTURE. OUR CHOICE* (Basic Books 2003) (other potential sources for the extinction or near extinction of humanity include the reversal of the Earth’s magnetic field and flood-basalt volcanism).

of the American space exploration initiative.<sup>6</sup> Accordingly, NASA plans to send a manned mission to Earth's Moon before 2020 as a prelude to a manned Mars mission, which should take place within the next 20 years.<sup>7</sup> The Russian space agency Roskosmos similarly announced in August, 2007 that it anticipated sending cosmonauts to Mars after the completion of a Lunar base in 2035.<sup>8</sup> The European Space Agency's (the ESA) Aurora program includes a manned mission to Mars by 2024.<sup>9</sup>

Serious interest in Mars will continue to intensify for two important reasons. First, Mars is far more capable of sustaining human life than any other planetary body in the Solar System. Roughly half the size of Earth, and with about the same amount of dry land, Mars' gravity and temperature are within the range of human tolerance. It is already known that Mars possesses vast resources of frozen carbon dioxide from which the important fuels of oxygen, deuterium and helium-3 can be derived. Liquid water, which could be used both for its oxygen and for irrigation in agriculture, is now thought to exist not far beneath the planet's surface.<sup>10</sup> The presence of water also raises the potential that isolated ecosystems may exist on Mars. Such ecosystems could provide genetic material that could be used to treat illnesses.<sup>11</sup> Mars' atmosphere, temperature and air pressure could be made to sustain human life through a complex process called terraforming, rendering the planet a potential refuge for humans should Earth become uninhabitable.<sup>12</sup> Mars has a 24-hour day. Mars is the only such celestial body in the solar system to have a 24 hour day other than Earth, which could allow greenhouses to be used to create gases necessary for human life.<sup>13</sup> Many useful ores also may exist on Mars that could be used to facilitate habitation.<sup>14</sup> Secondly, land claims on Mars will

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<sup>6</sup> See <http://www.whitehouse.gov/news/releases/2004/01/20040114-1.html>

<sup>7</sup> E. Baard & J. Winters, *First Stop: Mars*, in *SPACE 2100: TO MARS AND BEYOND IN THE CENTURY TO COME* 58 (Popular Science ed., 2003).

<sup>8</sup> William Atkins, *Manned Mission to Moon in Russia's Future*, IT WIRE, Sept. 3, 2007, <http://www.itwire.com/content/view/full/14267/1066/>.

<sup>9</sup> *European Scientists Plan Mars Missions*, CNN, Feb. 4, 2004, <http://www.cnn.com/2004/TECH/space/02/04/europe.mars.mission.ap/index.html>. It is noteworthy that no such date is given on the ESA's official website.

<sup>10</sup> Arden L. Albee, *The Unearthly Landscape of Mars*, 288 SCI. AM. 44, 49-52 (2003).

<sup>11</sup> LAURENCE BERGREEN, *VOYAGE TO MARS: NASA'S SEARCH FOR LIFE BEYOND EARTH* 208 (Riverhead Books 2000).

<sup>12</sup> Robert M. Zubrin & Christopher P. McKay, *Terraforming Mars*, in *ISLANDS IN THE SKY: BOLD NEW IDEAS FOR COLONIZING SPACE*, 125-126 (Stanley Schmidt & Robert M. Zubrin eds., 1996) (stating that a greenhouse effect would be created by producing CFC's on a massive scale or through orbital mirrors which will release native greenhouse gases, mostly from Mars' polar ice caps. Genetically modified vegetation will be planted later to produce oxygen. It is estimated that Mars could be rendered fully Earth-like in 500 years.).

<sup>13</sup> See Quick Facts, INTELLIGENT SYSTEMS DIVISION, [http://ti.arc.nasa.gov/destination/mars/quick\\_facts.php](http://ti.arc.nasa.gov/destination/mars/quick_facts.php).

<sup>14</sup> Robert M. Zubrin & David A Baker, *Mars Direct: A Proposal for the Rapid*

become more significant precisely because of its isolation from Earth. While Mars is close by astronomical standards(it is as little as 56 million kilometers away), with our current technology a mission to Mars would last at minimum two years and regular “return trips” to Earth are consequently unrealistic. It is therefore much more probable that Mars will eventually host a permanent, autonomous colony than, for example, the Moon. This much greater time frame for travel necessitates a commitment to reliable, independent systems and infrastructure.<sup>15</sup> Claims staked on land, such as mining, agricultural and settlement rights could last for whole life spans of colonists or beyond.

### III. THE CURRENT LEGAL REGIME FOR PROPERTY IN OUTER SPACE

In order to frame the discussion of future real property claims on Mars, this article will briefly discuss existing law on property in space. There are currently two relevant international treaties: The Outer Space Treaty and the Moon Treaty, both of which establish that Mars (and the other planets) are *res communis*: common property owned by the people of Earth. The former agreement, signed in 1967 as the result of efforts of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), establishes that space is “the province of all mankind” and “free for exploration and use by all states without discrimination of any kind, on a basis of equality” and also that there should be “free access to all areas of celestial bodies”,<sup>16</sup> clearly precluding the exclusivity of possession that is the foundation of ownership. Celestial bodies, including Mars, cannot be the subject of national appropriation by claims of sovereignty.<sup>17</sup> The Outer Space treaty was signed by the United States, the USSR and 89 other nations and as such it can be viewed as a legally binding commitment in international law. The later Moon Treaty, ratified by only seven countries, establishes that all resources outside the earth are the “common heritage of mankind” and that no entity, either public or private can exclusively own any space resource,<sup>18</sup> and that there must be “equitable sharing” by all state parties in the benefits derived from space resources, taking into consideration the needs of developing countries.<sup>19</sup> This language of public ownership mirrors The Law of the Sea convention, which

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*Exploration and Colonization of the Red Planet*, in ISLANDS IN THE SKY: BOLD NEW IDEAS FOR COLONIZING SPACE, *supra* note 12 at 64-67.

<sup>15</sup> BERGEEN, *supra* note 11, at 315. (stating that it would take six months to reach Mars and the crew would have to remain for 450 days to take advantage of Mars’ orbital position relative to Earth).

<sup>16</sup> Treaty on the Principles Governing the Activity of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies, art. I, Oct. 10, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 207-208 [hereinafter The Outer Space Treaty].

<sup>17</sup> The Outer Space Treaty, *supra* note 16, art. II

<sup>18</sup> The Moon Treaty, *supra* note 3, art 11.

<sup>19</sup> The Moon Treaty, *supra* note 3, art 11.

establishes that no nation can own the world's oceans.<sup>20</sup> The Moon Treaty permits the retention of "samples" taken from planetary bodies, although it encourages that such materials be made available to other nations for the purposes of scientific experiment.<sup>21</sup> The laws of space, interpreted by some to allow for commercial mining, thus recognize the concept of personal property.<sup>22</sup> Although the Moon Treaty allows parties to retain ownership of the equipment, vehicles and installations that they place there<sup>23</sup> this is not true ownership in the common law sense since there is no right to exclude because Article XV requires that all vehicles, installations and equipment shall be open to use by all other parties. This partial acknowledgement of private personality may hold the potential for "quasi-sovereignty" involving ownership of objects on the surface of planets by individuals or corporations.<sup>24</sup> The simple delineation between equipment and land may be difficult to draw on Mars, however, because the planet's atmosphere necessitates artificial construction, such as a greenhouse, in order to render the surface agriculturally productive or habitable. According to the common law, a chattel (in which ownership is retained in space) loses its status as a chattel and becomes a fixture when it is so affixed to land that it becomes part of the land,<sup>25</sup> and evidently according to treaty at that point ownership is lost. In this way a base built upon the soil or rock of Mars for the purpose of habitation or as a greenhouse, even if it is resting upon the planet's surface under its own weight without attachment, as long as it is intended to permanently improve the land, will become a fixture<sup>26</sup> and is therefore common property. Thus, there is a strong risk that an investment such as a base that possibly costs billions of dollars in preparation and transportation would become public property once it was placed upon the planet's surface.

Together the space treaties embody the now widely-criticized notion<sup>27</sup> that

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<sup>20</sup> *United Nations Convention on the Law of the Sea*, opened for signature Dec. 10, 1982, 1833 U.N.T.S. 397. This treaty met with opposition from American mining interests. Carl Christol, *The Moon Treaty and the Allocation of Resources*, 22 ANNALS OF AIR & SPACE L. 31 (1997) at 42.

<sup>21</sup> The Moon Treaty, *supra* note 3, art. 6.

<sup>22</sup> Christol, *supra* note 20 at 40.

<sup>23</sup> The Moon Treaty, *supra* note 3, art. 12.

<sup>24</sup> Kurt Anderson Baca, *Property Rights In Outer Space*, 58 J. AIR L. & COM. 1041 (1992-93) at 1065.

<sup>25</sup> 5 AMERICAN LAW OF PROPERTY: A TREATISE ON THE LAW OF PROPERTY IN THE UNITED STATES § 19.1 (A. James Casner ed. 1952).

<sup>26</sup> *Snedeker v. Warring*, 12 N.Y. 170, 175 (1854).

<sup>27</sup> See e.g., David Tan, *Towards a New Regime for the Protection of Outer Space as the "Province of All Mankind"*, 25 YALE J. INT'L L. 145, 146 (2000); Kelly M. Zullo, *The Need to Clarify the Status of Property Rights In International Space Law*, 90 GEO. L. J. 2413, 2416 (2002); Brandon C. Gruner, *A New Hope for International Space Law: Incorporating Nineteenth Century First Possession Principles into the 1967 Space Treaty for Colonization of Outer Space in the Twenty-First Century*, 35 SETON HALL L. REV. 299, 305-6 (2004).

every human, as represented by the states in which they are members, has an effective “right” to Mars. Under this regime the allocation of Martian resources, possibly including land itself, will be determined by the “administrative model” in which each nation decides the distribution based on each country having an equal vote, much like the current United Nations regime.<sup>28</sup> Not surprisingly, the United States and the Soviet Union rejected the limitations on the use of space resources, refusing to sign the Moon Treaty. Indeed none of the signatories of the Moon Treaty has space travel capability, suggesting that it does not reflect any practical concerns in space exploration and development. Rather, the Moon Treaty illustrates resistance to the idea of private advancement through the acquisition or use of space resources as expressed through the voting dominance of less-developed nations in intergovernmental organizations.<sup>29</sup> Still, as many legal commentators have noted, the benefit sharing doctrines enunciated in the treaties are fortuitously vague and as such have little force in international law. At best they are loose policy guidelines, not concrete obligations.<sup>30</sup> Interestingly, the treaties also present inconsistent principles: the Moon Treaty’s common ownership concept contradicts the prohibition against national appropriation found in the Outer Space Treaty,<sup>31</sup> although this is little more than a semantic distinction. The ambiguity of these treaties and the fact that the Moon Treaty has not been ratified by space-faring nations suggests that property law in space remains, hopefully for the purpose of incentivization, clouded. Many commentators, notably Carl W. Christol, further assert the need to clarify and formalize the law of space exploration generally.<sup>32</sup> An internationally recognized legal regime for property rights on Mars is essential; otherwise uncertainty (if not the fear of expropriation in the name of mankind) will endanger financial investment both in reaching and then colonizing the planet.

#### IV. OWNERSHIP AS AN INCENTIVE FOR PRODUCTIVE USE

In order to clarify the best regime for property on Mars it is first necessary to clarify how real property is treated on Earth, at least in Common Law jurisdictions. The Common Law views property as a bundle of rights: the right to use, to exclude others from use and to transfer those rights to others. As such, owning the planetary body of Mars in the legal sense would include the right to mine or build upon the planet’s surface, to deny permission to land upon it from space, possibly to put something in orbit around it, and to sell or otherwise transfer those rights to someone else. Property law also recognizes the distinction between public and private property, but this crucial distinction

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<sup>28</sup> Carl Q. Christol, *The Moon and Mars Missions: Can International Law Meet The Challenge?* 19 J. SPACE L. 123, 133 (1999).

<sup>29</sup> Christol, *supra* note 20 at 32-33.

<sup>30</sup> See e.g. Tan, *supra* note 27 at 147; Zullo, *supra* note 27, at 2417.

<sup>31</sup> Zullo, *supra* note 27, at 2425.

<sup>32</sup> See generally Christol, *supra* note 28.

is problematic when applied to such a vast area as an entire planet because such rights cannot be readily categorized as either public or private goods. Mars is a private good in that it may (and likely does) contain valuable mineral resources. These are private goods by definition because they can only be consumed by one person to the exclusion of others.<sup>33</sup> It has already been suggested that the existing treaties may acknowledge mining rights on the planets as such resources can be extracted and removed from the planet. On the other hand the land itself, the vast terrain of the planet's surface, could be viewed as a public resource like a National Park or the Atlantic Ocean because it can be used in a non-rivalrous way.<sup>34</sup> However, the land on Mars is naturally inhospitable to humans and agriculture as we know it. The land must be altered through the establishment of infrastructure, like environmentally controlled bases or artificially irrigated greenhouses, before it can be useful in any practical sense. Because of the enormous technological commitment involved, land uses of this nature will be relatively restrictive (at least at first) and probably of small dimension compared to the entire surface of the globe. Such uses are therefore exclusive and rivalrous because there is limited room to live in a constructed base, limited soil under a greenhouse roof, limited artificially liberated oxygen (from the carbon dioxide atmosphere) for breathing and limited melted water for drinking. In that sense the land of Mars should also be viewed as a private good. The incentive to make these productive uses of the land of Mars necessitates non-communal ownership because private property rights encourage the maximization of resource potential due to the prospect of higher individual gains. The cost of monitoring property is also negated through a regime where private entitlements are enforced by law.<sup>35</sup> Similarly, it has now been widely and effectively argued<sup>36</sup> that the recognition of property rights will be a strong incentive for space exploration because the expectation of future profit, such as derived from property claims, legitimizes the enormous expense from a rational cost-benefit perspective. Missions to Mars are particularly needful of such clear incentivization because of the high costs and uncertain benefits. Recent estimates suggest that a manned mission to Mars would cost \$55 billion.<sup>37</sup> The establishment of bases or other such infrastructure could cost significantly more, and the value of such improved land is at best uncertain,

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<sup>33</sup> ROBERT COOTER & THOMAS ULEN, *LAW AND ECONOMICS* 107 (4th ed. 2004).

<sup>34</sup> *Id.*

<sup>35</sup> CENTO VELJANOVSKI, *ECONOMIC PRINCIPLES OF LAW* 61 (2007); COOTER & ULEN, *supra* note 33, at 107.

<sup>36</sup> John Adolph, *Recent Boom in Private Space Development and the Necessity of an International Framework Embracing Private Property Rights to Encourage Investment* 40 *INT'L LAW*. 961, 984-985 (2006).

<sup>37</sup> BERGREEN, *supra* note 10, at 325. A Mars mission involving the construction of a large spacecraft in conjunction with a series of smaller landers was estimated to cost \$600 billion. Baard, *supra* note 7, at 58.

especially since its expected utility may depend on some as yet unknowable future eventuality on Earth. In contrast, equal distribution of Martian land in line with the Common Heritage principle would lead to no profit in the economic sense and would inevitably result in the “tragedy of the commons,” the risk of self-interested over-exploitation or under-exploitation of shared resources if there is no enforcement mechanism that ensures each user pulls their own weight.<sup>38</sup> If each nation or person has equal claim to Mars as a matter of right and not as a function of contribution, then non-space faring nations and their taxpayers will avoid contributing to the efforts to reach and develop Mars. No country is likely to undertake the enormous risks, economic and otherwise, associated with Mars colonization without the legal certainty that their rewards will not be distributed to others.<sup>39</sup> The private property rights to exclude others from specific developed areas of Mars, to transfer that right to others in a market, and to use the land in a productive manner are crucial incentives.

A key advantage of recognizing private ownership of real property on Mars is that non-state bodies could become committed to the productive use of land on the planet. Financing a Mars mission as a business venture could be an efficient way to reach the planet and to establish human habitation there.<sup>40</sup> Individuals or organizations could buy shares in the Mars mission to be compensated by land claims on the planet that would rise in value in proportion to the extent of colonization. The uncertain legal framework of the existing treaty regime would undermine optimal investment since there would be fear of uncompensated expropriation under the auspices of the UN or some other international organization favoring absolute common ownership of all extra-planetary resources. Thus, as Hoffstadt has noted, a stable legal regime is required in order for investment in space exploration to be viable.<sup>41</sup> A clear and consistent legal regime will induce productive private capitalization of Mars missions in the future and would be advantageous in the development of Mars.<sup>42</sup> While the negotiation of a legal framework fostering investment in extra planetary land has the potential itself to be costly, it is expected that the relative costs will only increase over time as more nations and corporations become involved, suggesting that earlier settling of legal entitlements is favorable. Although at present it seems unlikely that interplanetary travel, let

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<sup>38</sup> Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243 (1968); VELJANOVSKI, *supra* note 35, at 66-68.

<sup>39</sup> Baca, *supra* note 24, at 1045.

<sup>40</sup> The corporate model of space exploration has been proposed by Christol, *supra* note 28, at 133.

<sup>41</sup> Hoffstadt, *supra* note 4, at 580.

<sup>42</sup> A stable legal regime involving the recognition of property rights and the enforcement of contracts is seen as a prerequisite to economically productive investment generally. DOUGLAS ARNER, *FINANCIAL STABILITY, ECONOMIC GROWTH AND THE ROLE OF LAW* 91 (Cambridge University Press 2007).



alone planetary colonization, could be achieved by a corporation or other private body due to insufficient resource consolidation, there are signs that private space exploration is becoming more relevant. Growing interest in private space exploration is evidenced by the numerous non-market initiatives to encourage a non-state role in space exploration, such as the Ansari X prize for suborbital spaceflight and Google's recent To the Moon prize to be awarded to the first individual to successfully place an object on the Moon.<sup>43</sup> Recent successful advancements in private space flight, such as SpaceShipOne and the voyage of tourist Dennis Tito to the International Space Station, may be indicative of future trends for involvement of private enterprise in this field.<sup>44</sup> Non-state space exploration has the economic advantage of capitalization from sources that would be unavailable to a publicly funded agency like NASA, such as selling the broadcast rights to video and audio images of the mission. The Mars Rover and Mars Explorer photographs were among the most popular images on the Internet for some time.<sup>45</sup> It is unlikely that private space exploration initiatives, such as ones involving the development of land on Mars, would occur without the prospect of economic recovery if not surplus profit.

Single state or private enterprise ownership of land on Mars is more efficient than an international regime of common ownership as envisioned by the Outer Space treaty because the transaction costs of international public action are much higher than those of private entities, or even single state governments. Epstein termed this "negativism;" without unanimous agreement from all members of society on how to exploit a common resource, it may remain unused.<sup>46</sup> Indeed, space exploration is a notorious example of the difficulty in achieving collective international action.<sup>47</sup> Common ownership of Mars demands international regulatory unanimity that would be both prohibitively expensive and potentially impossible to implement. In contrast, private, or single sovereign ownership of a resource such as organizing colonization or a terraforming project on Mars, tends to result in the most efficient administration of that resource because bargaining among smaller groups tends to result in cooperation.<sup>48</sup> In this way, the first expeditions to

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<sup>43</sup> See generally [Googlelunarprize.org](http://www.googlelunarprize.org), About the Google Lunar X Prize, <http://www.googlelunarprize.org/lunar/about-the-prize> (last visited September, 2007).

<sup>44</sup> Adolph, *supra* note 36, at 961.

<sup>45</sup> This idea was suggested by BERGREEN, *supra* note 11, at 325.

<sup>46</sup> Richard A. Epstein, *Possession as the Root of Title*, 13 GA. L. REV. 1221, 1237 (1979).

<sup>47</sup> Consider for example the difficulties involved in the Hubble Space Telescope and the International Space Station. Other practical problems, such as having an international crew may raise costs because of additional stresses cultural and language differences would place on a small Mars mission team, who would spend several years together.

<sup>48</sup> See e.g., COOTER & ULEN, *supra* note 33 at 141; Harold Demsetz, *Toward a Theory of Property Rights II: The Competitiveness Between Private and Collective Ownership* 31 J. LEGAL STUD. S653 (2002).

Mars will be undertaken by the party that can do so at least cost. The costs should be lower for single states or private entities because fewer resources will be expended on decision-making than in an international initiative, even one coordinated by a centralized body such as the United Nations.

A Mars expedition will be undertaken when the expected benefit exceeds the cost. However, the fact that NASA and other agencies have already expended resources in Mars' exploration without economic gain illustrates that most, if not all, of the benefits derived from space exploration so far are non-market benefits, like the advancement of scientific knowledge and the satisfaction of curiosity. Similarly, a significant component of the cost of manned space exploration is the risk of human safety, which also cannot be readily quantified for the purposes of cost-benefit assessment. While the expense of a manned Mars mission would be much higher than the robotic missions to date, one might expect that such costs and human risks will decline over time because of corresponding increases in technology. The expected gains from a Mars expedition should also increase over time because technology should augment the extent and quality of knowledge that can be gained from such missions. Also, technology should enhance the degree to which the planet can be developed profitably, for example, with improved methods of transforming deuterium ice into a ready energy supply. Thus, the initial missions emerge as the least efficient from a cost-benefit perspective. Yet, property law suggests that the initial missions are the most important for the purpose of establishing a claim, although this may depend upon what activities count as possessory.

#### V. LAND CLAIMS ON MARS VIA FIRST POSSESSION

As intimated in the introduction to this article, there may be economic and moral justifications to assert that real property claims to terrain on Mars should already exist in favor of those nations that have sent probes that have landed on the surface. Such an argument is in keeping with a classic interpretation from Locke, who claimed that possession is determined by the act of mixing one's labor with property.<sup>49</sup> Unfortunately, this doctrine does not lend itself readily to celestial bodies because much of the early, yet important, "labors" of astronomy involved mere observation which pre-date recorded history. It is further unreasonable to assert that, for example, Galileo could have claimed ownership of Jupiter's three largest moons because he built a telescope to observe them, despite the fact that the effort and ingenuity involved in so doing could be described as labor. Similarly, imaginative private citizen Dennis Hope claimed ownership of Mars in a declaration delivered to the United Nations in 1980.<sup>50</sup> However, the issuance of a written statement alone is not

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<sup>49</sup> JOHN LOCKE, *THE SECOND TREATISE OF GOVERNMENT AND A LETTER CONCERNING TOLERATION* 12-13 (Tom Crawford ed., Dover Thrift 2002) (1689).

<sup>50</sup> Hope has authorized an Internet-based agency to sell plots of Mars at a cost of £14.25 per acre. MoonEstates.com – Buy Land on the Moon, Mars, and Venus,

legally sufficient to connote possession under the common law, and his assertion is, accordingly, meaningless. Locke's conception of possession probably contemplated some kind of physical interaction with property, such as building or repairing equipment or cultivating land. This is largely reflected in the Anglo-American tradition of property law and its characterization of the concepts of use and possession. In a very real sense then, the five American probes that physically landed on Mars to take photographs and make charts, mixed human labor with the planet, such that America should own Mars. This cannot be the correct conclusion, however, because it seems more justifiable, practically as well as morally, to require a putative owner herself to have a physical presence on the planet's surface, at least at some point.

One of the complaints of the international community against sovereign claims on Antarctica was that there was no effective occupation by human settlers.<sup>51</sup> This is because international law requires that "acts of discovery" must be perfected by a form of administrative control, which is difficult in vast areas with harsh conditions, such as Antarctica or Mars.<sup>52</sup> If human occupation is to become a requirement for recognition of property rights under international law, one might be tempted to conclude that Mars belongs to Russia while the Russian space crew is there, only to become a *res nullius* once they depart. Indeed, under the common law, acts of possession, such as presence, can establish or maintain *de facto* ownership of land. The extent of the required acts depends on the nature of the land itself and how it can be used.<sup>53</sup> In this way, perhaps the numerous probes sent by Earth-based claimants could perpetuate ownership of barren Martian terrain if humans had once visited it. It is important to recognize that Locke's idea of "mixing labor" hinged on the addition of value to that property<sup>54</sup>. Therefore, if a robotic spacecraft can map the land, analyze the soil, or deposit useful goods on the planet's surface that would benefit subsequent visitors, then the value of the land has increased. The many small landers that were sent to Mars in recent years were intended to facilitate future manned missions, in part by mapping the land features.<sup>55</sup> Rendering a planet more capable to sustain human visitors will increase its value. However, such claims are tenuous because of the limited physical terrain, in terms of a percentage of the planet's entire surface,

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[http://www.moonestates.com/shop-moonestates\\_mars.asp](http://www.moonestates.com/shop-moonestates_mars.asp) (last visited Sept., 2007).

<sup>51</sup> Jennifer Frakes, *The Common Heritage of Mankind Principle and the Deep Seabed, Outer Space, and Antarctica: Will Developed and Developing Nations Reach a Compromise?* 21 WIS. INT'L L.J. 409, 430 (2003).

<sup>52</sup> DONALD P. ROTHWELL, *THE POLAR REGIONS AND THE DEVELOPMENT OF INTERNATIONAL LAW* 59, 67 (1996).

<sup>53</sup> For example, the mere shooting of rifle bullets over land during the winter months was sufficient to constitute *de facto* possession of the land. *Harper v. Charlesworth*, 4 B. & C. 574, 584 (1825).

<sup>54</sup> LOCKE, *supra* note 49.

<sup>55</sup> BERGREEN, *supra* note 11, at 64-65.

photographed and explored by the landing probes and also by the fact that their data transmissions are not permanent. The first Viking probes, which landed on Mars in the 1970s, are no longer operational. This could constitute a kind of common law abandonment that would negate a once-existing property entitlement.

As a more readily comprehensible and morally defensible system of property claims in space, Baca has argued that the 19<sup>th</sup> century principle of first possession, as in first physical presence by humans, should govern the initial claims for space-based resources.<sup>56</sup> Gruner recently echoed this theory in relation to the Moon and the planets of the Solar System.<sup>57</sup> Rooted in natural law, “first possession” is compatible with Locke’s principle of adding value to an object by investing labor in it. The historic equivalent of this legal rule was evident in the early settlement of the American frontier.<sup>58</sup> First possession of unclaimed land, as in 18<sup>th</sup> century America, can be readily analogized to a planet because both consist of undeveloped, uninhabited physical space.<sup>59</sup> Other than the scientific information we have gained from probes, Mars currently offers nothing more than aesthetic value to humanity as a curiosity in the night sky. Yet its enormous potential value as a future human settlement, possibly to save humanity, can only be actualized as it becomes physically attainable through space travel and habitable through colonization. As Mars will be rendered valuable by adding the characteristics of accessibility and habitability to it, then the party who reaches and develops it first should be able to claim ownership of it. In addition to compensating the first productive uses, first possession rewards the daring of the claimant possessor. In literal terms, then, an equal distribution of property rights on Mars among all nations undermines the vast resources expended in the achievement of technological supremacy of states like the United States, Russia and members of the European Union.<sup>60</sup>

While relatively straightforward and based upon historic precedent, the doctrine of first possession may not be the most efficient way to direct resources towards the exploration and development of Mars because the first nation to land on Mars is not necessarily the one that will use the planet’s land in the most productive way. The failure of homestead farms in American history showed that the rush to possess empty land pulled these resources out

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<sup>56</sup> Baca, *supra* note 24, at 1054-56.

<sup>57</sup> Gruner *supra* note 27, at 349. Gruner advocates granting private property rights through first possession with settlers will act on “behalf of the interests of humanity.” *Id.* at 354.

<sup>58</sup> Epstein, *supra* note 46, at 1232, 1241. This doctrine is seen also in modern trademark law which grants protection to words based on their first usage. 15 U.S.C. § 1114(1) (2008).

<sup>59</sup> Ignoring, for the purposes of comparison, the aboriginal presence in the American west.

<sup>60</sup> Frakes, *supra* note 51, at 425.

of the hands of other more productive uses that came later.<sup>61</sup> Under the doctrine of first possession, resources could be drawn from more productive uses at a faster than optimal rate.<sup>62</sup> For example, resources spent on getting to Mars quickly may have been more efficiently directed to technology that could develop Mars more fully at some later point, or on technology that could combat the effects of global warming (possibly rendering humanity's future escape to Mars unnecessary). Of course, a Mars mission could lead to indirect gains - technological innovations with applications in other industries. It is reasonable to expect that such innovations, for example food synthesis or alternative energy sources, could lead to the improvement of the standards of living for people on Earth, which is an explicit aim of the Moon Treaty<sup>63</sup>, as well as the United Nations<sup>64</sup>. Moreover there are important non-market gains to be achieved from winning a space race to Mars, such as a morale boost to the claimant nation. Still, one NASA analyst cautions that without a credible and immediate scientific purpose, such a "cheap-and-dirty" approach to a Mars mission would amount to little more than a technological demonstration.<sup>65</sup> That the principle of first possession can lead to over-investment in the activities legally required for obtaining title demands investigation into other more efficient ways of allocating real property rights on Mars.

#### VI. ALLOCATING PROPERTY RIGHTS ON MARS BEFORE ARRIVAL

In order to stimulate productive use of the land on Mars while avoiding an inefficient race to first possession, initial property rights allocation could be achieved via competitive bidding in advance of actually landing on Mars. In this way the party that values Mars the most, and therein would accordingly be expected to make the most valuable use of it, will be granted title to the planet. This method has been rejected as inefficient because of the immense bureaucracy that would be needed to conduct auctions.<sup>66</sup> There are also logistical problems regarding the way in which the auction would be conducted.<sup>67</sup> The most pressing problem with this system is that the winning

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<sup>61</sup> Robert P. Merges & Glenn H. Reynolds, *Space Resources, Common Property and the Collective Action Problem*, 6 N.Y.U. ENVTL. L.J. 107, 117 (1997).

<sup>62</sup> *Id.*

<sup>63</sup> Art Agreement Governing the Activities of the States on the Moon and Other Celestial Bodies, G.A. Res. 34/68, at art. IV, U.N. Doc. A/34/20/Annex II (Dec. 5, 1979).

<sup>64</sup> "To promote social progress and better standards of life in larger freedom." U.N. Charter Preamble, <http://www.un.org/aboutun/charter/preamble.htm> (last visited Mar. 3, 2008).

<sup>65</sup> BERGREEN, *supra* note 11, at 321.

<sup>66</sup> Merges & Reynolds, *supra* note 61, at 118.

<sup>67</sup> The winning bidder could "pay off" all other losing bidders for their share of the planet. The funds from the highest bid could be distributed evenly amongst all other bidders, or perhaps only to those nations that could actually have made good on their bid to reach Mars. The bid funds could be divided equally between every nation or distributed per

bidder would be forced to expend vast resources in compensating the losers rather than in a Mars expedition itself; clearly an inefficient cost from the perspective of space resource improvement, much as a race for first possession would be. Even if the auction were to involve the purchase of parcels of Martian land rather than rights to the entire planet (as suggested below), such that there could be multiple “winners”, valuable resources would still be wasted in the purchase of the land (i.e. the allocation of pre-existing rights based on a principle of common ownership) that could have been channeled more efficiently into reaching or developing the planet.

The more realistic Mars exploration and settlement becomes, the more costly such entitlement payments become. As future technology and the need to resort to Mars for resources or habitation increase, such payments could become economically prohibitive; the cost to purchase advance Martian property rights could exceed the eventual profits derived from the use of that land.<sup>68</sup> However, if compensation payments are static, meaning that they are locked into a current (probably low) value that reflects the current high level of risk associated with a Mars mission, then the parties could bargain as envisioned by the Coase Theorem.<sup>69</sup> According to the theory, goods will end up in the hands of the party, or parties in the case of a vast resource like a planet, that values the goods the most. The theory explains that initial legal entitlements are irrelevant; the efficient allocation of resources will be achieved through bargaining, provided that transaction costs are zero.<sup>70</sup> With this in mind, putative Mars explorers could pay a “Mars Tax” or use tax which could be distributed to all the nations of the world in recognition of the pre-existing entitlements of “Common Heritage of Mankind” and, more specifically, Article XI.7b of the Moon Treaty which calls for an “equitable sharing of the benefits” derived from the resources of the planets. Such an arrangement might also fit well with the requirement of an “international regime . . . to govern the exploitation of the natural resources” of the planets, as mandated by Article 11.5 of the Moon Treaty. Provided that the compensation fee was sufficiently low so as not to discourage exploration, the efficient development of Mars would be undertaken regardless. A non-economically prohibitive level of “Mars Tax” is probable, given the future discount<sup>71</sup> that many nations would likely place on the uncertain prospect of

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capita.

<sup>68</sup> This is provided, of course, that such anticipated Mars missions are for economic purposes and not survival ones; such as escaping Earth because of our own planet’s inability to sustain life in which case there are strong moral, non-economic reasons.

<sup>69</sup> Ronald Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960). The Coase theorem’s neglect of transaction costs is particularly problematic in the realm of space exploration where there is international activity as well as high uncertainty. Merges & Reynolds, *supra* note 61, at 116.

<sup>70</sup> Which of course they never are in reality, the key flaw in the Coase Theorem.

<sup>71</sup> This is known as Discounted Cash Flow Analysis. See e.g., VELJANOVSKI *supra* note 35, at 29.

Mars exploration in exchange for giving up their claims. A use tax on Mars would be much less prohibitive than one on the Moon, the exploitation of which is more readily achievable with current technology. Most nations would be willing to concede future property claims of dubious (although potentially large) value to exploring parties in exchange for guaranteed, although marginal, payment today.<sup>72</sup> Such tax could be looked upon as an ordinary transaction cost – such as highway taxes or landing fees at airports that are a necessary cost associated with market participation. Compensation payments of this nature might take another form – that of the government “taking” of property as seen in the Eminent Domain clause of the US Constitution.<sup>73</sup> An international Earth government, such as some future version of the United Nations, could seize land on Mars for public use, for example in the event of an emergency on Earth, and compensate the original owner in the process. Provided that full market value is paid, as required for example under the Constitutional provision, then such a transaction amounts to efficient bargaining. Seizures for something less than the full market value should be prohibited both from a standpoint of fairness as well as efficiency.

As an alternative to a use tax on Mars, in order to uphold the spirit of the Outer Space Treaty and the Moon Treaty, a portion of the Martian terrain could be set aside as common territory for the people of the Earth as envisioned in Article 7.3 of the Moon Treaty which references “scientific preserves.” This land could be the interplanetary equivalent of land set aside for public use, such as parks, during the construction of housing subdivisions. Perhaps 25% of the Martian equatorial zone, where conditions for human habitation are most favorable, could be reserved for public uses in the future.

#### VII. BOUNDED FIRST POSSESSION BY LANDFALL

As an alternative to fixing future claims on Mars based upon a re-allocation of pre-existing ones, the most efficient mechanism of real property allocation of an un-owned *res nullius* planet Mars would be a limited form of first possession: the allotment of only a portion of land to the first arriving organization, not the entire surface of the planet. The size of the allocation would be set at the optimal level to encourage exploration and development while conserving land for future explorers. The first landers could claim all terrain, for example, within a hundred kilometer radius of their landing point subject to an increase if productive use is made of an even larger portion. The rest of the planet would remain un-owned and available to become possessed by subsequent explorers. This bounded first possession is in keeping with the language of the Outer Space Treaty and Moon Treaties that prohibit only sovereign claims to the celestial body, which could be interpreted to mean the planetary sphere itself. Such a credible interpretation reads in the word “entire” to the following provision for the purpose of clarity: “neither the

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<sup>72</sup> The famed Manhattan purchase for \$24 comes to mind as a historic precedent.

<sup>73</sup> U.S. CONST. amend.V.

*entire* surface or *entire* subsurface of the Moon [or Mars] shall become the property of any State”.<sup>74</sup> Partial allocation as described is just because landing on one minuscule portion of a world should not entitle a claimant to ownership of all of it, much of which may be left completely idle by the original explorer, resulting in an inefficient use of the planet’s resources. The problem of inefficient races to achieve the legal right to first possession will be avoided by this regime, as second and third place finishers will be rewarded with other plots of land on the surface. Consequently pre-mature and therefore non-productive missions will be avoided because there is no risk of exclusion for failing to land first; the marginal benefit of arriving second will be as high as the marginal benefit of arriving first. Of course, the pride engendered by first arrival, such as that generated by the first Moon landing, would help to encourage earlier Mars expeditions rather than later ones. Incentive to settle on Mars before others may similarly result from the fact that some regions of the planet could be more valuable than others. For example, just as the flat, northern hemisphere would may be more conducive for agriculture than the rugged southern hemisphere, the equatorial zone would probably hold greater value because of their warmer climates.<sup>75</sup> Part of the concern of developing nations in espousing the Common Heritage principle for planetary bodies was that the planet’s resources would already be depleted by the time nations with weaker initial resource endowments (the developing world) are capable of exploiting the land on Mars.<sup>76</sup> Plot ownership would address this concern since vast regions of Mars would likely remain un-owned for centuries, giving developing nations a chance to “catch up”.

Private easements and restrictive covenants arrived at by bargaining among the landed owners (rather than through international political consensus) and enforced through private litigation would control competing land uses such as over exploitation or pollution in order to produce an efficient allocation of resources. At least in the early stages of colonization there would be no need to incur the cost of a special “Mars Court” to adjudicate such disputes. Instead, landowners could litigate in the courts of their choice on Earth, subject to that court’s own rules on taking jurisdiction. For example, an American corporation owning land on Mars could bring suit in nuisance against another American landowner in the Federal court of the United States.<sup>77</sup> Disputes between sovereign landowners on Mars could similarly be brought in the International Court of Justice.<sup>78</sup> Again, it is expected that such private land use adjudication among fewer parties should be less costly than public control of

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<sup>74</sup> The Moon Treaty, *supra* note 3, art. 11.

<sup>75</sup> BERGREEN, *supra* note 11, at 305.

<sup>76</sup> Frakes, *supra* note 51, at 433.

<sup>77</sup> Possibly as an extension of the subject matter jurisdiction over admiralty and maritime issues under Article III of the Constitution. U.S. CONST. art. III, § 2.

<sup>78</sup> As a general court of law regarding disputes between sovereign nations as constituted under Chapter XIV of the UN Charter. UN Charter, *supra* note 64, ch. XIV.



commonly held land through regulation.<sup>79</sup> Moreover, bargaining among a limited number of initial owners should arrive at the most efficient manner of land use without the need to resort to lawsuits. Excessive land use regulation resulting from the need to satisfy all decision-makers could diminish the overall productivity of the land, especially if such regulations were imposed *ex post* after valuable resources had already been wasted. It is further expected that landowners on Mars would adopt the self-imposed obligation to engage in reasonable and productive use of that land in order to maximize the value of their own holdings. Such “injunctions against waste”<sup>80</sup> would become more significant in later stages of settlement when vacant land on Mars had become scarcer. Accordingly, if a plot is not being used efficiently, for example, by an owner that held expertise in space travel but not in colonization, then title in the land could be transferred on the authority of a court, perhaps through the Common Law doctrine of adverse possession,<sup>81</sup> to another party that had these skills and intentions.

Should a terraforming project be undertaken – transforming the whole of Mars into an environment that could sustain life - landowners would have an incentive to “free ride” by not contributing resources to such an inherently communal project, allowing them to benefit from the labors of others without cost. Perhaps a mandatory fee could be imposed upon all residents by a court in order to address this problem – although it is unclear what legal precedent could be invoked to do so - in advance of the establishment of zoning or centralized governance on the planet.<sup>82</sup> Market forces should provide, however, that a party not adding value to its land through development would have an incentive to sell or lease it to a party that would make a more productive use of it. Thus, the first explorers might wish simply to sell their claims as suggested above. To facilitate such bargaining among landowners, the establishment of a land registry system, which would set standardized plot dimensions and record transactions and would represent one of the few costs associated with private ownership of land on Mars, would be necessary.<sup>83</sup>

The recognition of bounded land claims on a planet appears already to be envisioned by the text of the Moon Treaty which as noted above, permits individual states to retain jurisdiction and control over their personal property, such as bases and equipment, that is brought to the moon.<sup>84</sup> However, as noted above, the rights in such chattels are not equivalent to the full property rights exercised by terrestrial landowners since there is no exclusivity – treaty

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<sup>79</sup> COOTER & ULEN, *supra* note 33, at 141 and VELJANOVSKI, *supra* note 35, at 70.

<sup>80</sup> EPSTEIN, *supra* note 46, at 1230.

<sup>81</sup> *E.g.*, Fletcher v. Fuller, 120 U.S. 534 (1887); Peabody v U. S., 231 U.S. 530 (1913).

<sup>82</sup> Baca notes how a similar system mandating a “reasonable use” is implemented by the International Telecommunications Union for geostationary orbits. Baca, *supra* note 24, at 1079.

<sup>83</sup> Merges & Reynolds, *supra* note 61, at 119.

<sup>84</sup> The Moon Treaty, *supra* note 3, at art. 12.

requires parties to allow others to use these equipment and facilities when requested.<sup>85</sup> On one hand such compulsory property sharing is economically efficient because it would encourage further development by minimizing one of the costliest aspects of settlement. A subsequent arrival could benefit from existing infrastructure devoting resources to the more productive development of the region without redundant expenditure that would impede overall progress. However, the common property regime envisioned by the space treaties ignores the reality that without adequate compensation for such sharing there might be an incentive to free-ride by waiting for another explorer to incur the initial costs of establishing a Mars base with oxygen/fuel production facilities. It would therefore be more cost effective to be the second or third Mars colonizer, potentially inducing a strategic waiting game. To resolve this problem it should be permissible to charge a fee for the use of one's facilities because such fees represent the fundamental economic gain of granting property rights in land on Mars. Developed land, such as land with a base upon it that could sustain human life, becomes valuable to subsequent visitors, and this can generate revenue that will offset the initial costs. Bargaining would naturally set the use fee at an optimal level that encouraged subsequent parties to land and make use of existing facilities and would not be too low to deter the initial landing and construction. Thus, the direction to share resources in the Moon Treaty might be unnecessary – sharing might increase wealth for all parties, much as land values increase in proportion to the rise in population of an area. Given that large scale inhabitation of Mars might only result from a catastrophe on Earth, there may be some need to incorporate the common law defense of necessity for emergency trespass, although this defense would not preclude the payment of reasonable compensation for use or damage to existing infrastructure.<sup>86</sup>

#### VIII. CONCLUSION

The much-maligned Common Heritage of Mankind doctrine is little more than “a lofty academic concept that looks good on paper, but fails in practice”<sup>87</sup> and has done a disservice to space exploration. When the imminent manned missions are ultimately undertaken, we can expect that they will not be as productive as they might have been because the prohibitive uncertainty of expected tangible gain is exacerbated by a legal regime that disregards private ownership of extra terrestrial land that may be enhanced, at great cost, to support human life. The potential of the planet Mars as a future site of human settlement is predicated on an investment in infrastructure on the planet's surface to render it habitable for long-term human habitation. In order to facilitate such productive activities and to create incentives for manned missions to Mars, international law must allocate private and sovereign

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<sup>85</sup> *Id.* at art. 15.

<sup>86</sup> *Vincent v. Lake Erie Transport*, 109 Minn. 456 (1910).

<sup>87</sup> Frakes, *supra* note 51, at 420.

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ownership of real property on the planet in a manner that will allow the recovery of costs through user fees imposed upon subsequent visitors. This article has suggested a system of bounded first possession by landfall of limited plots of land on Mars, the use of which will be controlled by relatively low cost private bargaining and litigation. Although multiple ownership may negate the competition of a winner takes all approach, this system will foster efficient investment in space travel and colonization because it will offer the potential of reward for effort to as many explorers who wish to undertake the risk. A stable legal regime such as this must be put in place now, as the first manned missions are being planned, so we can achieve the timely and beneficial development of Mars in anticipation of a time when it will host our future generations.