COLONIZING THE FINAL FRONTIER: WHY SPACE EXPLORATION BEYOND LOW-EARTH ORBIT IS CENTRAL TO U.S. FOREIGN POLICY, AND THE LEGAL CHALLENGES IT MAY POSE

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The exploration of space will go ahead, whether we join in it or not, and it is one of the great adventures of all time, and no nation which expects to be the leader of other nations can expect to stay behind in the race for space.
—John F. Kennedy

I. INTRODUCTION

Space: the final frontier.[1] Paradoxically, it is as limitless as it is final. To humanity, outer-space is the last great unknown, yet some part of it will always be unexplored. Beyond the Moon is Mars, beyond Mars are the gas giants, interstellar space, the rest of the Milky Way, and an expanding universe.[2]

In the span of a century, humanity has gone from being an earthbound species to a spacefaring one: a mere sixty-six years after the Wright brothers' first flight, the United States ("U.S.") had men on the moon.[3] As technologies

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1. *Star Trek* (CBS television broadcast 1966).

2. *The Expanding Universe*, SLOAN DIGITAL SKY SURVEY, http://skyserver.sdss.org/dr1/en/astro/universe/universe.asp. (last visited Nov. 10, 2016).

3. *History of Flight Timeline*, AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, https://aiaa.org/HistoryTimeline/ (last visited Mar. 10, 2017).

allowing humanity to escape the confines of Earth continue to evolve, so too should the policy and strategy of the Earth-based states that are active in space. This note will examine the evolution of the U.S.'s space exploration programs and their use as tools of foreign policy. Further, this note will argue that programs aimed at expanding human capability to traverse deep-space are critical to the U.S.'s national competitive strategies. It will also evaluate the legal ramifications of proposed outer-space activities, within the context of both international and domestic law. Finally, this note will propose that as nations and non-state actors expand their outer-space activities, and establish a permanent presence on extraterrestrial bodies, the current model under which Earth-based nations exercise jurisdiction over their spacefaring nationals will become inadequate, and concerns about power in space will spur nations to affect legal regime change.

II. SPACE EXPLORATION AS SMART POWER

As a byproduct of the Cold War tensions between the U.S. and the Soviet Union, space exploration has always been inextricably tied to foreign policy. During the Cold War, both the U.S. and the Soviet Union matched each other move-for-move while carrying out rocket research and conducting human spaceflights, so as not to fall behind in either technological capabilities or prestige. After the dissolution of the Soviet Union, the neck-and-neck competition that took place between the superpowers shifted to a subtler form of cooperation on the International Space Station ("ISS"), but even that is a de facto competition. The U.S. and other nations and agencies cooperate on the ISS because they do not want to be left behind. Thus, a state's ability to launch into orbit and explore space is arguably the greatest form of smart power there is. "Smart power" refers to the strategic combination of hard and soft power, which the Center for Strategic and International Studies defines as "an approach that underscores the necessity of a strong military, but also invests heavily in alliances, partnerships, and institutions at all levels to expand American influence and establish the legitimacy of American action."[4] Nothing embodies this concept better than the U.S.'s space exploration programs.

A. HARD POWER: LAUNCH CAPABILITY

The first modern rockets were produced for a military application rather than an astronautic one: as intercontinental ballistic missiles ("ICBMs") were built for use by Hitler's Nazi forces during World War II.[5] A state's capacity to build and launch rockets is thus a serious component of its ability to exercise hard power, which is defined as a coercive approach to international relations, usually involving the use of military power.[6] The

4. RICHARD L. ARMITRAGE & JOSEPH S. NYE, JR., CSIS COMMISSION ON SMART POWER: A SMARTER, MORE SECURE AMERICA, 7 (2006).
5. *Brief History of Rockets*, NASA, https://www.grc.nasa.gov/www/k-12/TRC/Rockets/history_of_rockets.html (last updated June 12, 2014).
6. Definition of *Hard Power*, OXFORD ENGLISH DICTIONARY, https://en.oxforddictionaries.com/definition/hard_power (last visited Nov. 5, 2017).

threat presented by a state's ability to launch far-reaching missiles serves as a deterrent to other states. For this reason, rockets and space launch technology are regulated under the Missile Technology Control Regime.[7]

The concept of space exploration capability as hard power is reinforced by the fact that all space technology—not only launch technology—developed in the U.S. is subject to the International Traffic in Arms Regulations ("ITAR").[8] Under the ITAR regime, space technology is classified as dual-use and export controlled, due to its potential weaponized applications to missile technology.[9] Some argue that ITAR protocols have held the U.S. space industry back by creating a "virtual wall."[10] However, it is unfair to characterize ITAR as chiefly detrimental—it can be argued that ITAR regulations are a wise preemptive defense. The need to protect U.S. space technology is felt even by those in the industry that ITAR allegedly stifles. In a 2012 interview, SpaceX's founder, Elon Musk, explained the lengths his company goes to in order to protect its technology: "We have essentially no patents in SpaceX. Our primary long-term competition is in China—if we published patents, it would be farcical, because the Chinese would just use them as a recipe book."[11] Notably, Musk did not mention a competitive threat from the Russians—the U.S.'s original space rival. Although Russia is still one of the world's foremost space powers, its space program is no longer what it used to be; in fact, in May 2015, Deputy Prime Minister Dmitry Rogozin declared that Roscosmos was now "nine times less advanced" than NASA.[12] China, now, has assumed the mantle as the U.S.'s biggest rival in space exploration.[13]

B. SOFT POWER: EXPLORATORY ACHIEVEMENTS AND POST-COLD WAR COLLABORATION

Soft power is defined as the ability to attract parties without coercion, such as through economic or cultural influence.[14] One such example is the human spaceflight program. The U.S. spaceflight program during the Cold War was a major soft power offensive against communism—the most notable result of which was the Apollo program and its moon landings:

> The Apollo program was a direct response to the increasing credibility of communism as a viable alternative to capitalism, of which successes on the

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7. *Missile Technology Control Regime (MTCR)*, U.S. DEP'T OF STATE (Mar. 4, 2009), https://www.state.gov/t/isn/rls/fs/120017.htm.

8. Vincent Sabathier & Ashley Bander, *Foreign Policy Opportunities for NASA*, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES (Mar. 9, 2009), https://www.csis.org/analysis/foreign-policy-opportunities-nasa.

9. *Id.*

10. *Id.*

11. Chris Anderson, *Elon Musk's Mission to Mars*, WIRED (Oct. 21, 2012), https://www.wired.com/2012/10/ff-elon-musk-qa/all/.

12. Emma G. Ellis, *Russia's Space Program is Blowing Up. So Are Its Rockets*, WIRED (Dec. 7, 2016), https://www.wired.com/2016/12/russias-space-program-blowing-rockets/; Damien Sharkov, *Russia Revives Soviet Plans for Moon Base,* NEWSWEEK (Jun. 21, 2016), http://www.newsweek.com/russia-putin-soviet-plans-moon-base-colony-space-race-472802.

13. Bloomberg News, *China's Secretive Space Program Threatens NASA's Dominance*, BLOOMBERG (Nov. 28, 2016), https://www.bloomberg.com/graphics/2016-asia-space-race/china.html.

14. Armitrage, *supra* note 4.

> ground in Indochina and in space with flights such as that of Yuri Gagarin were simply the most manifest examples. Taking on the challenge of putting a person on the Moon was a deliberate effort to regain the initiative by identifying national prestige and good government with a major scientific and technological achievement which tested the mettle of astronauts, engineers, administrators, and industry alike.[15]

The achievements of the Apollo program firmly established the U.S. as a scientific and technological leader in the international community and bolstered its legitimacy—and by extension, its soft power. NASA's other projects—such as its international collaborations for the Helios and Cassini-Huygens probes—played a similarly significant political and cultural role by projecting a positive image of U.S. power and democracy abroad.[16] As a NASA Task Force noted in 1987, "[I]nternational cooperation in space from the outset has been motivated primarily by foreign policy objectives."[17] The era of outer space cooperation that succeeded the Cold War illustrates this idea.

The post-Cold War cooperation with Russia was a significant use of the U.S.'s soft power. After the Cold War, the U.S. government urged its businesses to collaborate with the Russian defense industry in an attempt to establish a U.S.-Russian partnership while simultaneously preventing the proliferation of Russian military technology.[18] The result of this collaboration was the RD-180 engine.[19] Designed and built in Russia, the RD-180 is currently used to power the Atlas V rocket, an expendable launch vehicle developed by the United Launch Alliance ("ULA") and used by the United States Air Force to transport government payloads into orbit.[20] The U.S. ramped up cooperation during the Clinton administration, when it invited Russia to become a partner in the ISS program.[21] As with the RD-180 collaboration, the key foreign policy rationale behind this decision was a desire to prevent proliferation of Russian weapon technology.[22] The hope was that the ISS program would incentivize the Russian government and military industries to adhere to the Missile Technology Control Regime and other nonproliferation measures.[23] Both the RD-180 and the ISS

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15. John Krige, *NASA as an Instrument of U.S. Foreign Policy*, *in* SOCIETAL IMPACT OF SPACEFLIGHT 207, 211 (Steven J. Dick ed., 2007).

16. *Id.* at 207 (Helios was a solar probe designed in conjunction with Germany, and Cassini-Huygens was a collaboration between the Jet Propulsion Laboratory, the ESA, and the Italian space agency).

17. *International Space Policy for the 1990's and Beyond: Hearing Before the Subcomm. On Space Science and Applications*, 100th Cong. 18 (1987).

18. *See* United Launch Alliance, *Frequently Asked Questions–RD-180 Engine*, http://www.ulalaunch.com/faqs-rd-180.aspx. (last visited Dec. 11, 2016).

19. *Id.*

20. *Id.*; *see also* Mike Gruss, *Nelson Shepherds RD-180 Compromise Through Senate*, SPACENEWS.COM (Jun. 14 2016), http://spacenews.com/nelson-shepherds-senate-compromise-on-rd-180-issue/, (following Russia's annexation of Crimea, the use of RD-180s in the Atlas V rocket for national security launches has come under fire in Congress and become the subject of a debate regarding a potential ban).

21. JOHN M. LOGSDON & JAMES R. MILLAR, U.S. –RUSSIAN COOPERATION IN HUMAN SPACE FLIGHT: ASSESSING THE IMPACTS, SPACE POLICY INSTITUTE 5 (Feb. 2001).

22. *Id.*

23. *Id.*

collaborations are examples of strategic and successful uses of soft power: by engaging its rival in scientific ventures on the basis of shared values, the U.S. was able to further its own interests, both at home and abroad.

In conjunction with the ISS program, the U.S. commenced a new spaceflight program—the Space Shuttle, officially called the Space Transportation System ("STS").[24] NASA operated the Space Shuttle program for thirty years: from April 12, 1981 to July 21, 2011, the shuttle fleet flew a total of 135 missions, ferrying astronauts from sixteen different countries to and from orbit.[25] By providing transportation to and from the ISS for partner nations, the U.S. leveraged its spaceflight capability as soft power in the broader international community while also promoting an image of technological prestige.

C. STATUS OF U.S. POWER TODAY

After the *Columbia* accident in 2003, the Bush Administration decided to end the Space Shuttle program.[26] Since the Space Shuttle's retirement in 2011, the lack of a replacement vehicle has forced NASA to purchase seats onboard the Russian *Soyuz* capsule in order to get American astronauts to the ISS.[27] Between 2008 and 2015, NASA signed six contract modifications worth a total of approximately $2.469 billion with the Russian space agency, Roscosmos, for crew transportation services on the *Soyuz*.[28] The continuing lack of an American mode of transport is a problem that was exacerbated further when NASA's Constellation program was cancelled by the Obama

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24. *Space Shuttle Era*, NASA, https://www.nasa.gov/mission_pages/shuttle/flyout/index.html (last visited Dec. 1, 2016).

25. *Id.*

26. Stephen C. Smith, *Why Bush Cancelled the Space Shuttle*, SPACE KSC (Mar. 2, 2010), http://spaceksc.blogspot.com/2010/03/why-bush-cancelled-space-shuttle.html (discussing Bush's decision to cancel the Space Shuttle program due to its unsafe design). *See also* Stephen Dowling, *What Caused the Space Shuttle Columbia Disaster?*, BBC (Jan. 30, 2015), http://www.bbc.com/future/story/20150130-what-caused-the-columbia-disaster. (detailing how *Columbia* disintegrated during reentry when superheated atmospheric gases forced their way into the orbiter's airframe via a breach in the Thermal Protection System on the left wing, resulting in the loss of all seven astronauts' lives).

27. *See generally* Richard Hollingham, *Soyuz: The Soviet Space Survivor*, BBC (Dec. 2, 2014), http://www.bbc.com/future/story/20141202-the-greatest-spacecraft-ever.

28. Michael Braukus, *NASA Extends Contract with Russian Federal Space Agency*, NASA (Dec. 2, 2008), https://www.nasa.gov/home/hqnews/2008/dec/HQ_C08-068_Soyuz_Extension.html (discussing NASA's $141 million modification for crew launching in fall 2011 and landing spring 2012); Michael Braukus, *NASA Extends Contract with Russian Federal Space Agency*, NASA (May 28, 2008), https://www.nasa.gov/home/hqnews/2009/may/HQ_C09-024_Soyuz_Con_Mod.html (discussing a $306 million modification for crews launching in spring 2012 and fall 2012); John Yembrick, *NASA Extends Contract with Russian Federal Space Agency*, NASA (Apr. 6, 2010), https://www.nasa.gov/home/hqnews/2010/apr/HQ_C10-023_Soyuz_Extension.html (discussing a $355 million modification for four crews launching in 2013, with two returning in 2013 and two returning in 2014); David Weaver, *NASA Extends Crew Flight Contract With Russian Space Agency Administrator Bolden Repeats Call For American-Made Commercial Alternative*, NASA (Mar. 14, 2011), https://www.nasa.gov/home/hqnews/2011/mar/HQ_C11-013_Soyuz_Contract.html (discussing a $753 million modification for crew transportation services from 2014 to June 2016); Joshua Buck, *NASA Extends Crew Flight Contract with Russian Space Agency*, NASA, (Apr. 30, 2013), https://www.nasa.gov/home/hqnews/2013/apr/HQ_C13-027_Soyuz_Services.html (discussing a $424 million modification for crew transportation services through 2016 and ending in June 2017); *NASA Notifies Congress about Space Station Contract Modification with Russia*, NASA, https://www.nasa.gov/sites/default/files/atoms/files/soyuz_seat_modification_letter.pdf (last visited Sept. 5, 2017) (discussing a $490 million modification through 2017 due to reductions in funding for NASA's Commercial Crew program).

administration in 2010.[29] The Constellation program's major goals were to develop and fly the Crew Exploration Vehicle ("Orion") by 2014 and to put NASA astronauts back on the lunar surface by 2020; the Orion spacecraft and its launch vehicle, the Ares rocket, were the intended replacement for the Space Shuttle.[30]

In an article released by the Center for Strategic and International Studies, Vincent Sabathier and Ashley Bander argue that NASA's direction in the last decade has been detrimental to the U.S., due to export controls and the leadership's decision to "ignore domestic and international capabilities alike to focus its effort on a new national space transportation system, resulting in additional self-isolation . . . these policy and programmatic choices have prevented the U.S. government from making use of space as an extraordinarily valuable foreign policy tool from exercising smart power through space."[31] Given the current political climate, however, a new national space transportation system is now more important than ever to maintaining U.S. leadership in space.[32] Cancelling the Constellation project, which would have provided such a system, can therefore be characterized as a foreign policy mistake:

> For The [sic] United States, the leading space faring nation for nearly half a century, to be without carriage to low Earth orbit and with no human exploration capability to go beyond Earth orbit for an indeterminate time into the future, destines our nation to become one of second or even third rate stature.[33]

The U.S. human spaceflight program has become dependent on Russia, the latest low in a steadily declining trend of U.S. progress in spaceflight.[34] It has now become critical for the U.S. to rehabilitate its smart power by reducing its reliance on Russia and reclaiming American spaceflight capability with a space transportation system for U.S. astronauts. Further, it is no longer enough to simply be able to launch astronauts to low-Earth

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29. Jonathan Amos, *Obama Cancels Moon Return Project*, BBC (Feb. 2010), http://news.bbc.co.uk/2/hi/science/nature/8489097.stm.

30. John F. Connolly, *Constellation Program Overview*, NASA, https://www.nasa.gov/pdf/163092main_constellation_program_overview.pdf (last visited Sep. 14, 2017); Tariq Malik, *NASA Grieves Over Canceled Program*, NBC NEWS (Feb. 2, 2010), http://www.nbcnews.com/id/35209628/ns/technology_and_science-space/t/nasa-grieves-over-canceled-program/#.WE8BZvkrI2w.

31. Vincent Sabathier & Ashley Bander, *Foreign Policy Opportunities for NASA*, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES (Mar. 2009) (https://www.csis.org/analysis/foreign-policy-opportunities-nasa).

32. Ken Dilanian, *New Cold War? Russia, U.S. Relations at Lowest Point Since 1970s*, NBC NEWS (Oct. 5, 2016), http://www.nbcnews.com/news/us-news/new-cold-war-russia-u-s-relations-lowest-point-1970s-n660126 (describing how US-Russia relations have deteriorated to their lowest point since the Cold War, and how analysts see little likelihood of any improvement in the near-term, especially since Russian president Vladimir Putin perceives Western democracies as a threat to his interests).

33. Kit Eaton, *Moon Men to Obama: Your NASA Plans Suck Asteroids*, FASTCOMPANY (April 14, 2010) https://www.fastcompany.com/1616120/moon-men-obama-your-nasa-plans-suck-asteroids (quoting from an open letter to President Obama regarding his cancellation of the Constellation program, written by Apollo commanders Neil Armstrong, Jim Lovell, and Gene Cernan).

34. *See generally* Dean Praetorius, *Neil Armstrong: U.S. Space Program is 'Embarrassing' and Risks Losing Prominence*, HUFFINGTON POST (Sept. 27, 2011), http://www.huffingtonpost.com/2011/09/26/neil-armstrong-nasa-space-program_n_981309.html (noting that Armstrong called the U.S. space program "embarrassing and unacceptable", with his fellow astronaut Eugene Cernan expressed a similar sentiment, saying "Today we are on a path of decay.").

orbit—the U.S. first demonstrated this capability fifty-five years ago with Mercury astronaut John Glenn's historic orbit around the Earth in 1962; in a "giant leap for mankind," this capability was surpassed a short seven years later when the Apollo program took Neil Armstrong all the way to the moon.[35] In order for the U.S. to remain a preeminent space power, it must develop its soft power by making manned deep-space exploration a national priority.

III. RECLAIMING U.S. HUMAN SPACEFLIGHT CAPABILITY

As a matter of common sense, making deep-space exploration a priority requires the U.S. to have the technological capability for it. The capacity for human spaceflight has only existed for fifty-five years—0.000275% of modern humanity's approximately 200,000-year existence—yet within a relatively short time span, humanity has made tremendous technological strides towards entering and exploring the new frontier.[36] The International Space Exploration Coordination Group ("ISECG"), of which NASA is a part, is a continuation of that effort. ISECG is a voluntary forum through which participating space agencies work to advance long-range human space exploration strategy.[37] In 2013, NASA and eleven other ISECG member agencies released an updated Global Exploration Roadmap ("GER"), which reflects a common strategy that begins with the ISS, expands the synergies between human and robotic missions, and eventually leads to Mars.[38] In order to be a leader in these efforts, the U.S. needs its own human spaceflight program. The following section is an examination of current efforts to develop a U.S. space transportation system.

A. COMMERCIAL CREW TRANSPORTATION CAPABILITY ("CCTCAP")

In September 2014, NASA announced the Commercial Crew Transportation Capability ("CCtCap") program, with the goal of achieving safe, reliable, and cost-effective crew transportation to low-Earth Orbit.[39] Under the CCtCap program, NASA awarded two fixed-price contracts for crew transportation services worth $2.6 billion to SpaceX and $4.2 billion to Boeing.[40] By leveraging the commercial space-transportation companies,

35. *A Brief History of Space Exploration*, THE AEROSPACE CORPORATION, http://www.aerospace.org/education/stem-outreach/space-primer/a-brief-history-of-space-exploration/ (last visited Nov. 15, 2017).

36. Nola Taylor Redd, *Yuri Gagarin: First Man in Space*, SPACE.COM (July 24, 2012), https://www.space.com/16159-first-man-in-space.html (describing how on 12 April 1961, Russian cosmonaut Yuri Gagarin became the first human to travel to space when he launched into orbit on the Vostok 3KA-3); Elizabeth Howell, *How Long Have Humans Been on Earth?* UNIVERSE TODAY, http://www.universetoday.com/38125/how-long-have-humans-been-on-earth/ (last updated Dec. 23, 2015).

37. *About the International Space Exploration Coordination Group*, NASA, https://www.nasa.gov/exploration/about/isecg/#.WFJy3fkrJhE (last visited Sep. 14, 2017).

38. *Global Exploration Roadmap*, GLOBALSPACEEXPLORATION.ORG, (Aug 20, 2013), http://www.globalspaceexploration.org/wordpress/wp-content/uploads/2013/10/GER_2013.pdf.

39. *Commercial Crew Program–The Essentials*, NASA, (last updated Feb. 25, 2016) https://www.nasa.gov/content/commercial-crew-program-the-essentials/.

40. *Id.*; *see also* NASA, JOURNEY TO MARS – PIONEERING NEXT STEPS IN SPACE EXPLORATION 15 (2015), https://www.nasa.gov/sites/default/files/atoms/files/journey-to-mars-next-steps-20151008_

CCtCap aligns with one of the U.S.'s main space policy goals: to energize competitive domestic industries.[41] More importantly, the CCtCap program is critical to near-term national interests because it would bring human spaceflight capability back to U.S. soil.[42] Once the Crew Dragon and the CST-100 Starliner are certified by NASA, each vehicle will be capable of between two and six operational flights to the ISS.[43] Provided the companies meet their milestones, NASA would have two crew vehicles by 2018, which would officially allow the agency to cease depending on the *Soyuz* for flights to the ISS.[44] Having crew transportation capability will give the U.S. international competitive leverage, as it will once again be able to deliver crewmembers from its international partner nations to the ISS. In the long-term, Commercial Crew is important not only because it will give the U.S. domestic access to space, but also because it represents the latest spaceflight technology; the ability to launch astronauts to low-Earth orbit is a basic stepping-stone to further developing spaceflight technology for deep space applications.

1. SpaceX's Crew Dragon

The Crew Dragon is a derivative of SpaceX's current Dragon vehicle, which is being used to transport cargo to and from the ISS under the Commercial Resupply Services contract.[45] In its launch configuration, the Crew Dragon would be on top of SpaceX's Falcon launch vehicle, similar to the configuration used by the U.S. spaceflight program before the Space Shuttle.[46] Unlike the *Soyuz*, which has a maximum capacity of three crewmembers, Crew Dragon is designed to accommodate up to seven astronauts at a time, or less with cargo.[47]

Beyond their immediate intended purpose, SpaceX's Crew Dragon Falcon are a boon to the U.S. due to their technical specifications and future application. In December 2015, SpaceX made history when it successfully returned the first stage of an orbital-class Falcon 9 rocket booster to its Cape Canaveral launch site for a retropropulsive soft-landing—a milestone in rocket technology.[48] Since then, the company has accomplished another

508.pdf.

41. *National Space Policy of the United States of America*, NASA (Jun. 28, 2010), https://www.nasa.gov/sites/default/files/national_space_policy_6-28-10.pdf.

42. *Commercial Crew Program,* NASA, https://www.nasa.gov/exploration/commercial/crew/index.html (last updated Sept. 5, 2017).

43. Jeff Foust, *NASA Selects Boeing and SpaceX for Commercial Crew Contracts*, SPACENEWS (Sept. 16, 2014), http://spacenews.com/41891nasa-selects-boeing-and-spacex-for-commercial-crew-contracts/.

44. Derek Richardson, *SpaceX Crew Dragon Test Flights Delayed*, SPACEFLIGHT INSIDER (Dec. 13, 2016), http://www.spaceflightinsider.com/organizations/space-exploration-technologies/spacex-crew-dragon-test-flights-delayed/. NASA's current contract provides for *Soyuz* flights only through 2018 and the agency has no plans to purchase additional flights beyond that.

45. *Commercial Resupply Services Overview*, NASA, https://www.nasa.gov/mission_pages/station/structure/launch/overview.html (last updated Aug. 3, 2017).

46. *Dragon Version 2: SpaceX's Next Generation Manned Spacecraft*, SPACEX (May 30, 2014), http://www.spacex.com/news/2014/05/30/dragon-v2-spacexs-next-generation-manned-spacecraft.

47. *Id.*

48. Mike Wall, *Wow! SpaceX Lands Orbital Rocket Successfully in Historic First,* SPACE.COM (Dec. 2015), http://www.space.com/31420-spacex-rocket-landing-success.html; *see also* Loren Grush, *Why You Shouldn't Compare Blue Origin's Rocket Landing to SpaceX*, THE VERGE (Nov. 24, 2015),

fifteen booster landings: seven at Landing Zone 1 (LZ-1) at Cape Canaveral and nine on its autonomous spaceport drone ships.[49] Successfully landing first-stage boosters has since allowed SpaceX to refurbish those boosters for reuse—on March 30, 2017, the company claimed yet another "first" by reflying a previously landed booster.[50] SpaceX originally planned to apply the same retropropulsive strategy to its Crew Dragon, which would have relied primarily on its SuperDraco thrusters to provide supersonic retropropulsion as its entry, descent, and landing ("EDL") system.[51] This would have made the Crew Dragon the first manned spacecraft capable of making a terrestrial soft landing using only retropropulsive technology. Project Mercury, Project Gemini, and the Apollo program all utilized the capsule design for their spacecraft, and landings were conducted by deploying parachutes to slow the descent speed before splashdown into the ocean.[52] The Space Shuttle orbiter was a sharp departure from this design; the delta-wing design allowed the orbiter to be flown like an aircraft during reentry, with a drag chute deployed during touchdown to reduce landing speed.[53] The Russian *Soyuz* spacecraft uses parachutes with a propulsive assist just prior to touchdown in order to soften the impact.[54] As a capsule capable of retropropulsive landing "almost anywhere in the world," the Crew Dragon not only provided the U.S. with revolutionary spacecraft, but also with the intangible benefit of demonstrating American technological excellence.[55] As of July 2017, however, SpaceX has removed the retropropulsive landing concept from its Crew Dragon, citing safety concerns about powered landings for crew transport.[56] Nevertheless, SpaceX's decision to remove the capability from its crew capsule does not signal a complete departure from the technology. CEO Elon Musk has stated that the propulsive landings will still be implemented in Mars landings "for sure, but with a vastly bigger ship."[57]

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http://www.theverge.com/2015/11/24/9793220/blue-origin-vs-spacex-rocket-landing-jeff-bezos-elon-musk (describing a comparison of the sub-orbital Blue Origin New Horizons rocket booster with the orbit-class SpaceX Falcon 9 rocket booster as "controversial").

49. *See generally* Falcon 9, SpaceX (accessed Mar. 9, 2017), http://www.spacex.com/falcon9; SpaceX Statistics (last visited Sept. 13, 2017) https://spacexnow.com/stats.php (statistics current as of September 14, 2017).

50. Alan Boyle, *It's another first for SpaceX! Previously launched Falcon 9 rocket lifts off and lands a second time*, GEEKWIRE (March 30, 2017, 7:30 PM), https://www.geekwire.com/2017/spacex-launch-reuse-falcon-9-ses/.

51. Chris Bergin, *Dragon V2 Will Initially Rely on Parachute Landings*, NASA SPACEFLIGHT (Aug. 28, 2014), https://www.nasaspaceflight.com/2014/08/dragon-v2-rely-parachutes-landing/. Besides the retropropulsion system, Dragon will be equipped to handle water or ground landings with parachutes as redundancies. *Id.*

52. *Splashdown*, CONCEPTS.ORG, http://www.concepts.org/index.php?title=Splashdown_(spacecraft_landing) (last visited Nov. 5, 2017).

53. *Landing 101*, NASA, https://www.nasa.gov/mission_pages/shuttle/launch/landing101.html (last visited Nov. 7, 2017).

54. Bergin, *supra* note 51.

55. *Dragon Version 2: SpaceX's Next Generation Manned Spacecraft*, SPACEX (May 30, 2014), http://www.spacex.com/news/2014/05/30/dragon-v2-spacexs-next-generation-manned-spacecraft.

56. Monica Hunter-Hart, *Here's Why SpaceX Ditched Propulsive Landings for Dragon Spacecraft: It was a beautiful dream while it lasted*, INVERSE (Jul. 19, 2017), https://www.inverse.com/article/34409-elon-musk-spacex-powered-thrust-landings.

57. *Id.*

Developments like this reflect the fact that these spacecraft are being designed with more than just the Commercial Crew requirements in mind—the company's end goal, ultimately, is Mars.[58] The unprecedented Falcon 9 landings are the first step towards SpaceX's goal of making rockets fully reusable in order to make space launches more cost-effective as part of a long-term vision for Mars exploration.[59] Similarly, the retropropulsive technology that is being developed for SpaceX's future manned vehicles is designed to make possible "interplanetary trips that would otherwise be constrained by ocean landings."[60]

2. Boeing's CST-100 Starliner

Like the Crew Dragon, Boeing's CST-100 will be capable of transporting up to seven crew members, or a mix of crew and cargo.[61] Unlike the Dragon, however, the CST-100 is being designed primarily for missions to low-Earth orbit.[62] Similar to the *Soyuz*, the CST-100 will employ a parachute and airbag system to land on the ground.[63]

One of the key features of the CST-100 is its adaptability. While the CST-100's default launch vehicle is the Atlas V—which is currently used by the United States Air Force—the capsule is launch-vehicle agnostic, which means that it can be configured to launch on other rockets.[64] For the U.S., this is a critical capability that will extend the useful lifespan of the CST-100. The CST-100's operational flexibility allows it to remain a viable human-rated spacecraft even as launch vehicles evolve, which could save the U.S. billions in development costs for new spacecraft.

B. ORION AND THE SPACE LAUNCH SYSTEM

Following the cancellation of the Constellation program, NASA redirected its efforts into what is now the Orion and Space Launch System ("SLS"). Originally part of the Constellation architecture, the Orion spacecraft is now being utilized in the SLS program. The Orion spacecraft is designed to carry a crew of up to four astronauts into deep space, "for decades to come."[65] SLS is NASA's new heavy lift launch vehicle, and is designed to evolve into increasingly more powerful configurations: Block 1, Block 1B, and Block 2.[66] This design will allow NASA to provide a launch vehicle that is able to meet the evolving needs of the U.S. space exploration

58. *See generally*, *About SpaceX*, SPACEX, http://www.spacex.com/about (last visited Mar. 10, 2017).
59. *Id.*
60. *Dragon Version 2*, *supra* note 55.
61. *Crew Space Transportation System*, BOEING, http://www.boeing.com/space/crew-space-transportation-100-vehicle/#/design-details (last visited Nov. 7, 2017).
62. *Id.*
63. *Id.*
64. *Id.*
65. NASA, *Orion Spacecraft Overview*, NASAFACTS, https://www.nasa.gov/sites/default/files/617409main_orion_overview_fs_33012.pdf (last visited Nov. 7, 2011).
66. NASA, *Space Launch System*, NASAFACTS (Oct. 2015), https://www.nasa.gov/sites/default/files/atoms/files/sls_october_2015_fact_sheet.pdf.

effort in the shortest time possible.[67] This is significant to U.S. interests because it provides an assurance of continued access to domestic space transportation, which would avert another situation like the present, in which the U.S. is forced to rely on Russia despite deteriorating relations. Even in its initial Block 1 configuration, the SLS will be the world's most powerful rocket: it will provide 15% more thrust than the Saturn V.[68]

Though the CCtCap program will provide NASA with spaceflight services, it is not the same as having a national, agency-operated spaceflight system. When they become operational, the Orion and SLS will no doubt be invaluable in restoring the U.S.'s image, and returning NASA to a competitive position in the international arena.

IV. ROAD TO THE RED PLANET: DEVELOPMENTS IN THE SPACE INDUSTRY

After its unparalleled Moon landings in the 1960s, the U.S. enjoyed a position of leadership and esteem: the same will likely be true of the first nation to set foot on Mars.[69] Mars is becoming an important theater in which Earth-based nations vie for soft power in the form of scientific achievement. In the future, however, Mars could be a source of commercial opportunity, and being able to exploit Martian resources would contribute immensely to a nation's hard power. Mars exploration, the precursor to future manned Mars missions, is one area in which the U.S. appears to be maintaining a slight lead: of seven robotic Mars landers launched from the U.S., six were successfully landed and functioned as intended—this stands in stark contrast with mostly failed Soviet attempts to land and deploy operational probes on Mars, as well as the European Space Agency's ("ESA") loss of its Beagle 2 probe.[70] While this success rate is laudable, it should not remain NASA's crowning achievement on Mars for much longer. However, the road to Mars is long and will likely occur in tandem with new developments in the space industry, such as the Space Resource Exploration and Utilization Act, which plans to return to the Moon, and SpaceX's Interplanetary Transport System.

A. SPACE RESOURCE EXPLORATION AND UTILIZATION ACT OF 2015

Since 2000, over $13.3 billion has been invested in private space start-up companies.[71] Thanks to the explosive growth of the commercial space industry, space exploration is no longer the province of the government

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67. *Id.*
68. *Id.*
69. *See generally, Sustaining Human Spaceflight Leadership,* AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONOMICS, https://www.aiaa.org/uploadedFiles/Issues_and_Advocacy/Policy_Papers/Information_Papers/HumanSpaceflightLeadership.pdf (last visited Nov. 7, 2017).
70. John Wenz, *All the Times We Tried to Get to Mars and Failed Magnificently*, POPULAR MECHANICS (Oct. 1, 2015), http://www.popularmechanics.com/space/moon-mars/a17407/mars-mission-failures/.
71. *Asteroid Mining*, DEEP SPACE INDUSTRIES, http://deepspaceindustries.com/mining/ (last visited Sep. 4, 2017).

alone.[72] One of the most recent developments in the space industry was legislation to match industry growth: H.R. 2262, also called the U.S. Commercial Space Launch Competitiveness Act, which was signed into law by President Barack Obama on November 25, 2015.[73]

Of particular note in H.R. 2262 is Title IV, also called the Space Resource Exploration and Utilization Act of 2015, through which President Obama not only authorized commercial exploitation of asteroid and space resources, but also recognized property rights in those resources.[74] The idea of mining asteroids has been a science fiction trope longer than it has been a science-backed enterprise.[75]However, if Congress allocates the funding for it, asteroid mining could become a reality by 2026.[76] The two U.S. companies that are at the forefront of this effort—Planetary Resources and Deep Space Industries ("DSI")—both propose harvesting water and metals from asteroids.[77] While the mining of precious metals from asteroids has obvious economic benefits, the companies' plans to harvest water is even more important. Both companies plan not only to harvest water as H2O, but also to break it down into its component parts for conversion into liquid hydrogen ("LH2") and liquid oxygen ("Lox"), which are used as rocket fuel and oxidizer, respectively.[78] As envisioned by Planetary Resources and DSI, these refineries would be located in space, and would double as strategically-placed fueling depots.[79] This in-space infrastructure for the provision of water and fuel could easily become asteroid mining's most valuable contribution to the advancement of deep space exploration, because it would reduce the amount of water and fuel that needs to be launched from the surface, thus freeing up payload space.[80]

Also of note is the fact that although the Act is colloquially known as the "asteroid mining bill," the actual language defines such commercial activity as "recovery of any asteroid resource or a space resource."[81] By using the open-ended term "space resource," Congress thus leaves the door open for future U.S.-backed resource-recovery operations on celestial bodies besides asteroids. One such celestial body is Mars, which has been confirmed as having enormous quantities of subsurface water in the form of ice deposits,

72. Mark Rockwell, *FAA Challenged by Growing Commercial Space Industry*, FEDERAL COMPUTER WEEK, (Feb. 7, 2017), https://fcw.com/articles/2017/02/07/faa-space-traffic-rockwell.aspx.
73. U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704, (2015).
74. *Id.*
75. Frank Catalano, *Science Fiction Writers Inspired as Asteroid Miners Make Fiction Fact,* GEEKWIRE (Apr. 25, 2012), http://www.geekwire.com/2012/planetary-resources-asteroid-mining-plans-inspire-sciencefiction-writers/.
76. Michael Busch, *Asteroid Mining Could Become a Reality in As Soon as Ten Years*, FORBES (Dec. 15, 2016), https://www.forbes.com/sites/quora/2016/12/15/asteroid-mining-could-become-a-reality-in-as-soon-as-ten-years/#56c997be5256.
77. *Asteroids*, PLANETARY RESOURCES, http://www.planetaryresources.com/asteroids/#asteroids-intro (last visited Mar. 1, 2017); *Asteroid Mining*, *supra* note 71.
78. *Market for H2O*, PLANETARY RESOURCES, http://www.planetaryresources.com/asteroids/market-for-h2o/ (last visited Sep. 4, 2017); *Liquid Hydrogen–The Fuel of Choice for Space Exploration*, NASA, https://www.nasa.gov/topics/technology/hydrogen/hydrogen_fuel_of_choice.html (last visited Mar. 1, 2017).
79. *Market for H2O*, *supra* note 78.
80. *Id*.
81. U.S. Commercial Space Launch Competitiveness Act, *supra* note 73, at §51303.

some of which are being considered as resources for astronauts.[82] Hypothetically, if water is harvested from these ice deposits, it could be broken down into hydrogen and oxygen and refined for rocket fuel; such a capability would no doubt be an advantage for manned Mars exploration.

B. RETURNING TO THE LUNAR SURFACE

At 10:54:37 p.m. on December 14, 1972, Apollo 17's lunar module ascent stage lifted off from the lunar surface—no human has set foot on the moon ever since.[83] Post-Apollo, the human spaceflight program has been limited to low-Earth orbit, with a focus on the ISS. Now, over four decades later, plans to revisit the lunar vicinity are finally reemerging. The ESA has proposed building a permanent lunar outpost, a so-called "moon village," as a future replacement for the ISS, which is due to be decommissioned by 2024.[84] China, which has been ramping up its space capabilities over the last decade, is currently evaluating the feasibility of launching a permanently manned radar station on the moon.[85] Russia's Roscosmos is also considering a prospective moon base, using Soviet Union plans that were originally drafted in the 1960s.[86]

In its "Journey to Mars" mission plan, NASA proposes that it will achieve its goals of extending human presence deeper into the solar system through continued cooperation with international and commercial partners.[87] The plan also espouses the view that cislunar space, the region between the earth and the moon or the moon's orbit, is the ideal "Proving Ground" in which to test various systems and practice deep space operations as a necessary precursor to conducting crewed missions to Mars.[88] Similarly, the Global Exploration Roadmap released by the ISECG advocates "extended duration crew missions in the lunar vicinity" and on the lunar surface that will advance readiness for human Mars missions after 2030.[89]

The ability to get its astronauts to cislunar space and beyond is vital to strengthening the U.S.'s leadership both on Earth and in space, and NASA's present position mirrors this reality—it is currently developing the Orion spacecraft and its launch vehicle, which will provide core transportation capabilities for future deep space missions.[90] There are some, such as Apollo astronaut Buzz Aldrin, who do not share this view: "If we go back to the

82. Jet Propulsion Laboratory California Institute of Technology, *Mars Ice Deposit Holds as Much Water as Lake Superior*, NASA (Nov. 22, 2016), https://www.jpl.nasa.gov/news/news.php?feature=6680.
83. Apollo 17 Mission Objective, NASA, https://www.nasa.gov/mission_pages/apollo/missions/apollo17.html (last visited Nov. 7, 2018).
84. Press Association, *Moon Village Concept Attracts Worldwide Support*, GUARDIAN (Dec. 2, 2016, 1:10 PM), https://www.theguardian.com/science/2016/dec/02/moon-village-concept-attracting-worldwide-support-european-space-agency-lunar-outpost.
85. Anthony Cuthbertson, *China Plans Permanent Manned Moon Base*, NEWSWEEK (Aug. 23, 2016, 9:58 AM), http://www.newsweek.com/china-moon-base-lunar-station-antenna-communication-military-spy-492661.
86. Sharkov, *supra* note 12.
87. *Journey to Mars*, *supra* note 40, at 1.
88. *Id.* at 4.; *Cislunar*, MERRIAM-WEBSTER, https://www.merriam-webster.com/dictionary/cislunar (last visited Sept. 4, 2017).
89. Global Exploration Roadmap, *supra* note 38, at 3.
90. Journey to Mars, *supra* note 40, at 19.

Moon, we are guaranteed second, maybe third place."[91] However, in light of the above, even returning to the lunar vicinity might not be enough—neglecting the possibility could be even worse. As the only nation in the world that has ever sent manned missions to the Moon, the U.S. stands to lose a great deal if it does not return to the surface: failure to timely establish an American lunar presence could become a symbol of the U.S.'s decline, and weaken its position in the international community.[92]

C. SPACEX'S INTERPLANETARY TRANSPORT SYSTEM

Independent of NASA and its partner agencies there are privatized efforts to reach Mars. In the U.S., the most prominent is the bold plan advocated by SpaceX's Elon Musk. In September 2016 at the International Astronautical Congress in Guadalajara, Mexico, Musk revealed SpaceX's Mars colonization system architecture: the Interplanetary Transport System ("ITS").[93]

Musk's projected timeline puts humans on the Martian surface as early as 2023, which is at least five years earlier than NASA and the ISECG.[94] This is because Musk, like Aldrin, thinks the value of proceeding directly to Mars missions outweighs the value of any missions to cislunar space. Why not the moon? "Because it is much smaller than a planet, has no atmosphere, and is not a resource-rich."[95] This conflicts with NASA and the international community's plans to transition from cislunar missions to deep space missions, and could raise questions about the legal feasibility of SpaceX bypassing NASA's objectives.

Nevertheless, allowing SpaceX to "trailblaze" would serve U.S. interests. In the near-term, SpaceX's pioneering Red Dragon missions to Mars will be an invaluable source of scientific data, especially due to their intended use of the supersonic retropropulsion system.[96] By agreeing to assist SpaceX, NASA has ensured that it will have access to the resulting data "at least a decade sooner at a fraction of the cost to NASA."[97] This is significant not only because of what the U.S. government would save by allowing SpaceX to forge ahead, but also because it will be data that has never been generated before, which puts the U.S. ahead of its international competitors. Moreover, though the success would not belong to NASA, if the ITS were to execute a successful Mars mission, the accomplishment would most likely bolster the U.S.'s image in the international community. Lastly, if NASA decided to certify the ITS like CCtCap vehicles, the ITS would significantly

91. James M. Clash, *Buzz Aldrin, Moonwalker, Says US Must Aim For Mars*, LIVEMINT (May 24, 2013), http://www.livemint.com/Consumer/lmCN7dHuX6i9mINZ6uiHyI/Buzz-Aldrin-Moonwalker-says-US-must-aim-for-Mars.html.

92. *Sustaining Human Spaceflight Leadership*, *supra* note 69, at 1.

93. Elon Musk, CEO, SpaceX, Address at International Astronautical Congress: Making Humans a Multiplanetary Species (Sept. 27, 2016), https://www.youtube.com/watch?v=H7Uyfqi_TE8.

94. *Id.*

95. *Id*.

96. James Grebey, *SpaceX's Red Dragon Will Use Badass New Tech to Land on Mars*, INVERSE (Sept. 21, 2016), https://www.inverse.com/article/21282-spacex-s-red-dragon-land-on-mars-supersonic-retropropulsion.

97. *Id.* (quoting Phil McAlister, NASA's director of commercial spaceflight development).

increase U.S. spaceflight capacity, since it is being designed to carry one-hundred to two-hundred persons, at minimum—this makes it more like a passenger airliner, a first in spaceflight.[98]

V. LEGAL QUESTIONS POSED BY NEW DEVELOPMENTS IN THE SPACE INDUSTRY

While the visionary ideas and plans mentioned thus far herald a bright future for U.S.-backed space programs, they also present a number of legal questions with regard to both domestic policy and international law.

A. SPACE RESOURCES AND EMINENT DOMAIN

A close reading of the Space Resource Utilization and Exploitation Act's definition of a space resource—"an abiotic resource in situ in outer space"––presents an interesting question.[99] Abiotic material is material that is "not derived from living organisms"; rather, it is "physical rather than biological material," examples of which include the water and minerals that private companies plan to recover from asteroids.[100] The issue, is whether commercial companies and private citizens would be permitted to recover and retain ownership of *biotic* material. Should the Act be read as prohibiting commercial companies and private citizens from recovering biotic material? If someone did recover biotic material, such as microbial life or remnants thereof, whose property would it be?

One way to read this might be as a general proscription on recovery of biotic material. Such a prohibition could be an attempt to preserve and protect extraterrestrial life. Famed astronomer Carl Sagan once wrote, "If there is life on Mars, I believe we should do nothing with Mars. Mars then belongs to the Martians, even if the Martians are only microbes."[101] This concept of non-interference has found expression in popular culture in the form of the "Prime Directive," the guiding ethical principle in the Star Trek universe.[102] In line with the sentiment expressed by Sagan, the Prime Directive prohibits Starfleet[103] personnel from interfering with alien cultures and civilizations—even at the cost of their own lives.[104] Noble as it may be,

98. Musk, *supra* note 93.
99. U.S. Commercial Space Launch Competitiveness Act, Pub. L. 114-90, 129 Stat. 704 (2015).
100. *Abiotic*, OXFORD DICTIONARY, https://en.oxforddictionaries.com/definition/abiotic (last visited Mar. 8, 2017).
101. Maria Popova, *Carl Sagan's Message to Mars Explorers, With a Gentle Warning,* BRAINPICKINGS (Aug. 08, 2012), https://www.brainpickings.org/2012/08/08/carl-sagan-message-to-mars/.
102. *Prime Directive*, MEMORY ALPHA, http://memory-alpha.wikia.com/wiki/Prime_Directive. (last visited Sep. 4, 2017).
103. Starfleet is the fictional space-exploration and defense service maintained by the also fictional United Federation of Planets. *Starfleet*, MEMORY ALPHA, http://memory-alpha.wikia.com/wiki/Starfleet (last visited Sep. 4, 2017).
104. *Id.*

however, this interpretation of the Act's language is extreme and likely off base, given that NASA is actively searching for extraterrestrial life.[105]

Another way to interpret this might be to look at it as preemptive maneuvering by the U.S. government. Hypothetically, it is possible that the U.S. will allow private companies to recover biotic resources, with the intent to appropriate any such resources under the property law doctrine of eminent domain.[106] The power of eminent domain, derived from the Takings Clause of the Fifth Amendment, gives the government the power to take private property—both real and personal—for public use, as long as it provides just compensation.[107] By specifying "abiotic" and thus excluding biotic material from the category of legally recoverable space resources, the government may be setting itself up to preempt any challenges to its use of eminent domain to appropriate biotic resources recovered by commercial companies. However, the government's appropriation of any such biotic material would have to be intended for "public use."[108]

The question of what constitutes "public use" was addressed by the Supreme Court in *Kelo v. City of New London*, 545 U.S. 469 (2005), in which the Court interpreted "public use" as serving a public purpose or benefit, rather than a "literal requirement that condemned property be put into use for the [general] public."[109] The government would have to show that any biotic material it takes would serve a public purpose, and could probably satisfy the very liberal standard set out in *Kelo* by justifying the appropriation of biotic material as necessary to accomplishing NASA objectives and the eventual promotion of scientific study and understanding.[110]

If the government actually took biotic material via eminent domain, "just compensation" would be its biggest issue.[111] Humans have yet to discover biotic material anywhere besides Earth[112]—and if they ever do, that discovery will have unquestionable, unquantifiable value. From this perspective, eminent domain seems like a terrible approach to obtaining biotic material, as the discoverer could potentially engage in profiteering and force the government into paying exorbitant amounts of money as compensation for the biotic material.

A third possible interpretation of the Act is one in which the government designates abiotic resources as recoverable and omits biotic resources from

105. Eric Berger, *Inside NASA's Daring $8 Billion Plan to Finally Find Extraterrestrial Life*, ARSTECHNICA (Mar. 7, 2017), https://arstechnica.com/science/2017/03/inside-nasas-daring-8-billion-plan-to-finally-find-extraterrestrial-life/.

106. It should be noted that this is pure conjecture, as are several other portions of this section.

107. U.S. CONST. amend. V ("[N]or shall private property be taken for public use, without just compensation.").

108. *Id.*

109. *Kelo v. City of New London*, 545 U.S. 469, 479 (2005) (quoting *Hawaii Housing Authority v. Midkiff*, 467 U.S. 229, 244 (1984)); *see also Rindge Co. v. County of Los Angeles*, 262 U.S. 700 (1923) ("It is not essential that the entire community, nor even any considerable portion, . . . directly enjoy or participate in any improvement in order [for it] to constitute a public use.").

110. *See generally* Berger, *supra* note 105.

111. U.S. Const. amend. V.

112. *See Extraterrestrial Life,* SCIENCE DAILY, https://www.sciencedaily.com/terms/extraterrestrial_life.htm (last visited Sep. 7, 2017)*; see also Fermi Paradox*, SETI INSTITUTE, https://www.seti.org/seti-institute/project/details/fermi-paradox (last visited Sep. 7, 2017).

the definition, thereby silently reserving the right to recover biotic material for itself.

B. COMPLIANCE WITH INTERNATIONAL OBLIGATIONS

The international legal system is comprised of two groups of rules: those created by general (also called customary) international law, which are binding on all subjects of international law, and those created by treaties, which are binding only on contracting states.[113] As of now, international space law is composed of a series of treaties, which cannot create rights or duties for non-party states without their consent.[114] The U.S., along with a host of other nations, is a signatory to the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies ("Outer Space Treaty"); the 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; the 1972 Convention on International Liability for Damage Caused by Space Objects; the 1975 Convention on Registration of Objects Launched into Outer Space; and the now dormant 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.[115] In the context of the developing U.S. space exploration industry, one of the most onerous provisions in international law is Article VI of the Outer Space Treaty, which provides that:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.[116]

Pursuant to Article VI, the U.S. government would be responsible for all the activities of the U.S. commercial space sector; this burden may be the catalyst behind new laws such as the Commercial Space Launch Competitiveness Act discussed above.[117] In a recent testimony before the

113. BIN CHENG, STUDIES IN INTERNATIONAL SPACE LAW 384 (1997).
114. *Id.*
115. Matthew J. Kleiman, *Space Law 101: An Introduction to Space Law*, AMERICAN BAR ASSOCIATION, http://www.americanbar.org/groups/young_lawyers/publications/the_101_201_practice_series/space_law_101_an_introduction_to_space_law.html (last visited Sep. 7, 2017).
116. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies art. 6, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205.
117. U.S. Commercial Space Launch Competitiveness Act, Pub. L. 114-90, 129 Stat. 704 (2015).

House Subcommittee on Aviation, Dr. George C. Nield, the Federal Aviation Administration's ("FAA") Associate Administrator for Commercial Space Transportation, remarked: "[t]hese ambitious plans [by private space companies] require new ways of thinking about regulations and about what constitutes government authorization and supervision."[118] According to Dr. Nield, while the FAA licenses the launch and reentry of commercial space launch vehicles, the agency "does not license their activity in Earth orbit or beyond."[119] Simply put, this suggests that the current body of domestic law is not ready to regulate or support activities such as asteroid mining or proposed missions to Mars; however, in order to be in compliance with international law, the U.S. needs to propagate new national laws for the governance of outer space activities.

Take, for example, asteroid mining: because it has never been done before, there are currently no regulations that would control the process of asteroid mining, other than the House bill that authorized it.[120] They are necessary, however, because the current proposals from companies like Planetary Resources and DSI would likely require massive harvesting and refining infrastructures to be launched into space.[121] If used and discarded, the infrastructure might become a source of orbital debris—something that the international community is trying to reduce, and therefore is worthy of regulation.[122] Further, the proposed network of fuel depots, while an attractive idea, needs to be thoroughly vetted for safety and reliability because space is an unforgiving environment.

Even more concerning than asteroid mining are the potential liabilities stemming from commercial spaceflight—more specifically due to SpaceX's ITS infrastructure. In the case of spaceflight, the government's main concern will probably be liability. Elon Musk himself has said that the first travelers should be prepared to die: "The risk of fatality will be very high. There's just no way around it."[123] The 1972 Convention on International Liability for Damage Caused by Space Objects governs liability for damage or loss of life caused on earth or in flight, and assigns liability to the launching State.[124] Should the ITS suffer an accident during, launch, flight, or landing, with a full crew of people onboard, it would result in a catastrophic loss of life at least one order of magnitude higher than those of previous spaceflight accidents.[125] The proposed ITS would expose the U.S. government to an extreme degree of liability. Though the U.S. should not attempt to restrict privatized efforts to reach Mars simply out of fear, it will certainly need to

118. *Testimony–Statement of Dr. George C. Nield*, FAA (June 22, 2016), https://www.faa.gov/news/testimony/news_story.cfm?newsId=20534.

119. *Id.*

120. U.S. Commercial Space Launch Competitiveness Act, *supra* note 117.

121. *See generally*, *Market for H2O*, *supra* note 78; *Asteroid Mining*, *supra* note 71.

122. *See* Daniel Gregory, *Space Debris Elimination*, NASA, https://www.nasa.gov/directorates/spacetech/niac/gregory_space_debris_elimination.html (last visited Sep. 7, 2017).

123. Dave Mosher, Ali Sundermier, & Rafi Letzer, *This is Elon Musk's Plan to Begin Colonizing Mars by 2022*, BUS. INSIDER (Sept. 27, 2016), http://www.businessinsider.com/elon-musk-spacex-mars-colony-talk-iac-2016-9.

124. CHENG, *supra* note 113, at 614.

125. *See generally* Remy Melina, *Fallen Heroes of Spaceflight*, LIVESCIENCE (Apr. 1, 2011), http://www.livescience.com/33175-the-fallen-heroes-of-human-spaceflight.html.

evaluate its current domestic space and aviation law and prepare for a new era of flight safety and liability.

VI. EXTRATERRESTRIAL SOVEREIGNTY AND JURISDICTION

Much further down the line is one of the biggest questions with respect to manned space exploration and potential colonization: sovereignty and jurisdiction. Sovereignty, a state's power to govern itself without interference from outside sources, is inextricably tied to jurisdiction.[126] On its face, jurisdiction can be understood as either a state's authority to make and enforce laws, or as the actual geographical territory within which it can exercise this authority.[127] Jurisdiction in international law can be separated into three categories: territorial jurisdiction, which is enjoyed by the State over its own territory and over all persons and things within it; quasi-territorial jurisdiction, which is enjoyed by the State over ships and aircraft of its nationality, and over all persons and things on board; and personal jurisdiction, which is enjoyed by the State over its nationals.[128] Each type of jurisdiction consists of two components: jurisfaction, which is a State's right to make laws, and jurisaction, which is the State's ability to implement and enforce these laws.[129]

The jurisdictional problem stems from the uncertain territorial status of outer space, and the nebulous, still-developing body of law that addresses it. General international law recognizes three types of territory: national territory, over which a state exercises territorial sovereignty to the exclusion of others; *territorium extra commercium*, which cannot be made the territory of any state; and *territorium nullius*, which are not yet under the sovereignty of any state but can be acquired.[130] A fourth type, the *territorium commune humanitatis*, or the "common heritage of all mankind," was introduced by the now dormant Moon Treaty.[131] Under general international law, outer space, like the high seas, is *extra commercium* and therefore not subject to national appropriation; celestial bodies, on the other hand, are *res nullius* and therefore capable of being lawfully occupied or subject to national sovereignty.[132] Under the 1967 Outer Space Treaty, however, celestial bodies are also rendered *territorium extra commercium* to the treaty's contracting states.[133] In principle, however, should the U.S. choose to withdraw from the 1967 Outer Space Treaty, it would be free to lawfully occupy and appropriate the Moon, Mars, asteroids, or other bodies.[134] While spacefaring states have adhered to the principles set forth by the United Nations in the 1967 Outer

126. Sovereignty, OXFORD ENGLISH DICTIONARY, https://en.oxforddictionaries.com/definition/sovereignty (last visited Sep. 7, 2017).
127. Jurisdiction, MERRIAM-WEBSTER, https://www.merriam-webster.com/dictionary/jurisdiction (last visited Sep. 7, 2017).
128. CHENG, *supra* note 113, at 622.
129. *Id.* at 623-624.
130. *Id.* at 386.
131. *Id.*
132. *Id.* at 390.
133. *Id.* at 229.
134. *See id.* at 392.

Space Treaty, this may change as technology advances to a state that would support deep space exploration.

A. A POINT OF COMPARISON: ANTARCTICA

Besides outer space and the high seas, there are two other areas considered "global commons": the atmosphere and Antarctica.[135] Like outer space, Antarctica does not have a native human population and under the Antarctic Treaty System ("ATS"), is reserved as a research arena to which nations may not lay claim.[136] The Outer Space Treaty was modeled after the Antarctic Treaty, which sought to prevent a "new form of colonial competition" and the damage that would follow such self-interested exploitation.[137] This desire is evident in both treaties' usage of the phraseology, "interest of all mankind." [138]

A notable difference between the two treaties is their definition of the treaty area. Article VI of the Antarctic Treaty states that the treaty will apply to "the area south of 60° South Latitude."[139] By contrast, the Outer Space Treaty remains silent regarding the exact point or height above earth at which outer space begins.[140] Further, Antarctica has been the subject of territorial claims—though the ATS now forbids the exertion of any new claims, it also does not invalidate the prior existing claims.[141]

B. SPACE JURISDICTION CURRENTLY

The current body of international space law is unclear and contains many discrepancies with regard to the issue of jurisdiction. Article VIII of the 1967 Space Treaty attributes jurisdiction and control over objects launched into space and their personnel to the state of registry, which is essentially quasi-territorial jurisdiction.[142] The 1975 Registration Convention stipulates that space objects launched into earth orbit or beyond are to be registered by their respective launching state; however, the treaty's definition of a "launching state" can be interpreted in multiple ways, thus rendering uncertain which state has a duty to register the object in question.[143]

This complicated framework can be seen in practice on the ISS. Pursuant to the Intergovernmental Agreement that governs the orbiting laboratory,

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135. Juan F. Salazar, *Antarctica May Hold the Key to Regulating Mining in Space*, PHYS.ORG (Aug. 10, 2015), https://phys.org/news/2015-08-antarctica-key-space.html.

136. Antarctic Treaty, Dec. 1, 1959, U.N.T.S.; *see also The Antarctic Treaty Explained*, BRITISH ANTARCTIC SURVEY, https://www.bas.ac.uk/about/antarctica/the-antarctic-treaty/the-antarctic-treaty-explained/ (last accessed Sep. 7, 2017).

137. S*ee* Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, *supra* note 116, at preamble; *see also* Antarctic Treaty, *supra* note 136.

138. *Id.*

139. Antarctic Treaty, *supra* note 136, at Art. VI.

140. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, *supra* note 116.

141. *Antarctic Treaty*, U.S. DEPARTMENT OF STATE (last visited Mar. 8, 2017), https://www.state.gov/t/avc/trty/193967.htm.

142. CHENG, *supra* note 113, at 623-25.

143. *Id.* at 626-27.

jurisdiction is varied according to the module or part.[144] The nation of registry retains jurisdiction over the modules that it registers, as well as over its own nationals.[145] This is a combination of quasi-territorial and personal jurisdiction that raises the problem of conflicting jurisdictions.[146] This system is no doubt motivated by concerns about national appropriation. Missions to the lunar surface and international missions to Mars as envisioned by NASA and the ISECG might follow a similar model—and by extension, encounter a similar problem.

C. JURISDICTION ON MARS

What is less is clear is how jurisdiction would work with respect to permanently occupied structures on terra firma*,* such as on the surface of the Moon or Mars. Under the Outer Space Treaty, the Moon and Mars are *territorium extra commercium*; the model used for the ISS and other space objects encounters difficulty here because if exclusive jurisdiction is granted to a nation over any portion of land on terra firma, it would be difficult to "avoid the semblance of national appropriation."[147] However, neither would it be wise for there to be no jurisdiction at all, since the complete absence of government authority would be anarchy.[148]

If a humanity does establish a large and permanent presence on Mars, such that it can be considered a self-sustaining colony, new problems arise. Unlike the ISS, which is a scientific partnership and on which the astronauts are functionally diplomats, a self-sustaining Martian settlement would hypothetically consist of a much larger group of people—not all diplomatic envoys—and would therefore eventually require some form of governance.[149] Another significant difference between the ISS and a hypothetical Martian colony is the distance between each and the Earth; the ISS lies in low-Earth orbit and thereby enjoys near instantaneous communication with Earth. Mars, on the other hand, is 54.6 million km away from Earth at its closest, 401 million km away at its furthest, and 225 million km away on average.[150] The speed of the electromagnetic waves that comprise communications travel at the speed of light in vacuum (c = 299,792 km/s).[151] The communication delays, therefore, would be as follows:

144. International Space Station Intergovernmental Agreement, January 29, 1998, T.I.A.S. No. 12927 (each partner nation registers any module or element that it will provide; pursuant to Article VIII of the Outer Space Treaty and Article II of the Registration Convention, the providing Partner retains jurisdiction over the elements it registers); Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, *supra* note 116, at Art. VIII.

145. Nathan C. Goldman, American Space Law: International and Domestic 225 (2nd ed. 1996).

146. *Id.*

147. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *supra* note 116, at Art. II.

148. Anarchy, MERRIAM-WEBSTER (Mar. 9, 2017), https://www.merriam-webster.com/dictionary/anarchy.

149. *See generally*, *Human Settlement On Mars*, MARSONE, http://www.mars-one.com/ (last visited Sep. 7, 2017)

150. *What is the Distance Between Earth and Mars*, SPACE, https://www.space.com/14729-spacekids-distance-earth-mars.html (last visited Sept. 13, 2017).

151. *The Electromagnetic Spectrum*, BBC, http://www.bbc.co.uk/schools/gcsebitesize/science/edexcel_pre_2011/waves/theelectromagneticspectrumrev2.shtml (last visited Sep. 7, 2017).

Distance between Earth and Mars / Speed of EM waves in vacuum = Time delay[152]		
At closest distance:	54,600,000 km / 299,792 km/s = 182.1269 s	(approximately 3.035 minutes)
At average distance:	225,000,000 km / 299,792 km/s = 750.519 s	(approximately 12.508 minutes)
At furthest distance:	401,000,000 km / 299,792 km/s = 1337.592 s	(approximately 22.293 minutes)

The long communication delays would make Earth-to-Mars governance cumbersome and inefficient, which suggests that the Martian colony will most certainly require its own form of government, whether integrated or independent of the Earth-based nations.

A more micro-level concern would be the status of future Martian residents themselves. In the distant future, assuming a permanent and well-established settlement in which colonizers are having children on Mars, what would their nationality be? If no state has jurisdiction over structures on Martian terra firma due to concerns of national appropriation, the child would not receive citizenship through jus soli by virtue of the fact that he or she was born in a non-territory.[153] The parents would then have to apply for the child to inherit citizenship jus sanguinis.[154] But if, for some reason, neither was a viable method of obtaining citizenship, would the child then nation-less? Would there eventually be Martian citizenship? Questions like these will merit serious consideration the closer the U.S. draws to manned exploration of Mars.

VII. CONCLUSION

The words of President John F. Kennedy ring just as true today as they did in the 1960s: "Now it is time to take longer strides—time for a great new American enterprise—time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future here on Earth."[155] One of the main obstacles to contributing to the U.S.'s stagnating position in space achievement is the government's tendency to over-rely on hard power, a problem best illustrated by the vast discrepancy in funding between the military and NASA: for the fiscal year 2015, the defense budget was $601 billion—more than thirty-four times the size of NASA's operating budget of $17.4 billion.[156] Dismissing projects such as Constellation may seem fiscally efficient in the short-term, but the long-term

152. Calculated by the author using basic principles of physics (distance / speed = time).

153. *See generally* Jus Sanguinis, OXFORD REFERENCE, http://www.oxfordreference.com/view/10.1093/oi/authority.20110803100027515 (Sep. 7, 2017).

154. *Id.*

155. John F. Kennedy, *Excerpt from Special Message to Congress on Urgent National Needs*, NASA (May 25, 1961), https://www.nasa.gov/vision/space/features/jfk_speech_text.html.

156. CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES, *supra* note 8, at 7; Skye Gould & Jeremy Bender, *These Charts Show the Immensity of the US' Defense Budget*, BUSINESS INSIDER (Aug. 31, 2015), http://www.businessinsider.com/the-us-defense-budget-is-massive-2015-8.

ramifications of such disregard can negatively affect the U.S. manned space exploration beyond low-Earth orbit. This may prove detrimental to the U.S.'s effective use of smart power both in space and on Earth, and for the government to cut funding any more than it already has is would hinder its ability to exercise that power or to keep pace with other nations.

More importantly, exercising smart power through space exploration will necessitate major change in the current body of international space law. That the Outer Space Treaty of 1967 was produced by the international community on the eve of the Apollo 11's moon landing, one of the biggest milestones in space exploration history and a "giant leap for mankind," is no coincidence—the Treaty was "unquestionably" the result of a need for an international agreement in advance of man's landing on the moon.[157] The next forecasted "giant leap" may not just be a manned landing on Mars; if commercial companies have their way, the next "giant leap" may be the establishment of a permanent human presence outside of Earth.[158] The current international legal framework, while adequate for the present-day, will be not be a workable model if humans ever colonize Mars. Just as the run-up to the Apollo program's "giant leap for mankind" spurred legal regime change, current preparations for manned exploration of deep space should motivate U.S. lawmakers and leaders to reevaluate the international legal framework to begin making necessary changes, or else technology and exploration will outpace the law.

157. CHENG, *supra* note 113, at 215.
158. *See generally* Musk, *supra* note 93; *see also Human Settlement On Mars*, *supra* note 149.