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## Extending Humanity's Reach: A Public-Private Framework for Space Exploration

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## **Extending Humanity's Reach: A Public-Private Framework for Space Exploration**

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## Introduction

### The Evolution of Space Travel

Space travel is an exciting global accomplishment that has enabled humanity to extend its reach beyond earth. The Soviet Union's launch of Sputnik initiated a dualistic space race that inspired rapid technological development within the United States to ensure the prosperity of Western democracy against the communist regime in the new frontier of outer space. With this technological competition for ideological supremacy as the beginning of significant efforts to explore the ever-expanding void of space, countries became the initial primary actors in this new environment. The end of the Apollo program in the United States, however, followed by the retirement of the Space Shuttle, tempered the urgency that had previously characterized the race to space. No longer did the United States fear the domination of space by communism, nor did it lack faith in its technological abilities. The end of the dualistic Cold War mentality brought with it a new view of space, in which the United States already saw itself as victor.

A renewed interest in human space exploration has countered this stagnation of American efforts to reach new frontiers in space. However, the competitive nation-based approach that characterized the space race of the Cold War is notably absent from this exploratory phase. Rather, cooperative agreements between the National Aeronautics and Space Administration (NASA) and private space companies have become increasingly responsible for the efforts to send humans back to the Moon and to lead the first manned missions to Mars. The Trump Administration's Space Policy Directives build upon the Obama Administration's plans to re-ignite human space exploration, utilizing the dynamic and robust commercial space industry to accelerate economical efforts to reach new distances and uncharted celestial bodies.<sup>1</sup>

While timelines for human missions to Mars exist, how these flagship missions will lead to a sustained presence on the red planet is largely unknown. Little policy exists as a guide to exploring a planet for the first time, and current international agreements prevent any single country from colonizing Mars and other celestial bodies. It will be essential to

address these complications to facilitate the transition from a largely public space exploration model to a burgeoning public-private framework. The efficiency and rapid pace of innovation of private companies will become crucial characteristics of successful manned missions to Mars.

Private exploration of a planet, however, appears incompatible with the 1967 Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (OST) as it exists today. While the OST does not deny private entities the ability to claim ownership of territory and resources in space, as it does to states, it neither supports private activities, nor establishes an enforcement mechanism for such claims. As a result, the profits that incentivize private companies to dedicate their resources to space exploration may be difficult to protect. Without some semblance of international assurance of the ability to operate safely and securely in space, the commercial space industry will refrain from applying its resources to the expansion of humanity throughout the solar system. These consequent limitations to wholly private space travel reveal the importance of cooperation between the private sector and NASA. Through its own international cooperative relationships, NASA, as a national sponsor to private activities, can inspire the confidence necessary to encourage private space companies to conduct progressively complex missions. To enable the most effective journey to Mars, international cooperation in the development of missions to and activities on Mars, between public space agencies and private companies alike, will become a key feature of interplanetary travel.

As private companies develop the technologies to send humans to Mars, NASA will continue to work to establish critical mission infrastructure. The extension of humanity deeper into space will therefore depend largely upon collective international recognition of the importance of private companies in the advancement of human exploration beyond low-earth orbit (LEO). This article will trace the evolution of American space travel from a public-dominated approach to an emerging “commercial network model,” and assert the importance of adopting this public-private approach for manned missions to Mars. International recognition of the right of private companies to operate in space will become a stable foundation for progressively complex missions. Finally, through this unprecedented acceptance of the commercial space sector, public-private

partnerships will enable sustainable human transport through a strategic transition of responsibility from the efforts of space agencies to the innovative technologies of private companies. With this public-private foundation established, the international space community must consider the implications of the OST regarding the right of private companies to explore other planets.

## Competition-Driven Exploration: The Realm of the Nation-State

The transition from a NASA-dominated public space industry to the emerging public-private system began with the end of the Cold War. As the Soviet Union dissolved, so too did the sense of urgency that spurred the rapid mobilization of American efforts in space. Throughout the 1960s, the Cold War prompted an unprecedented level of investment in space travel: By 1965, the United States government was dedicating five percent of its national budget to NASA.<sup>2</sup> This sense of urgency emerged as a response to the first successful launch of an artificial satellite into orbit. The launch of Sputnik I by the Soviet Union, on October 4, 1957, not only confirmed the country's ability to extend its reach off earth but also revealed that space travel was no longer a feat of fiction. Haunted by the regular "beep" of Sputnik as it orbited the earth every 90-minutes, the United States spread its resources from the ideological battle on earth to the new technological battlefield in space.<sup>3</sup> Sputnik's success became a significant motivation for the resulting space race as the threat of a communist-dominated world expanded into the realm of outer space. Quickly, the United States attempted to match the Soviet accomplishment with the Vanguard TV3 mission.<sup>4</sup> The explosion of the American satellite on the launchpad, however, deepened the public feeling of inadequacy that characterized the nation's disposition toward space.

This competition between the United States and Soviet Union to establish a significant presence in space molded the new uncharted frontier as a territory to be conquered. The binary political battle of the Cold War to extend each countries' respective influence beyond earth supplanted the urge to explore the solar system. This dualistic mentality led to the formulation of space as a political environment, which, through its early technological success, the Soviet Union began to dominate. Space, consequently, was defined in terms of the terrestrial conflicts of nation-

states, where technological dominance, and, eventually, ideological superiority could be achieved. Through the American perspective, the growing communist influence transformed the frontier of space from an empty void of little relevance to a potentially Soviet-controlled territory that required a swift response.<sup>5</sup> This ideological transformation of space defined the environment's vast expanse and unprecedented potential solely through an extension of the dualistic conflict of nation-states; exploration and discovery remained inconsequential objectives. As the initial phase of human space travel, though, this nation-based mentality would serve as the foundation for future missions in the new environment. United States policy and international agreements soon emerged to facilitate increasing activity in space, as political conflicts on earth transformed the new frontier from a battlefield into a new symbol of national achievement.

### *The Threat of Militarization*

An arms race in space threatened to explode between the United States and Soviet Union as each country created new technologies and conducted missions to secure more of the environment before the other. John Glenn's successful 1962 orbital flight around earth began to shift the ownership of space to the United States, as the country's technological capabilities became the driving force behind increased exploration.<sup>6</sup> Soon, however, both the United States and the Soviet Union identified the Moon as the next milestone in the progression of space travel. Considering space as an extension of the nation-state, the Moon, and the dominant control over space it represented, presented a seemingly impenetrable extension of military power. Both nations necessarily confronted this possibility, eager to prevent the emergence of an unparalleled threat in the then-current binary conflict. This threat seemed detrimental enough, as both the United States and Soviet Union, along with other concerned countries, began formulating international agreements to prevent the militarization of space.

This perspective of national defense solidified space as a concern of the present, a new environment to harbor the evolving military threats that characterized the Cold War. In September 1963, projections of nuclear weapons orbiting in space and attached to celestial bodies, like the Moon or asteroids, became the subject of international mediation.<sup>7</sup> The next month, the United Nations General Assembly unanimously adopted a

resolution to ban any state from launching weapons of mass destruction into outer space.<sup>8</sup> This initial step to govern space further contributed to its classification as an arena for state activity, as citizens watched and read from their lives on earth the reports of giant rockets blasting into the unknown. Rather than a series of technological accomplishments attributed solely to the efforts of both nations' space agencies, American rockets or Soviet missiles carried either nations' presence into space. Consequently, the emerging Cold War space policies both recognized and deepened this characterization of the increasingly familiar environment as an arena for national activity.

Despite the agreement not to launch nuclear weapons into space, the United States sought to limit the Soviet Union's influence in the new environment further. Soviet concern mirrored that of the United States as it aimed to restrict the ability of Western private enterprise from exploiting the resources of space before it established its state-run capabilities.<sup>9</sup> In June 1966, both countries presented their plans to govern the use of outer space to the United Nations General Assembly.<sup>10</sup> Seeking to curtail the early advantage of the Soviet Union, the United States presented an agreement that would prevent any state from claiming celestial bodies as national territory. The Soviet Union, however, recommended a policy that would protect the entire environment of space from national domination either through claims of sovereignty or military advancements. Following the plan outlined by the Soviet Union, the United Nations ratified the OST in 1967. The Treaty prohibits states from extending territorial sovereignty to any part of space, including celestial bodies.<sup>11</sup> The OST confirmed the nation-state as the main actor in space, with the citizens and organizations of any state subject to the government's authority and policies whenever conducting activities off earth. Article I of the OST holds that "The exploration and use of outer space... shall be carried out for the benefit and in the interests of all countries" and all activities in this expansive environment should encourage international cooperation.<sup>12</sup> While the agreement supported the accelerating efforts to reach new heights in space, it simultaneously limited the extension of influence by prohibiting states from claiming any part of outer space, including the Moon and other celestial bodies, as national territory. Therefore, through neither occupation nor utilization can a state lay exclusive claim to a celestial body in order to prevent other states from exploring it.

## From Public to Private

As the United States raced to solidify its technological superiority in its competition against the Soviet Union, it dedicated its efforts to landing a man on the Moon. The resulting Apollo program introduced a traditional public approach to space travel that would soon give way to cooperative public-private partnerships between NASA and the commercial space industry as the competition of the Cold War waned. While both countries had previously flown humans around earth, successfully landing on the unexplored celestial body known to all became the clear next step in this symbolic race. From 1960 to 1973, NASA's budget increased to unprecedented levels. With 42 percent of these funds spent on the Apollo Moon landing initiative, the United States effectively invested its national character in NASA's efforts to reach the Moon.<sup>13</sup> This reliance on the national space agency remained consistent with the OST, as NASA controlled mission planning, manufacturing and execution. The agency maintained hierarchical relationships with its contractors, setting the specifications and technological capability of its commercially built and purchased products.<sup>14</sup> While successive failures may have tainted public perception of American space efforts, continued investment and routine attempts began to reinforce an unwavering trust in NASA. Moreover, as the world watched American astronauts take the first steps on the lunar surface, a global belief in NASA's technological invincibility and exceptionalism became a proxy for the United States' dominant position in space.<sup>15</sup> Propelled by Cold War competition, the Apollo era introduced the traditional model of space travel in which NASA became the exclusive customer of, and consequently controlled, manufacturing companies. This traditional model of public-private cooperation limited the flexibility to innovate in the private space sector, but revealed the technological capacities of the commercial space industry that could revolutionize American space efforts.

### *Apollo Leads the Way*

Accession to the OST became an important decision in the era of the competitive space race mentality that fueled the Apollo program, as the agreement effectively ensured space remained an arena for state action. The idea of preserving space for the benefit of all countries, however, began to dull the specter of the environment that attracted government



and private interest. The end of the Apollo program, followed by the retirement of the Space Shuttle revealed the stagnation, spurred by the OST, felt throughout NASA and the nascent private space industry. This transitional phase from bilateral competition, to the classification of space as a peaceful environment immune to national exploitation, revealed a gap between the contest that once fueled American space exploration and the present egalitarian structure of the environment. Flexible cooperation between NASA and private space companies began to fill this gap by sparking a new sense of technological capability and serving as the foundation for a sustained human presence in space, and eventually on Mars. The end of the space race dissolved the sense of urgency that characterized the United States' rapid mobilization to space during the Cold War, as manifested in the Apollo program. Further, as the national budget for space exploration decreased, so too did public excitement to reach new distances. However, NASA's reduced activity paired with technological innovation by private companies became an ideal recipe for the growth of the private space industry in the United States, a creative, efficient, and effective sector that renewed the urge to explore.

While NASA owned all resulting technology produced by its contracted companies in traditional public-private partnerships, Apollo 11's unprecedented success introduced new concerns surrounding the future efficacy of the OST. While the mission remained an act of a state party to the agreement, conducted by a United States federal agency, it revealed a new potential for human space exploration. Would the United States use its proven capabilities to assert from above its dominance on earth? Alternatively, would it promote "the principle of co-operation" and respect the interests of other states in the agreement?<sup>16</sup> These questions surround and continue to percolate into the discussion of nation-based space travel, especially as the prospect for manned missions to Mars continues to develop. While the OST affords countries the right to explore celestial bodies, it explicitly prohibits the national appropriation of any territory in outer space.<sup>17</sup> However, as the space race-mentality wore away, and private companies emerged to fill the void left by the dissolution of the urgency to reach space, the once protected domain transitioned into a widely accessible environment for commercial activity and exploration. As the next phase of American space activity would soon reveal, this transition is enabling humanity to reach new heights that continue to call into question the applicability of the OST.

### *The Space Shuttle Launches*

The success of Apollo 11 led to foundational questions regarding the next steps of the American space program. In 1970, NASA sought to establish a far-reaching space program through President Nixon's Space Task Group. In coordination with NASA, the Space Task Group recommended a forward-facing approach to space travel, beginning with the development of a space station, a reusable space shuttle, a base on the Moon, and finally human trips to Mars.<sup>18</sup> Despite this demonstrated acceptance of space as the next frontier for American exploration, President Nixon neglected to adopt the Space Task Group's plan; the many critical problems on earth, Nixon believed, required the full attention of the nation's scientific community.<sup>19</sup> Two years later, the push to continue exploring space penetrated Nixon's conservative mindset. In 1972, the President announced plans to develop an "entirely new type of space transportation system designed to help transform the space frontier of the 1970s into familiar territory, easily accessible for human endeavor."<sup>20</sup> This new type of transportation system became the Space Shuttle, a class of vehicle capable of flying a variety of payloads, including astronauts and satellites, into LEO. To facilitate this enhanced presence in space, the Space Shuttle program utilized reusable vehicles that could return to the surface of earth after completing short-term missions to space. The Space Shuttle became a new tool that accelerated the transformation of space from a conquerable territory into a commercial environment to expand the reach of humanity.

With a new means of preserving a continued presence in space, the United States began to use its capabilities to launch payloads set to enhance human knowledge of the solar system. In 1989, the 30<sup>th</sup> Space Shuttle mission launched the spacecraft Magellan towards Venus to explore the planet from orbit; by 1990, the probe had mapped 99 percent of the planet's surface.<sup>21</sup> This unprecedented access to information about another planet revealed the foundational importance of the Space Shuttle program, for it demonstrated the ability of humans on earth to gain crucial insight into the solar system they hoped to explore. Similarly, the Hubble Space Telescope entered space as a passenger on the Space Shuttle *Discovery* in 1990, making significant astronomical discoveries that continue to inspire exploration of the vast universe.<sup>22</sup> Despite the failures of various Space Shuttle missions, notably the destruction of *Challenger* in 1986 and the *Columbia* disaster in 2003, the program's continued operation revealed a

serious commitment to space from which the United States would not easily retreat. This dedication to expand the human foundation in space, through the Space Shuttle program, would further manifest itself in a new phase of international cooperation to gain the experience essential for further exploration of the solar system. The Space Shuttle *Discovery* illustrated this mutually beneficial treatment of space in 1994, as it launched, for the first time, a Russian cosmonaut alongside American astronauts on a U.S. mission.<sup>23</sup> The battlefield of space no longer remained a conquerable environment for one nation over all others. Rather, as the competitive mentality of the space race faded, so too did the tendency to unconditionally pursue national goals. Countries began to recognize the value of cooperation in expanding the presence of humankind throughout the solar system, an invaluable realization, as manned missions to Mars become increasingly feasible objectives.

## Exploring the Commercial Alternative

The initiation of the construction of the International Space Station (ISS) in 1998 emphasized the increasingly international nature of space. Russia launched the first segment of the ISS, the Zarya control module, using one of the nation's own rockets.<sup>24</sup> The first U.S.-built segment of the ISS met the Russian module that same year, riding to orbit on the Space Shuttle.<sup>25</sup> The collaboration between these two once-competing countries resulted in an unprecedented accomplishment in space, enabling sustainable access to and long-term experiments within the still-mysterious environment. Humans have lived on the ISS since the first crew arrived on November 2, 2000, providing insight into the long-term effects of the adverse conditions of space on the human body.<sup>26</sup> By sustaining a human presence on the ISS, the international partners have also gained valuable experience in maintaining a spacecraft for long-term human use, a foundational component of missions to deep space. Since humans began inhabiting the Station, the European Space Agency and its Japanese counterpart have launched additional laboratory modules to facilitate research in space.<sup>27</sup> While the Space Shuttle enabled this phase of international cooperation, its retirement in 2011 marked another structural change in the relationship between the United States, Russia, and each countries' efforts in space.

The end of the Space Shuttle program in 2011 initially resulted in a new dependence on Russian space capabilities, as the country's Soyuz rocket became the only method to send American astronauts to the ISS. While this reliance strengthened international cooperation in space, it further exasperated the gap left by the end of the space race. The United States consequently lacked the capability to send its own astronauts to the ISS and to conduct future missions into deep space. NASA realized this eventual lack of capability during the construction of the ISS. In 2006, the agency began to contract its ISS resupply missions to private space companies through the Commercial Resupply Services (CRS) program, one of two strategies managed by the Commercial Crew and Cargo Program Office (C3PO).<sup>28</sup> This decision to utilize the technologies of the commercial space industry to fulfill the nation's obligations to the ISS initiated a new relationship between NASA and private space companies that ushered in a new phase of space travel. In addition to providing an alternative to dependence on Russian rockets, this widening cooperation between NASA and the commercial space industry displayed the dynamic capabilities of private companies to support the agency's goal of maintaining a proactive presence in space. Inherently, the commercial space sector focused on cost-effective and innovative products to develop the most efficient technologies possible for space travel. While this natural profit-driven tendency of private industry may have revealed a failure of NASA to use its resources effectively, profitability became a powerful source of motivation to innovate. Innovation in the private space sector not only sustained resupply missions to the ISS but also catalyzed an entire space economy fueled largely by the burgeoning commercial space industry. By 2011, driven by the growth of commercial opportunities in space, this global space economy grew to nearly \$290 million and instilled a strong sense of confidence in future commercial activity in the expansive environment.<sup>29</sup>

The partnerships between NASA and private companies, beginning with the CRS program, introduced a new model for advancing the presence of humans in space. These Space Act Agreements (SAAs) became the main form of collaboration between NASA and commercial organizations.<sup>30</sup> The National Aeronautics and Space Act of 1958 granted NASA the authority to enter into SAAs at its creation and enabled the agency to harness the innovations of private organizations to fulfill its mandated goals in space. Increased efficiency of routine missions to the ISS became the primary

goal of the privatization of activities in space through these SAAs. Consequently, through the natural competition of the commercial space industry, NASA began awarding its contracts to the companies developing the most cost-effective capabilities.

The CRS program utilized a costs-plus model in which NASA entered into binding agreements to purchase the hardware and services of its private partners no matter the cost, as it did in the Apollo era. A new form of SAAs emerged through the Commercial Orbital Transportation Services (COTS) program.<sup>31</sup> This new public-private strategy enabled NASA to set the objectives of its partnerships and made private companies responsible for reaching these goals in the most efficient manner possible, with NASA a primary investor and customer. Moreover, because companies are paid only for their achievements, NASA effectively spurs competition throughout the industry as companies strive to create the most efficient and effective technologies to attract the agency's contracts. This system of progressive payments has encouraged unprecedented innovation and efficiency. SpaceX, for example, under a contract through the COTS program, built its Falcon 9 rocket and Dragon capsule for less than one-third the cost of NASA's estimate.<sup>32</sup> This tremendous efficiency has revealed the benefit of pursuing public-private partnerships following the model of the COTS program. As a customer of private space companies, NASA not only gains the ability to maintain the American presence in space but can also dedicate its limited resources to the development of novel missions to deeper space, specifically missions to Mars.

The retirement of the Space Shuttle program reinforced this seminal transition to a commercial-network model, for private companies will provide the hardware necessary to send American astronauts to space on American rockets once again. Collaboration between NASA and the commercial space sector allows the agency to target its efforts on the extension of humanity's reach throughout the solar system while reinforcing its previous accomplishments in space. As a result, public-private partnerships spurred by the COTS program have not only laid the foundation of the current phase of American space travel but have become the stepping-stones to human missions to Mars.

### *Harnessing Commercial Opportunities*

As SpaceX successfully demonstrated its evolving and increasingly powerful capabilities with the launch of its Falcon Heavy rocket in 2017, excitement for space travel surged. This renewed enthusiasm for space, however, differed fundamentally from the triumph of Apollo 11; it came at the hands of a private company, not a national agency that served as a proxy for the entire country in an international battle. Despite this operational shift of NASA's role, new SAAs are allowing the agency to benefit from the relatively rapid pace of innovation in the private sector, while still creating a new sense of possibility in space. In a major act in this public-private phase of space travel, a foundational step in the journey to Mars, NASA partnered with SpaceX to successfully launch astronauts to the ISS in the company's Crew Dragon capsule on May 30, 2020. The National Aeronautics and Space Administration's SpaceX Demo-2 mission marked not only the first commercially constructed and operated manned space flight, but the first time since the Space Shuttle's retirement that astronauts launched from American soil.<sup>33</sup> The agency plans to continue to send humans back to the ISS using commercial vehicles from SpaceX and, eventually, Boeing. Conducted under the mandate of the C3PO, these privately flown missions, purchased by NASA, can end the dependence on Russia to launch American astronauts and spur competition in the commercial space sector as companies strive to win NASA's lucrative business.<sup>34</sup> In addition to demonstrating the feasibility of public-private partnerships in space, the ability of private companies to conduct these routinized missions to the ISS becomes a crucial step in the development of the capabilities necessary for missions to Mars. Engaging in repeatable missions to the ISS allows private companies to simulate the launch, travel, and landing processes that will be crucial as manned missions into deep space transition from proof-of-concept missions to cost-effective routine transportation. Sustained travel to LEO alone, though, will not stimulate the innovation necessary for missions to Mars. Rather, to prepare for this ultimate goal, private companies should conduct progressively complex missions through contracts with NASA to fill the gaps the agency opens as it dedicates its resources to novel missions into deeper space. Through this supplementary relationship, private space companies gain the opportunity to build upon their technologies and refine their processes to ensure the transition from wholly public agency-based missions to routine public-private trips is as seamless as possible.

The Global Exploration Roadmap (GER), a coordinated international framework to advance human exploration of the solar system, expresses the importance of an “evolution of critical capabilities which are necessary for executing increasingly complex missions to multiple destinations,” culminating with Mars.<sup>35</sup> While the GER of 2013, along with its 2018 refinements, underestimates the role of public-private partnerships in the development of manned missions to Mars, it establishes a functional path to reach the red planet through international collaboration between space agencies. The integration of public-private partnerships into this proposed itinerary, however, will unlock increased flexibility in the efforts of public space agencies. In its three-phase plan, the GER identifies potential commercial opportunities only in missions to the Moon and its vicinity.<sup>36</sup> The GER recognizes the existing role of commercial actors in LEO, especially in the continued use of the ISS, but cites only the technologies of participating space agencies as the potential means to conduct human missions into deep space.<sup>37</sup> Each phase of the GER identifies a key step in the development of the capabilities to conduct missions to Mars, each building upon another in complexity to gain crucial knowledge and experience. While international collaboration will remain an essential precursor to sustainable human missions to the red planet, public-private partnerships will offer innovative solutions to support this sustained human presence.

In its first phase, the GER aims to preserve the ISS as an environment for research and technology testing. This phase of the plan remains consistent with many of its internationally defined goals, notably the development of exploration technologies that promote the advancement of earth and space science, and extend understanding of the effects of space on human health.<sup>38</sup> As the only currently operational phase of the GER, the ISS enables its visitors to gain unique insights into the current capabilities of humans in space. The Station has become a platform upon which various actors in space can conduct research and simulate long-term travel through space.<sup>39</sup> Consequently, sustained operation of the ISS has revealed the benefit of maintaining common objectives between international collaborators; its construction and continual evolution as a preparatory environment for deep space travel materialized through integrated international efforts. Since 2011, however, NASA has relied on contracts with private space companies to sustain its scientific presence on the ISS. Through new SAAs, NASA has revealed the importance of the private

sector in space, as its partnerships have spurred a continuous cycle of innovation that can meet the GER's plans for continued use of the ISS. This new network of public-private partnerships will facilitate NASA's efforts to send humans to the ISS while enabling the agency to pursue the progressively complex goals of the GER. Ultimately, the commercial space sector, with NASA as its main customer, is becoming the foundation of this international plan to reach Mars, as it assumes increasing responsibility for U.S. missions to the ISS.

Public-private partnerships remain similarly important in the subsequent phases of the GER. The international plan advocates for an expansion of the synergy between human and robotic missions to "increase the unique contribution of each to achieving exploration goals."<sup>40</sup> Robotic missions will therefore continue the pursuit of knowledge about the solar system before humans reach uncharted destinations. Gaining access to space through robotic missions can generate fundamental knowledge of the future locations of human space flight. This knowledge-generation facilitates the safety of human explorers while providing key preparatory insight to help guide formulation of future human missions to new destinations. Findings from these robotic missions can significantly affect the confidence with which public-private networks conduct future missions to the lunar surface, and eventually to Mars. When paired with the experience of sustaining a human presence on the ISS, robotic missions around and upon the Moon may become the next foundational step towards manned missions to Mars.

With a variety of robotic missions planned for the lunar surface in the coming decade, the role of maturing private space companies grows in importance. The cost-effective and innovative developments of the United States' commercial space sector have revealed the benefit of shifting responsibility from NASA and assigning routine missions to private companies. This planned proliferation of unmanned reconnaissance missions, that provide a constant stream of information about future destinations for humans, can serve as a model for the robotic exploration phase of the GER. The repeatability of these robotic missions is highly compatible with the efficient efforts of private companies, and enables public space agencies to conduct these foundational operations at a lower cost. While these partnerships enhance the flexibility of space agencies to act within limited budgets, they also enable private companies to gain the



hands-on experience that will be essential to conducting missions to Mars. As a result, robotic missions not only advance the readiness of space agencies, as the GER projects, but also prepare private partners for their transition to conducting increasingly complex routinized missions.

### *Empowering Exploration into Deep Space*

The knowledge gained through robotic missions facilitates the next phase of the GER and the next step on the journey to Mars: Human exploration beyond LEO. Similar to the integrated international effort to develop the capabilities to sustain a human presence on the Moon, NASA's Moon to Mars plan considers a robust human transport system to the lunar surface a precursor to missions to Mars. NASA's Artemis program aims to return humans to the Moon by 2024 through the development of a lunar station in orbit, Gateway, followed by sustainable human missions to the lunar surface.<sup>41</sup> This goal of establishing a permanent presence on the Moon, a potential model for future missions to Mars, depends upon the continued partnership between NASA and private companies. Without the efficient services of the commercial space sector, NASA's commitment to sustain the human presence on the ISS restrains the agency from exploring beyond LEO. By shifting its LEO responsibilities to private companies through new SAAs, NASA gains the freedom necessary to pursue its goals on the Moon and further into deep space. Consequently, as NASA leads the international effort to sustain humanity on the Moon and develop the capabilities to reach Mars, the efficiency and flexibility of private space companies will become a central part of the journey to the red planet. The GER defers the definition of missions to deeper space to the future, citing the importance of new discoveries and sustainable technologies to reach Mars.<sup>42</sup> Private space companies will come to define these deep space missions as they efficiently routinize the tasks previously reserved for public agencies and prepare to assume the eventual role of sustaining a human presence on Mars.

Artemis marks significant progress along the GER, as it supports the plan for robotic exploration of the Moon, followed by manned-missions to the lunar surface. The program harnesses widespread international collaboration to create a safe, sustainable, and efficient system for lunar exploration. At the crux of Artemis, NASA's Space Launch System (SLS) and Orion capsule will provide the power to carry astronauts and essential cargo beyond LEO and, with future upgrades, to Mars.<sup>43</sup> SLS, according to

NASA, is the only rocket capable of carrying astronauts and large cargo to the Moon on a single mission.<sup>44</sup> Built by the United Launch Alliance, a collaborative partnership between Boeing and Lockheed Martin, SLS is a product of traditional costs-plus agreements.<sup>45</sup> Its increasing budget and slipping first launch date reveal the potential disadvantages of these limiting contracts, especially without the competitive pressures inherent in new SAAs. SLS, however, is not the only heavy-lift rocket currently in development; SpaceX and Blue Origin, for example, are each constructing systems to compete with SLS. SpaceX's Starship is a fully reusable transportation system set to carry crew and cargo to earth orbit, the Moon, and Mars.<sup>46</sup> Blue Origin is developing New Glenn, a semi-reusable rocket that will conduct routine missions to LEO and beyond.<sup>47</sup> The National Aeronautics and Space Administration's efforts to build the capability to explore further into space are followed closely by private companies that match, if not supersede, the power and efficiency of SLS. This step outside public-private partnerships through SAAs back into the traditional model of cooperation may enable NASA to exert greater control over its initial flights to the Moon and Mars, but reveals the efficiency with which private companies can operate. While NASA may refrain from entering new SAAs with companies like SpaceX or Blue Origin for its flagship missions beyond LEO, the presence and continued efforts of private space companies will become essential to sustaining the presence established by SLS. The efforts of the commercial space industry are not contradictory to, but complementary of NASA.

Despite its inefficiency and relative lack of reusability, SLS has stimulated an internationally collaborative building process that will serve as the foundation of a human presence in space, sustained by public-private partnerships. In addition to facilitating the realization of the GER, NASA's efforts also continue to advance United States National Space Policy, as amended by Space Policy Directive 1 of December 2017. Under this presidential directive, NASA will "Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system."<sup>48</sup> Space Launch System will certainly provide the future capability for the United States to extend its presence beyond LEO, but the confluence of the accomplishments of private companies with the pioneering missions of NASA through new SAAs is similarly essential. In addition to its recent launch of NASA astronauts to the ISS, SpaceX, since 2012, has flown eighteen resupply

missions to the ISS for NASA under the C3PO.<sup>49</sup> The company's cost-effective services, bolstered by the reusability of its rockets, have enabled NASA to maintain its research efforts in space by reducing its spending on missions to the ISS. Boeing is currently testing its CST-100 Starliner spacecraft, competing directly with SpaceX to send astronauts to the ISS.<sup>50</sup> Despite the vehicle's failed orbital flight test in December 2019, its eventual operation will not only provide NASA another vehicle to power its efforts to maintain the American presence in space, but will spark competition with SpaceX that propels innovation.<sup>51</sup> These efforts will continue to transform the United States space program as it regains the ability to launch humans and cargo to the ISS. Crucially, as private companies assume responsibility for missions to the ISS and other locations within LEO, NASA can dedicate a larger part of its budget to SLS and deep space exploration to continue along the GER. This model of commercial reinvigoration of the United States space program provides a seminal framework for exploration beyond LEO that applies to NASA's current mandate and the GER.

As the commercial space sector continues to sustain NASA's presence on the ISS, the agency can dedicate its efforts to preparing SLS for missions to the Moon. By extension, once Gateway and manned missions to the lunar surface prove feasible, NASA can shift these missions to the private sector whose vehicles will provide a routine, affordable manner to sustain a human presence on and around the Moon. The significantly reduced cost of public-private missions to the Moon through new SAAs will enable NASA to pivot its resources to preparing SLS for travel to Mars. Meanwhile, private space companies can continue to build upon their experience conducting routine flights to the ISS with insight into the effects of prolonged travel through space on both vehicles and human passengers. First with its pioneering experience returning humans to the ISS and the Moon, then with the increased flexibility for development of SLS afforded to it by the innovation of private companies, NASA will conduct the first manned missions to Mars. Moreover, as private companies begin to conduct routine missions to the Moon as NASA invests in Mars, the allure of efficiency will allow the commercial sector to apply its accumulated experience in space to sustaining humanity on the red planet.

## Reaching New Heights Together

Predicated upon tightly integrated international cooperation and agreements with the commercial space sector, NASA can follow the GER and United States space policy to extend the reach of humanity. When paired with the push for collaboration among national space agencies by current United States space policy, however, the international nature of the GER reinforces the characterization of space as a place for nation-states. While this nation-based cast remains consistent with the terms of the OST, it consequently questions the legitimacy of private companies acting in space. Article IX of the OST holds that actors in space should “conduct all their activities in outer space... with due regard to the corresponding interests of all other states.”<sup>52</sup> Some states party to the agreement may neglect to recognize private entities as legal actors in space, thereby threatening the practicability of conducting progressively complex and expensive missions on behalf of national space agencies. The commercial space industry will necessarily seek dedicated support from sponsoring governments, as it prepares to launch missions deeper into space, to ensure protection for its activities from states less receptive to the growing role of private companies.

By establishing a pattern of public proof-of-concept missions followed by a shift to the private sector to sustain an extended human presence in space, public-private partnerships enable companies to gain the experience necessary for progressively complex missions. This cooperative succession will progressively construct the sense of confidence sought by space companies as they interact in a traditionally state-dominated environment. By conducting the first missions beyond LEO and eventually to Mars, public space agencies may dilute some of the uncertainty with which the commercial space industry would have to cope as it attempts to transition into its leading role.<sup>53</sup> The reinforcing relationship between public space agencies and private space companies, furthered by the cooperation between such agencies along the GER, will confirm the commercial space industry’s integrity as it works to extend humanity throughout the solar system.

By signaling the importance of international collaboration on the journey to Mars, the GER can serve as a stable foundation of the confidence the commercial space industry seeks before dedicating its resources to

sustaining a human presence in space. Public-private partnerships will further support the efforts of the space sector, as space agencies become a liaison for private companies operating in the traditionally state-run environment. The tight integration between the commercial space industry and NASA, for example, will enable companies to act on behalf of the United States as a proxy for the efforts of the agency. States can increase the efficiency of their activities, private companies can protect their profits, and humans will explore unprecedented distances because of this cooperation. Ultimately, public-private partnerships through new SAAs allow private companies to become an extension of the state. Through the innovative technologies of the commercial space industry that increase the efficiency of space travel, these partnerships will enable sponsoring state agencies to further the internationally shared goal of creating a sustained human presence in deep space.

### *Protecting Public-Private Progress*

The importance of public-private partnerships to reaching Mars, through the ISS and the Moon, will prevent a return to the dualistic nature of space that prompted the first missions to the lunar surface. A globally shared excitement for exploration has supplanted the competitive race to space, and private companies have become the key to this transformation, revealing innovative technologies that paint a view of a future where humanity is multiplanetary. Public-private partnerships capture this excitement; space agencies are recognizing the revolutionary role of private companies that are creating cost-effective and capable vehicles to reach unprecedented distances. While space agencies may still choose to conduct the pioneering missions to new locations alone, they can do so knowing the rapid efforts of private companies will readily make these flagship missions repeatable and efficient. National space agencies will find the freedom to devote their limited resources to developing these novel missions because private companies can quickly fill the gap with routinized missions to previously established destinations.

It is through this pattern of succession that private companies will gain the experience required to take on the challenge of sustaining humanity on Mars. Public-private partnerships, consequently, inhibit the characterization of space as a conquerable territory for one nation over all others. They promote a global sense of exploration, represented by the GER, in which the efforts of states and companies alike are mutually

dependent. In fact, private missions to the Moon and Mars may further ameliorate concerns of a return to a competitive space race mentality by effectively preventing countries from pursuing sovereignty in space and ignoring the terms of the OST. This multifaceted view of space, however, presents some difficulty in the application of the OST, for the era of public-private exploration of the Moon and Mars remains unprecedented.

By maintaining the state as the primary actor in space, the OST presents various obstacles to the successful realization of the GER and the exploration goals of the United States. Consistent with its effort to curb the militarization of space, the OST prohibits states from claiming sovereignty of any celestial body, including the Moon and Mars. While the OST recognizes the activities of non-governmental entities as legitimate if granted “authorization and continuing supervision by the appropriate State Party,” it falls short of protecting the public-private partnerships that will enable sustainable exploration into deep space.<sup>54</sup> A sense of security, as discussed above, in the tumultuous environment of outer space becomes increasingly salient as private companies assume greater responsibility for the tasks proven feasible by public space agencies. Private companies will seek a semblance of protection for their efforts and the significant costs they require, a safety net that the OST does not provide. Will companies claim the territory they explore and the resources they uncover on Mars to sustain its growing human population? Alternatively, will celestial bodies remain intangible destinations, benchmarks for the state of technology? The answers to these fundamental questions remain absent from the OST, but the model of public-private partnerships presented herein may guide the interested parties to a solution.

## Conclusion: Preparing for a Multiplanetary Future

The National Aeronautics and Space Administration’s efforts to integrate with the commercial space industry through new SAAs, like the COTS program, emphasize its dependence on the private sector to support its efforts in deep space. Because of the increasing presence of private actors on the ISS, and the many developing systems to reach the Moon and Mars, the commercial sector is becoming an increasingly familiar presence in space. By facilitating these private efforts, NASA not only drives the development of efficient methods to sustain the human presence in space

but also legitimizes private space companies as important stakeholders on the global journey to extend humanity's reach.

The United States' Commercial Space Launch Competitiveness Act of 2015 further supports the growing role of private space companies in the achievement of international exploration goals. The Act, in an effort to spur competition and innovation in the commercial space industry, "Discourages government barriers to the development of economically viable, safe, and stable industries... for commercial recovery of space resources."<sup>55</sup> By facilitating the growth of the industry, the United States government confirms the importance of the innovative and efficient developments of private space companies. The Act consequently deepens the confidence of the commercial space sector, asserting that private entities engaged in commercial exploration of space are entitled to any "space resource obtained, including to possess, own, transport, use, and sell."<sup>56</sup> By ensuring that this commercial capability does not equate to a claim of national sovereignty in space by the United States, the Act remains consistent with the OST. The consequent confidence the Act affords private companies, however, opens a new dimension of profitability accessed through routine missions that sustain humanity's expanded presence in space. As a policy that supports the profit-oriented activities of the commercial space sector, the Space Launch Competitiveness Act facilitates the industry's growth. The Act contributes to the sense of confidence that deepens cooperation between space companies and NASA, while permitting the United States government to maintain its commitment to the OST.

Through its innovative technologies, the private sector will "advance the readiness of partners for Mars surface missions," by sustaining an advanced presence on the ISS and the Moon that enables the generation of knowledge to support missions into deep space.<sup>57</sup> Ultimately, private companies offer NASA and other space agencies the opportunity to move closer to their goal of enabling sustainable human space exploration and, consequently, spur continued investment in the industry in the form of public-private partnerships. This reciprocal relationship provides a semblance of certainty and security for private companies, as public agencies largely rely on the safe and efficient products of these companies to meet their goals. The nature of public-private partnerships, further detailed by the Space Launch Competitiveness Act of 2015, provides a brief

answer to the role of private companies in space that lies outside of the ambiguous terms of the OST. Countries may accept this response because the benefits of defaulting to the private sector for routine missions to space will become increasingly visible, especially as public space agencies that embrace these partnerships reach unprecedented distances.

As manned missions to Mars shift into the domain of the commercial space industry, the acknowledgement of a new normative system may further solidify private companies as legitimate actors in space. The continued progress of companies like SpaceX, Blue Origin, and Boeing reveal to the world the increasingly seminal role of the commercial space industry in the United States space program. As these companies and others provide routine services for NASA to the ISS and, eventually, to the Moon and Mars, the potential to establish international precedent emerges. If countries accept the growing role of private space companies to meet the global goals of human exploration, eventual public-private missions to Mars can establish precedent that further legitimizes the central role of the commercial space sector. The OST, consequently, may no longer apply to states that continue to divest themselves from activities in space and support the efforts of non-state actors in a commercial environment. Rather, a multifaceted network of international cooperation has supplanted the dualistic competition that once fueled early missions to space and prompted acceptance of an agreement to equalize the environment for all nations. This shared goal between nations reveals the significance of the innovative efforts of private space companies working to support a unified objective in space. As international norms continue to develop within this new phase of international cooperation, the stage is set for the revolutionary technologies of the commercial space sector to sustain a multiplanetary species. Through a tight systematic integration between public space agencies and private space companies, humanity will reach great distances.

## Endnotes

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