Megatrends Paper 2015-02

The New Space Race: Competition for Lunar Resources

Background

The original "space race" – the Cold War-era competition between the United States and Soviet Union – resulted in dozens of manned and unmanned missions in the 1960s and '70s. The purpose of these ventures had less to do with the Moon itself, than with demonstrating national prestige and technical superiority. This rivalry spurred investments in science, technology, engineering, and mathematics education in the US, and produced many breakthroughs that directly and indirectly benefited both national security and civilian society. Then, almost as quickly as it began, the space race was over. The US and USSR pursued détente, symbolized by the cooperative Apollo-Soyuz test project in 1975. Apart from a few unmanned scientific missions by the US National Aeronautic and Space Administration (NASA), neither country has ventured to the Moon since 1976.

Even before the first manned Moon landing, 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* – better known as the "Outer Space Treaty" – provided the basic framework for international space law. This United Nations accord declares the Moon "is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means," and holds states responsible for national space activities, "whether such activities are carried on by governmental agencies or by non-governmental entities." Furthermore, the treaty calls for the Moon to be used "exclusively for peaceful purposes," and forbids the establishment of "military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres." Finally, it bars the placement of nuclear weapons or other weapons of mass destruction in Earth orbit, on celestial bodies, or in outer space.[1]

A follow-on "Moon Treaty" – the 1979 *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* – attempted to establish a more rigorous lunar legal framework. It declares the Moon and its natural resources are "the common heritage of mankind," and calls for the establishment on "an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon "as such exploitation is about to become feasible." It specifically outlaws

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[1] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (http://www.unoosa.org/oosa/en/SpaceLaw/outerspt.html)

NOTE: This is the latest in a series of "Megatrends" papers produced by the Joint Information Operations Warfare Center (JIOWC) Information Operations Futures Working Group (IOFWG). It is the result of literature review/analysis and the expert insights and opinions of team members. The subject matter deals with potential issues which may arise in the future, and thus is necessarily speculative. The paper is meant to highlight issues specific to IO which may not have been raised previously, for the consideration of IO practitioners, leaders and decision makers.

property ownership on the lunar surface and subsurface, and requires states to inform the UN of any stations they establish on the Moon.[2] However, the US never signed this treaty, and no other space-faring nation has ratified it, leaving the question of lunar property rights in legal limbo.

Returning to the Moon

Since the end of the Cold War, several nations have demonstrated the capability to reach the lunar surface. Japan (1993, 2009), the European Space Agency (2006), India (2008), and China (2009) have each crash-landed lunar orbiters or probes, while NASA has revisited the Moon several times (1998, 2009, 2012, 2014). In 2013, the Chinese Chang'e 3 rover conducted the first "soft" lunar landing in 28 years.[3]

The International Space Exploration Coordination Group (ISECG), a consortium of 14 national space agencies including those of the US, China, and Russia, is pursuing a coordinated effort to prepare for collaborative space exploration missions beginning with the International Space Station (ISS) and continuing to the Moon, near-Earth asteroids, and Mars. Their "Global Exploration Roadmap" projects manned missions to the lunar surface in the mid- to late-2020s, primarily as a staging area for future Mars missions. The 2013 report acknowledges," participating agencies recognize that the fundamental capabilities are available to support additional missions in the event that lunar science or other exploration activities are identified" – that is, pursuing commercial or other national interests on the Moon.[4]

In fact, several nations are pursuing such interests. Although the US has officially abandoned plans to return humans to the Moon by 2020,[5] both Chinese and Russian authorities have expressed interest in exploiting lunar resources, beyond the pursuit of local resources to support follow-on missions to Mars.[6] According to a recent study, the Moon possesses abundant raw materials of potential economic interest "to underpin a future industrial capability within the Earth-Moon system," and increasing access to lunar resources "may help 'bootstrap' a space-based economy from which the world economy, and possibly also the world's environment, will ultimately benefit."[7] Russia appears most keen on rare-earth

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[2] *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (http://www.unoosa.org/oosa/SpaceLaw/moon.html)

[3] The Planetary Society. Missions to the Moon webpage. (http://www.planetary.org/explore/space-topics/space-missions/missions-to-the-moon.html)

[4] International Space Exploration Coordination Group (ISECG). *The Global Exploration Roadmap*. 2013. (http://www.globalspaceexploration.org/wordpress/wp-content/uploads/2013/10/GER_2013.pdf)

[5] Chang, Kenneth. "Obama Calls for End to NASA's Moon Program." *New York Times*. February 1, 2010. (http://www.nytimes.com/2010/02/02/science/02nasa.html)

[6] Docksai, Rick. "Back to the Lunar Future." *The Futurist* Vol. 48, No. 5 (September-October 2014): 6-9 (http://www.wfs.org/futurist/2014-issues-futurist/september-october-2014-vol-48-no-5/back-lunar-future)

[7] Crawford, Ian A. "Lunar Resources: A Review." Accepted for publication in *Progress in Physical Geography*. (http://www.homepages.ucl.ac.uk/~ucfbiac/Lunar_resources_review_preprint_accepted_manuscript.pdf)

minerals, which may be more readily available on the Moon than in Russian territory.[8] The Chinese are also eyeing rare earth elements, as well as titanium, uranium, and helium-3 (^{3}He), a potential fuel for nuclear fusion.[9] Both countries are planning multiple robotic soft-lander and sample return missions (Luna-25/26/27, Chang'e 4/5/6) in the next few years. While NASA remains focused on asteroids and a future mission to Mars, China, in particular, may pose a serious challenge to US leadership in lunar exploitation.[10]

In addition to such state-sponsored efforts, commercial space flights are also headed to the Moon. The Google Lunar XPRIZE is a $30 million competition to land a privately funded robot on the Moon by the end of 2016. Two US-based companies, Astrobotic Technologies and Moon Express, have already claimed milestone prizes,[11] and both are participating in NASA's Lunar Cargo Transportation and Landing by Soft Touchdown (CATALYST) initiative to develop robotic lunar lander capabilities that could deliver payloads to the surface of the moon.[12] LiftPort, another US startup, has proposed constructing an "elevator" on the Moon by around 2025 to cheaply transport cargo and passengers to and from space.[13] Moon Express's billionaire co-founder, Naveen Jain, has concluded that, when it comes to space exploration, "it's clear that the baton has been passed from the government to the private sector."[14]

Ironically, one of the most potentially profitable space resources is simple ice. "Much like gold opened the West, lunar water will open space like never before," declares Shackleton Energy Company,[15] which has proposed the launch of a low-Earth orbit "gas station" offering hydrogen and oxygen fuel derived from Moon ice.[16] Near-Earth objects such as asteroids and comets are another potential source of such ice deposits, which by 2027 could provide drinking water for astronauts and space tourists; shielding from solar radiation and cosmic rays; and on-orbit fuel, reducing launch costs up to 90 percent. While products of asteroid metal mining are not forecast to return to Earth until at least 2033, the prospect of their arrival will likely drive down prices sooner, spurring new uses and technological development.[17] Lunar mining ventures would have a similar impact on futures markets.

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[8] Jamasmie, Cecilia. "Russia pushes forward plans to mine the moon." *Mining.com*. October 28, 2014. (http://www.mining.com/russia-pushes-forward-plans-to-mine-the-moon-13769/)

[9] Shukman, David. "Why China is fixated on the Moon." *BBC.com*. November 29, 2013. (http://www.bbc.com/news/25141597)

[10] Howell, Elizabeth. "New Space Race? US Eyes Asteroids as Other Nations Shoot for the Moon." *Space.com*. July 23, 2014. (http://www.space.com/26613-manned-moon-missions-china-russia.html)

[11] Google Lunar XPRIZE website (http://lunar.xprize.org/)

[12] Lunar CATALYST website (http://www.nasa.gov/lunarcatalyst/)

[13] Szondy, David. "LiftPort plans to build space elevator on the Moon by 2020." *Gizmag.com*. August 27, 2012. (http://www.gizmag.com/lunar-elevator/23884/) (http://www.space.com/24905-moon-elevator-lunar-exploration-liftport.html)

[14] Caminiti, Susan. "Billionaire Teams Up With NASA to Mine the Moon." *NBCNews.com*. March 10, 2015. (http://www.nbcnews.com/science/space/billionaire-teams-nasa-mine-moon-n321006)

[15] Shackleton Energy Company website (http://www.shackletonenergy.com/overview/#goingbacktothemoon)

[16] David, Leonard. "Futuristic Moon Elevator Idea Takes Aim at Lunar Lifts." *Space.com*. March 4, 2014. (http://www.space.com/24905-moon-elevator-lunar-exploration-liftport.html)

[17] Callaway, Kurt. "The Future of Harvesting Space Resources." Houston Foresight presentation at the WorldFuture 2014 conference. July 11-13, 2014.

The biggest game changer, however, is likely to be helium-3. Carried from the Sun into outer space by the solar wind, helium-3 is abundant on the Moon but rare on Earth as a result of our atmosphere and magnetic field. The lunar regolith is estimated to contain one million tons of helium-3, enough to meet current global energy needs here on Earth for five thousand years. It could theoretically replace fossil fuels and conventional nuclear fission in electricity production, with the potential for enormous environmental benefits, spectacular profits, and significant geopolitical influence for whoever controls the market. For now, however, commercially viable fusion energy production remains speculative. The International Thermonuclear Experimental Reactor (ITER), which features two hydrogen isotopes (deuterium and tritium), is expected to be fully operational by 2027, while third-generation helium-based (^{3}He-^{3}He) fusion may not be realistic until 2035 or later.[18]

If China or some other country corners the market for helium-3, they could substantially shift the economic balance of power here on Earth.[19] Moreover, this gaseous isotope could become an attractive fuel for nuclear weapons. Unlike the "dirty" fusion reaction produced by existing thermonuclear devices, the fusion of helium-3 with itself produces no neutron radiation. This not only makes electrical generation cleaner and safer than current nuclear fission techniques, it also could be used to make non-radioactive weapons with enormous destructive yields. Such armaments could challenge long-standing taboos on the employment of nuclear weapons.[20]

Implications of the New Space Race

The US may have won "bragging rights" to the Moon in the original space race, but "the countries or corporations that go there to stay will determine how the world closest to the Earth is developed." Whoever returns to this "new frontier" first "will establish what kind of political and social paradigm will be followed."[21] As various nations and corporations begin exploiting lunar resources, competition and conflict are likely to follow. In a December 2014 letter to Bigelow Aerospace, the US Federal Aviation Administration (FAA) reportedly indicated it intends to "leverage the FAA's existing launch licensing authority to encourage private sector investments in space systems by ensuring that commercial activities can be conducted on a non-interference basis." However, the letter noted US State Department concerns that "the national regulatory framework, in its present form, is ill-equipped to enable the US government to fulfill its obligations" under the UN Outer Space Treaty. The CEO of another space launch start-up concluded, "It's very much a wild west kind of mentality and approach

[18] Simko, Thomas and Matthew Gray. "Lunar Helium-3 Fuel for Nuclear Fusion: Technology, Economics, and Resources." *World Future Review* 6.2 (2014): 158-171.
[19] Bozzato, Fabrizio. "Moon Power: China's Pursuit of Lunar Helium-3." *TheDiplomat.com*. 16 June 2014. (http://thediplomat.com/2014/06/moon-power-chinas-pursuit-of-lunar-helium-3/)
[20] Mortier, Jan and Benjamin Finnis. "China Leads Race to the Moon." *TheDiplomat.com*. 7 January 2015. (http://thediplomat.com/2015/01/china-leads-race-to-the-moon/)
[21] Berger, Eric. "Adrift: Part 3." *Houston Chronicle*. July 13, 2014. (http://www.houstonchronicle.com/nasa/adrift/3/)

right now."[22] Without robust US leadership in this new space race, claims of domestic regulatory oversight are unlikely to carry much weight with foreign governments and corporations.

The failure of the UN Moon Treaty to implement an international regime for lunar exploitation suggests the potential for trouble ahead. Even if there were an effective regulatory regime in place, the US and other nations currently lack the ability to police activities or resolve disputes beyond low-Earth orbit, let alone to project military force to the Moon. Such capability may not prove necessary in the near to medium term, especially as any disputed lunar resources meant for use here on Earth could presumably be interdicted in transit, and the offending nation or corporation might face economic or other sanctions. However, over time the lunar landscape may become increasingly crowded and contentious, especially in the polar regions and other areas rich in "volatiles" (water, oxygen, etc.) or marketable minerals. An ambitious adversary could conceivably engage in aggressive actions on or near the Moon to secure a competitive advantage, without fear of reprisal in kind. Moreover, treaty obligations notwithstanding, an undefended Moon could be used as a military base, high ground from which to launch or threaten attacks on the Earth or its orbiting satellites – an eventuality predicted by science-fiction writer Robert Heinlein in his award-winning 1966 novel, *The Moon Is a Harsh Mistress*.

Effect on the Information Environment (IE)

By 2035, the physical dimensions of the IE will expand to the Moon and beyond. In addition to our traditional Russian rivals, the US will find itself competing or collaborating in space with China, India, Japan, South Korea, and other spacefaring nations, as well as with corporations seeking to exploit lunar resources for profit. Robotic landers will be joined by civilian space tourists and commercial mining ventures in an increasingly crowded moonscape.[23] Such lunar activity will require robust communications and command-and-control (C2) architectures, likely including a combination of Earth- and Moon-based infrastructure and orbiting satellites. These actors and nodes represent potential targets for future information operations (IO), as well as possible threats to US decision-making.

Implications for the Future Joint IO Force

The US risks ceding the lunar high ground to China or other challengers in coming decades. This could have serious implications for US foreign policy, potentially damaging US prestige and compromising national security interests. Furthermore, even if NASA remains disinterested in establishing a permanent presence on the Moon, US companies will be heavily engaged in exploiting lunar resources, raising expectations for legal, diplomatic, and even military support in the event of disputes. US joint force commanders engaged in space operations could require information-related capabilities such as Military

[22] Klotz, Irene. "Exclusive - The FAA: regulating business on the moon." *Reuters.com*. February 3, 2015. (http://www.reuters.com/article/2015/02/03/us-usa-moon-business-idUSKBN0L715F20150203)
[23] Callaway, Kurt. "The Future of Lunar Exploration – Baseline Scenario." Coursework for University of Houston *Futures Studies 6351* class. 10 December 2013.

Information Support Operations (MISO), Joint Electromagnetic Spectrum Operations (JEMSO), and cyberspace operations, as well as C2 and intelligence, surveillance and reconnaissance (ISR) capabilities. While current joint doctrine defines several mission areas (space control, space situational awareness, etc.) that would be relevant to such operations,[24] it does not specifically address the implications of military operations on or near the Moon.

To reduce the likelihood of future conflict, the US should develop a strategic communications plan addressing international competition for lunar resources. When the UN adopted the Moon Treaty more than three decades ago, opponents objected that designating the Moon and its resources as the "common heritage of mankind" would stifle free enterprise and investment.[25] Since then, however, the Cold War has ended, and the US is no longer the dominant global economic power or preeminent spacefaring nation. The need for some sort of framework to protect US economic and security interests on the Moon is more necessary now than ever. Consequently, the US should clarify its policy regarding lunar mineral and property rights, and pursue agreements with its ISECG partners on appropriate lunar activities. NASA, in partnership with the Department of Defense (DoD) and other agencies, should be prepared to establish an official, permanent US presence on the Moon. Furthermore, the US should carefully consider the implications for nuclear non-proliferation efforts of helium-3 as a fuel for nuclear weapons.

Findings for Further Action

Doctrine:

- D.1. Update JP 3-14 to introduce a new mission area for space operations on and near the Moon and other celestial bodies.

Materiel:

- M.1. Develop and field capabilities to conduct IO against potential target audiences on and near the Moon.

Policy:

- P.1. Clarify how US law, treaty obligations, international agreements, and law of armed conflict affect the conduct of IO and other DoD operations on and near the Moon and other celestial bodies.

- P.2. Support the development of US Government policies and strategic communications plans to reduce the likelihood of international conflict over lunar resources.

[24] Joint Publication 3-14, Space Operations. 29 May 2013.
[25] "L5 News: UN Moon Treaty Falling to US Opposition Groups." *National Space Society*. March 1982. (http://www.nss.org/settlement/L5news/1982-opposition.htm)

- P.3. Support the development of US Government policies and strategic communications plans to limit the use of helium-3 to fuel nuclear weapons by adversaries.