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14. ABSTRACT USSPACECOM and the USSF's primary area of responsibility is on military operations from the Kármán Line to Geosynchronous Orbit. It is a congested domain and USSPACECOM is tasked with providing combat power and support in this dynamic environment while the USSF provides the preponderance of forces to accomplish those missions. While critical, this mission relegates the new Combatant Command and Service as supporting commands to terrestrial-based entities and missions. This cannot be their sole focus, especially as commercial companies and adversarial nations try to exploit the multi-trillion-dollar economy that awaits. USSPACECOM and the USSF must begin investing in new cislunar missions, the area located between the Earth and Moon, such as Position, Navigation, and Timing (PNT) and Satellite Communications (SATCOM) to support and defend the US government and commercial economic and scientific missions.					
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Moonrush:

**How the USSF and USSPACCOM must Evolve their Missions to Support the Coming
Economy for Space Resources**



A paper submitted to the Faculty of the United States Naval War College, Newport, RI

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INTRODUCTION

A service must have a purpose larger than simply supporting another service...that complaint was one of the reasons why the US Army Air Corps demanded a different service.¹

To make cislunar space safe for economic exploitation for the benefit of humanity, the country first needs to establish the means to ensure military security in space.²

In the summer of 2019, the US government reestablished US Space Command (USSPACECOM) to deter conflict in, from, and through space, and if necessary, defeat aggression, deliver space combat power for the joint and combined force, and defend US vital interests with allies and partners.³ Months later, President Donald Trump signed into law legislation creating the US Space Force (USSF) to organize, train, and equip Guardians to conduct global space operations that enhance how our joint and coalition forces fight while offering decision-makers military options to achieve national objectives.⁴ To put it simply, the USSF provides the vast majority of forces that USSPACECOM uses for operations, just like the US Navy provides maritime forces to US Indo-Pacific Command (USINDOPACOM) or the US Air Force provides air forces to US Central Command (USCENTCOM). According to

¹ Joshua P. Carlson, *Spacepower Ascendant: Space Development Theory and a New Space Strategy*, 2020, 6.

² Theresa Hitchen, "Flag Follows Trade," *To Boldly Go: Leadership, Strategy, and Conflict in the 21st Century and Beyond*, 2021, 130.

³ "United States Space Command Organizational Fact Sheet," *United States Space Command*, accessed August 29, 2019, <https://www.spacecom.mil/Portals/32/USSPACECOM%20Fact%20Sheet%2018Jun20.pdf?ver=2020-06-18-155219-363>.

⁴ "United States Space Force Mission," *United States Space Force*, accessed April 5, 2023, <https://www.spaceforce.mil/About-Us/About-Space-Force/Mission/#:~:text=USSF%20Mission,options%20to%20achieve%20national%20objectives>.

astrophysicist Neil deGrasse Tyson, “Interplanetary space is the next arena where the soft power of technological bravado, augmented by the lure of unlimited resources, urges us to take flight.”⁵ Namrata Goswami and Peter Garretson refer to this lure of unlimited resources as a “Scramble for Resources.”⁶ This unfamiliar environment of space prospecting, mining, collection, and delivery is where the US and its allies are headed. It is the US military’s job to defend those vital interests and ensure security in space.

Currently, USSPACECOM and the USSF’s primary area of responsibility is on military operations from the Kármán Line, 62 miles from the surface of the Earth, to Geosynchronous Orbit, roughly 22,000 miles above the surface of the Earth. In 2022, 6,905 active satellites were orbiting the Earth.⁷ These satellites include US military, commercial, as well as adversary satellites. It is a congested domain and USSPACECOM is tasked with providing combat power and support in this dynamic environment while the USSF provides the preponderance of forces to accomplish those missions. While critical, this mission relegates the new Combatant Command and Service as supporting commands to terrestrial-based entities and missions. This cannot be their sole focus, especially as commercial companies and adversarial nations try to exploit the multi-trillion-dollar economy that awaits harvesting.⁸ USSPACECOM and the USSF must begin investing in new cislunar missions, the area located between the Earth and Moon, such as Position, Navigation, and Timing (PNT) and Satellite Communications (SATCOM) to support and defend the US government and commercial economic and scientific missions.

⁵ Neil deGrasse Tyson and Avis Lang, *Accessory to War: The Unspoken Alliance Between Astrophysics and the Military*, 2018, Loc 6682.

⁶ Namrata Goswami and Peter Garretson, *Scramble for the Skies: The Great Power Competition to Control the Resources of Outer Space*, 2020, 20.

⁷ “Number of active satellites from 1957 to 2022,” *Statista.com*, accessed April 17, 2023, <https://www.statista.com/statistics/897719/number-of-active-satellites-by-year/#:~:text=This%20statistic%20illustrates%20the%20number,active%20satellites%20on%202021's%20value>.

⁸ Goswami and Garretson, 47.

General Jay Raymond, the first Chief of Space Operations, put it perfectly stating, “It is our responsibility to maintain US advantages in space. If and when that extends beyond the Geosynchronous Belt, we will go beyond as needed.”⁹ The USSF and USSPACECOM must be prepared when this time comes.

TREATIES, ACTS, AND ACCORDS OH MY!

*As important treaties reach a certain age, the context in which they operate becomes different from the one in which they were conceived.*¹⁰

One crucial topic concerning resource mining in space is the legality behind such operations. In the past, the topic of resource mining was taboo due to international treaties limiting national appropriation of the celestial bodies themselves, to include the Moon. The wrong message would be sent to our allies and adversaries if USSPACECOM and the USSF supported illegal commercial mining activities that ran counter to recognized international standards. This section will examine three agreements to determine the position of the US on space mining, the legality behind corporations claiming ownership of the resources collected, and how the USSF and USSPACECOM can support those operations.

⁹ Theresa Hitchens, “How ‘The Expanse’ Is A Cautionary Tale for Real World Space Commercialization,” *Breaking Defense*, October 15, 2021, <https://breakingdefense.com/2021/10/how-the-expanse-is-a-cautionary-tale-for-real-world-space-commercialization-excerpt/>.

¹⁰ *Yearbook of the International Law Commission 2008* (United Nations 2008) vol II (2), Annex I, 154, para 14., https://legal.un.org/ilc/publications/yearbooks/english/ilc_2008_v2_p2.pdf.

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 (OST)) of 1967

The OST was the first treaty to mandate that outer space shall only be used for peaceful purposes. There are currently 113 parties to the treaty, including the US, Russia, and China.¹¹

Article II of the treaty is the most important concerning resource mining, dictating that Outer Space includes the Moon and other celestial bodies, and are not subject to national appropriation by any such claim of sovereignty, occupation or by any other means.¹² While the treaty forbids nations and states from claiming sovereignty over the Moon, the treaty does not explicitly address corporations or the resources on the Moon and other celestial bodies.

US Commercial Space Launch Competitiveness Act (CSLCA) of 2015

The objective for US policymakers regarding space should be to create policies and laws that will encourage the private economic development of space.¹³ The first step was the creation of the CSLCA, which allows US citizens and commercial companies to engage in the exploration and exploitation of space resources. It states, “a US citizen engaged in commercial recovery of...a space resource...shall be entitled to any...space resource obtained, including to possess, own, transport, use, and sell the...space resource obtained per applicable law.”¹⁴ This law has been viewed internationally as a challenge to the OST because it has a different interpretation of sovereignty or the ownership of natural resources found on a celestial body versus the actual body itself. The International Institute of Space Law (IISL) addressed the act,

¹¹ "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," United Nations Office for Disarmament Affairs, April 3, 2023, https://treaties.unoda.org/t/outer_space.

¹² Amanya Shree Gangawat, “Re-exploring Terra Nullius and Property Rights in Space: Could a Lunar Settlement Claim the Lunar Estate?” *Advanced Space Law*, Volume 6, 2020, 17.

¹³ Brandon J. Weichert, *Winning Space: How America Remains a Superpower*, September 15, 2020, (Alexandria, VA), 308.

¹⁴ US Commercial Space Launch Competitiveness Act, Section 402, Pub. L. No. 114-90, 129 Stat. 704 (2015), <https://www.congress.gov/114/plaws/publ90/PLAW-114publ90.pdf>.

siding with the US interpretation of the OST, and found the CSLCA legal. “In the view of the absence of clear prohibition of the taking of resources in the OST, one can conclude that the use of space resources is permitted.”¹⁵ This law by US policymakers shows a pivot from space exploration to space exploitation as commercial companies now have the technology to venture into space.

Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of The Moon, Mars, Comets, and Asteroids for Peaceful Purposes 2020

In terms of continuing the legacy of the OST and furthering the CSLCA on the international level, the Artemis Accords aim to refine and implement sections of the OST and CSLCA. They are a set of guidelines intended to foster best practices for the human exploration of celestial bodies, including the utilization of space resources and the sustainable use of outer space.¹⁶ One of the key provisions of the accords, supported by both scholarly literature and international lawyers, is that the extraction of space resources does not inherently constitute national appropriation.¹⁷ While eight separate nations support the US accords, acceptance is not universal. In the UN, countries like Russia and China have objected saying, “The unilateral action of individual States to promote their national private commercial interests or to allow the flag of convenience approach for corporate structures to exploit outer space resources is

¹⁵ International Institute of Space Law, Position Paper on the Space Resource Mining Adopted by consensus by the Board of Directors, December 20, 2015, <https://iislweb.space/wp-content/uploads/2020/01/SpaceResourceMining.pdf>.

¹⁶ *Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of The Moon, Mars, Comets, and Asteroids for Peaceful Purposes*, October 13, 2020, Preamble, para 5, <https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf>.

¹⁷ Rossana Deplano, “The Artemis Accords: Evolution or Revolution in International Space Law?” *International and Comparative Law Quarterly*, Vol 70, Issue 3, July 2021, <https://www.cambridge.org/core/journals/international-and-comparative-law-quarterly/article/artemis-accords-evolution-or-revolution-in-international-space-law/DC08E6D42F7D5A971067E6A1BA442DF1>.

unacceptable.”¹⁸ This view has not prevented the US or like-minded allies from continuing with the accords.

The US transitioned its outlook and strategy concerning space resources in the 53 years from the OST's ratification in 1967 to the signing of the Artemis Accords in 2020. This view has been accepted by international lawyers and signed by partners and allies. While the US's adversaries continue to claim that US actions in space are increasingly militaristic and dangerous, this should not deter US commercial companies from pursuing these resources. To enable the safety of these operations, the USSF and USSPACECOM have the fundamental responsibility to protect America's interests in space and therefore have to be the architects and designers of the space architecture and infrastructure that maximizes US power.¹⁹

IN 238,900 MILES, YOU HAVE ARRIVED AT YOUR DESTINATION

*NASA and its partners are returning to the Moon for good and they will need navigation capabilities for a sustainable presence on the Moon*²⁰

The impact of space-based PNT technology, more commonly called the Global Positioning System (GPS), is hard to grasp. Reports estimate that since the 1980s, GPS satellites have been crucial for synchronizing data networks and financial systems, which have helped generate nearly \$1.4 trillion in economic benefits.²¹ As the commercial Moonrush for resources takes off, a PNT mission must be implemented to facilitate accurate landing locations, navigate

¹⁸ “Report of the Legal Subcommittee on its Fifty-Sixth Session, April 18, 2017, UN Doc A/AC.105/1122. 33, para 250. <https://conferences.unite.un.org/dcpms2/api/finaldocuments?Language=en&Symbol=A/AC.105/1122>.

¹⁹ Jason Joll and Josh Gonzalez, Interview with Peter Garretson, Spacepower - Resources in Space and Great Power Competition, podcast audio, March 14, 2023, <https://www.dvidshub.net/audio/73008/spacepower-resources-space-and-great-power-competition-with-peter-garretson>.

²⁰ Lori Keesey, “NASA Eyes GPS at the Moon for Artemis Missions,” *NASA*, June 28, 2019, <https://www.nasa.gov/feature/goddard/2019/nasa-eyes-gps-at-the-moon-for-artemis-missions>

²¹ “A Brief History of GPS,” *Aerospace*, April 5, 2023, <https://aerospace.org/article/brief-history-gps>.

prospecting missions, and provide a common timing source for all lunar operations. Such a capability would provide navigational solutions to astronauts and ground controllers operating the spacecraft and space stations orbiting the Moon and lunar surface missions.²² Creating this architecture would be the first step in protecting US interests on the Moon.

The Moon spins on its axis once each time it orbits our planet. In other words, Earth's people only see one side of the Moon. This is key in creating a GPS constellation for cislunar operations, Lunar GPS or L-GPS. First, with one side of the Earth always having a line-of-sight (LOS) with the Moon, ground stations on the Earth can support cislunar PNT missions. Second, any operations on the Moon's far side or at the poles would be invisible from Earth. The challenge is that these locations are ideal for resource prospecting and operations while not being in the direct LOS of the Earth for support.²³ Spacecraft and personnel on the far side of the Moon would have to rely on L-GPS satellites to provide them with PNT. If not, they would need to contact relay satellites to receive the signals from Earth ground stations or GPS satellites orbiting the Earth. In 2024, NASA plans to launch a Lunar PNT experiment that will send a receiver to the lunar surface capable of picking up weak signals from two major PNT networks: the US's GPS and the European Union's Galileo.²⁴ In 2025, NASA is also launching a Moon orbiter with a PNT receiver on board, able to determine its location with an accuracy of less than 100 meters.²⁵ These are the first steps in developing a hybrid architecture for PNT operations on the

²² Keesey.

²³ Lihua Zhang, "Development and Prospect of Chinese Lunar Relay Communication Satellite," *Space: Science and Technology*, Vol 2021, April 27, 2021, <https://downloads.spj.sciencemag.org/space/2021/3471608.pdf>.

²⁴ Kristin Houser, "NASA and ESA are Racing to Bring GPS to the Moon," *Freethink*, January 9, 2023, [https://www.freethink.com/space/satnav-](https://www.freethink.com/space/satnav-Moon#:~:text=The%20LuGRE%3A%20In%202024%2C%20NASA,Galileo%20%E2%80%94%20to%20the%20lunar%20surface.)

[Moon#:~:text=The%20LuGRE%3A%20In%202024%2C%20NASA,Galileo%20%E2%80%94%20to%20the%20lunar%20surface.](https://www.freethink.com/space/satnav-Moon#:~:text=The%20LuGRE%3A%20In%202024%2C%20NASA,Galileo%20%E2%80%94%20to%20the%20lunar%20surface.)

²⁵ Houser

Moon, starting with terrestrial transmitters from the Earth and then cislunar orbit satellites, missions both the USSF and USSPACECOM are intimately familiar.

Today, the USSF, through the 22nd Space Operations Squadron (22 SOPS), commands the Satellite Control Network (SCN), a system of 19 antennas worldwide. This system allows all DoD satellites to transmit state-of-health updates and maneuvers while allowing operators to download mission data. All operations are deconflicted with mission taskings through USSPACECOM. To support cislunar operations, antenna modifications and upgrades would be required to transmit PNT signals to the Moon. Additionally, mission taskings would need to be updated and deconflicted through USSPACECOM to support both cislunar and Earth-orbiting missions. Once completed, 22 SOPS would be positioned to support cislunar PNT missions from Earth.

The second part of the hybrid architecture centers on cislunar orbital assets. For Earth, the GPS mission is organized, trained and equipped by the USSF's 2 SOPS, while the planning and executing of PNT operations are done by the Joint Navigation Warfare Center (JNWC) under USSPACECOM. Currently, the USSF operates 31 satellites, improving PNT performance in most parts of the world.²⁶ Because the Earth and Moon's orbits are similar, creating a L-GPS constellation would be relatively easy due to similarities in orbits. The problem would be the cost to build and launch these satellites, with each satellite costing roughly \$238M.²⁷

As commercial companies start exploring the Moon, a cislunar PNT system will be critical for any cislunar operations. Precise mapping data will help operations track their

²⁶ "Space Segment," *GPS.gov*, accessed April 17, 2023, <https://www.gps.gov/systems/gps/space/>.

²⁷ Greg Avery, "Space Force Spends \$737M on Colorado-Made GPS Satellites," *Denver Business Journal*, November 16, 2021, <https://www.bizjournals.com/denver/news/2021/11/16/lockheed-martin-space-force-gps-iii-satellites.html>.

locations across the craterous lunar surface.²⁸ A hybrid architecture of terrestrial transmitters from the Earth and cislunar orbit satellites will be needed to enable this. NASA has identified the criticality of this mission and has begun experimenting with cislunar PNT missions. It is clear that the USSF and USSPACECOM have the facilities and expertise to execute these operations; they now have to embrace and invest in this mission set.

CAN YOU HEAR ME NOW? GOOD!

*Exploration of the surface of the Moon and successful operation of lunar bases will depend on reliable, long-range communications over the lunar globe and between the Earth and Moon.*²⁹

It is hard to imagine transoceanic shipping, economic overtures, or even military operations without Satellite Communications (SATCOM) access. The world has become a tiny place because of SATCOM, allowing people without access to physical connectivity to join roundtable discussions from thousands of miles away.³⁰ As the commercial Moonrush for resources takes shape, a system of communications satellites in cislunar orbit will be needed. Many regions of interest on the Moon, for example, the inside of the impact craters near the poles, often have no direct LOS to Earth. Thus, for most lunar pole missions, SATCOM is needed.³¹ This cislunar SATCOM system would be the second step in the USSF and USSPACECOM supporting and defending the US government and commercial economic and scientific missions on the Moon.

²⁸ Keesey

²⁹ George E. Neuner, "Lunar Communication Satellites," *Progress in Astronautics and Rocketry*, Vol 19, 1966, <https://www.sciencedirect.com/science/article/pii/B9781483227160500499>, 887.

³⁰ Stephen Frempong, "The Impact of Satellite on Telecommunications Industry Around the World," *American Society for Engineering Education*, 2008, <https://peer.asee.org/the-impact-of-satellite-on-telecommunications-industry-around-the-world.pdf>.

³¹ Zhang, 10.

Similar to cislunar PNT operations, the orbit of the Moon becomes a challenge when dealing with SATCOM. For the Apollo missions, NASA used radio communications from the Moon to Earth through a network of antennas, the Spaceflight Tracking and Data Network, to receive radio signals.³² This was done through LOS from the lunar surface to the Earth or, when LOS was not possible, using the command and service module in cislunar orbit to act as a data relay. The hybrid architecture for cislunar PNT operations is more efficient because operations involve only receiving the signal, not transmitting it. A SATCOM architecture is more nuanced due to capacity and capability constraints needed for lunar operations.

In 1966, it was theorized that a global communication system for the Moon could be established using six lunar surface stations and 12 satellites, six equally spaced in two polar orbits.³³ This allows for complete coverage of the Moon, communication from the Earth to the Moon, from cislunar orbit to the surface of the Moon, and from one location on the Moon to another. With lunar resource operations focusing on the poles, the dark side of the Moon, and within craters, LOS antennas on the Earth would not be able to support resource missions without relay satellites in cislunar orbit. This is similar to the military SATCOM missions the USSF and USSPACECOM operate today for terrestrial missions.

Currently, 4 SOPS operates the USSF's protected and wideband military SATCOM systems providing joint and coalition warfighters global, secure, survivable, strategic, and tactical communication.³⁴ USSPACECOM manages the priority requests from users on the ground needed to utilize military SATCOM frequency bands. A Moon SATCOM constellation

³² "How Did Apollo 11 Communicate with Earth?" *Apollo11Space.com*, July 11, 2020, <https://apollo11space.com/how-did-apollo-11-communicate-with-earth/>.

³³ Neuner, 887.

³⁴ "4th Space Operations Squadron Mission," *United States Space Force*, accessed April 5, 2023, <https://www.spacebasedelta1.spaceforce.mil/About-Us/Fact-Sheets/Display/Article/2815644/4th-space-operations-squadron/#:~:text=4%20SOPS%20mission%20is%20to,the%20full%20spectrum%20of%20conflict.>

would be significant due to the number of satellites and the cost to develop, launch, and operate these satellites. SATCOM satellite development for the Earth could be utilized for producing lunar satellites, cutting down on research and development costs.³⁵ Currently, SATCOM satellites the USSF operates are roughly \$300M each.³⁶

As with a cislunar PNT architecture, cislunar SATCOM will be vital for lunar resource operations, especially at the poles, in deep craters, and on the Moon's dark side, the locations believed to be the most resource-heavy. Currently, USSPACECOM has yet to recognize the need for cislunar PNT or SATCOM constellations. This could be because commercial companies have yet to recognize the need or because their priorities are centered around the Geosynchronous orbit. Until the Combatant Command levies the requirement, the Service will likely not request the funding to build either of those constellations.

NOT MY CIRCUS, NOT MY MONKEYS!

*Buying commercial services means the Defense Department does not have to finance the cost of building and operating constellations and requires them acquire the data only.*³⁷

Arguments can be made that when potential adversaries increase their ability to threaten assets in all domains, primarily the space domain, sacrificing combat and defensive capabilities today in the local environment to support cislunar operations tomorrow is unwise. In 2023, the USSF's budget was \$30B, the largest space budget ever.³⁸ This budget will be allocated against

³⁵ Neuner, 889.

³⁶ Sandra Erwin, "US and International Partners to Share Launch Cost of New Communications Satellite," *SpaceNews*, February 22, 2022, <https://spacenews.com/u-s-and-international-partners-to-share-launch-cost-of-new-communications-satellite/>

³⁷ Sandra Erwin, "Military Building an Appetite for Commercial Space Services," *SpaceNews*, June 25, 2021, <https://spacenews.com/military-building-an-appetite-for-commercial-space-services/>.

³⁸ Sandra Erwin, "US Space Force Budget Hits \$30 Billion in 2024 Proposal," *SpaceNews*, March 13, 2023, <https://spacenews.com/u-s-space-force-budget-hits-30-billion-in-2024-funding-proposal/#:~:text=Its%20first%20budget%20in%20fiscal,plus%20a%20congressional%20add%2Don.>

the requirements USSPACECOM and other Combatant Commands have requested. These range from new missile warning satellites that can protect the homeland from an adversarial attack to modernized GPS and SATCOM satellites enabling warfighters in remote locations worldwide. As Secretary of the Air Force Frank Kendall says, "This budget is driven by the threat."³⁹ While the budget is the largest space budget for a military service, some programs were left on the chopping block due to lack of funds resulting in Combatant Command requirements going unfunded. Because of this, critics might say that the USSF should not devote sections of the budget towards a cislunar PNT or SATCOM architecture where there are no requirements to support from USSPACECOM. Instead, the service should let commercial organizations lead the way with these constellations since they will be the primary users of those capabilities. This will deviate from the traditional business model where the military dictates requirements and contractors are paid to build systems owned by the government.⁴⁰

While this plan makes sense in the short term, it fails to address the responsibility the USSF and USSPACECOM have to ensure military security in space to achieve national objectives. There is a 19th-century axiom that states, "Trade Follows the Flag." It is based on imperialist Britain and the close relationship between commerce and colonial expansionism.⁴¹ When Britain's reach became too much, it allowed the East India Trading Company to manage its colonies in India and, in some cases, usurp local government control. In this example, the axiom evolved to "Flag Follows Trade." This cannot happen in Space. Suppose the USSF and USSPACECOM do not have the capabilities to support and defend US and Allied corporations in Space. In that case, it is only natural that they will take matters into their own hands, which

³⁹ Sandra Erwin, "Biden's 2023 Defense Budget Adds Billions for US Space Force," *SpaceNews*, March 28, 2022, <https://spacenews.com/bidens-2023-defense-budget-adds-billions-for-u-s-space-force/>.

⁴⁰ Erwin, "Military Building an Appetite for Commercial Space Services."

⁴¹ Hitchen, 130.

causes problems for the military. The Pentagon does not want to become entirely dependent on commercial providers that may or may not be able to support the military during an armed conflict...the USSF will not outsource critical “no fail” capabilities like GPS navigation.⁴² While both PNT and SATCOM operations support commercial entities, they are inherently military missions. Every Service and Combatant Command has to make tough decisions on what requirements get written and how much money is allocated to fill those requirements. The USSF and USSPACECOM are no different. The time is now to start writing requirements for a cislunar PNT and SATCOM constellation to support the coming Moonrush and the multi-trillion-dollar economy that awaits harvesting.

GOING FORWARD

“The vast resources of space could tip the balance in favor of whichever nation proves most successful in exploiting them and ensuring the security of the celestial lines of commerce.”⁴³

In 1903 the New York Times carried the following editorial, "The flying machine which will fly might be evolved by the combined and continuous efforts of mathematicians and mechanists in from one million to ten million years."⁴⁴ Two months later, the Wright Brothers achieved the first powered flight. Just because the Moonrush has yet to happen and is not at the forefront of our minds does not mean the USSF and USSPACECOM should not start preparing for it when it could be months away. A complete lunar infrastructure should include global, continuous high-precision navigation information and full communication connectivity among lunar surface elements and the Earth to enable this new enterprise.⁴⁵ USSPACECOM should

⁴² Erwin, “Military Building an Appetite for Commercial Space Services.”

⁴³ Goswami and Garretson, 8

⁴⁴ Glenn Firebaugh, *Seven Rules for Social Research*, (Princeton and Oxford: Princeton University Press, 2008), 27.

⁴⁵ Zhang, 11.

begin formulating the requirements for a cislunar PNT and SATCOM architecture, and the USSF should start preparing to develop and operate these constellations.

However, as important as these mission areas are to expanding beyond the Geosynchronous Orbit, the future cislunar missions of the USSF and USSPACECOM should continue beyond a PNT and SATCOM architecture. As corporations start mining the Moon and transporting resources back to Earth, the military will take on new missions, such as convoy escort, similar to the US Navy's requirements during WWII. Steven Roskill once said, "If it is inevitable that the actions fought by the warships and aircraft gain the most attention, it must never be forgotten that the purpose of those actions is, nearly always, the protection of the merchantmen."⁴⁶ This will help support national objectives and the security of US and Allied commercial entities while ensuring security in the Space domain so that "Trade Follows Flag" and never the other way around.

⁴⁶ David Alman, Convoy Escort: The Navy's Forgotten (Purpose) Mission," *WarontheRocks*, December 30, 2020, <https://warontherocks.com/2020/12/convoy-escort-the-navys-forgotten-purpose-mission/>.

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