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Final Report:

Transforming the Defense Space Architecture with the Tools of the U.S. Federal Government

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We have to change the way that we build the space architecture. We built large platforms for efficiency. They're not built to be defended against threats. We operated them using the gifts that Kepler has given to us using orbits of fixed orbital energy, but they don't have to maneuver a whole lot. We have to completely rethink how we do our space architecture. We're probably going to have to be more nimble. We're going to have to find ways to have sustained maneuver in the domain in ways we do not do today.[1]

– Lt. Gen. John Shaw, Deputy Commander U.S. Space Command

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Executive Summary

The asymmetric advantage the United States has long enjoyed in space diminishes as adversaries threaten the space system architecture underlying that advantage. The U.S. space system architecture depends on large, exquisite capabilities and a ground segment to manage and link those capabilities. It was leveraged to devastating effect during warfighting in the nineties and proved that space capabilities could transform air, ground, and naval power.[2] It also spurred steep growth in the U.S. space industry, which had both first mover advantage and generous government contracts to grow its knowledge base. In subsequent years, the People's Republic of China (PRC) and Russia have sought to neutralize the advantage by developing strike and counterstrike capabilities of U.S. systems through kinetic, non-kinetic, electronic, and cyber-attacks. They have also sought to develop their own industrial base to compete with U.S. industry.

This report culminates the 2023 Eisenhower School Space Industry Study (SPC-IS) seminar research into how best to approach the transformation of the U.S. defense space system architecture. The report begins by defining a space system architecture encompassing the satellite, ground, and communications segments. It also defines the space enterprise based on the teachings of this course and interactions with industry, foreign governments, and federal agencies. Understanding the space system architecture and the supporting space enterprise was critical to our research and the proposed recommendations. The definitions are followed by a discussion on the evolution of space requirements, architecture, and enterprise and our analysis of the space industry, market conditions, and market.

The 2023 Eisenhower School Space Industry Study (SPC-IS) proposes actions for transforming the space system architecture framed in both a Fight Tonight and Winning the Fight Tomorrow context. The Fight Tonight portion of the paper focuses on fielding capabilities in the next 24 months by bolstering resiliency, closing capability gaps, and pursuing appropriate acquisition structures. The Winning the Fight Tomorrow portion of the paper proposes concepts and changes for the broader, long-term U.S. enterprise that can be started today.

The **Winning the Fight Tonight** recommendations are:

- **Buy What We Can** – Space Domain Awareness (SDA) is the priority. SDA provides detection and attribution capabilities as part of a deterrence strategy. SPC-IS recommends a continued partnership with the commercial industry to fill gaps quickly. Several commercial firms have innovative technology that can be leveraged today. However, we must ensure that we take a long-term view of commercial-government relationships and choose appropriate contract types.
- **Improving Immediate Surge Capabilities** – SPC-IS recommends developing Tactically Responsive Space Programs (TacRS) and a Commercial Augmentation Space Reserve capability.
- **Cyber Defense** – SPC-IS recommends prioritizing the cyber security of the entire space architecture by ensuring cyber defense capabilities are fully resourced.

The **Winning the Fight Tomorrow** recommendations are:

- **Defense Space Acquisition Strategy for the Fight Tomorrow** – SPC-IS discusses the benefits and risks of the Government Owned – Contractor Operated (GOCO) and the Contractor Owned – Contractor Operated (COCO) relationships as the military seeks to leverage commercial company capabilities. Secondly, SPC-IS recommends that the U.S. Space Force (USSF) produce and distribute integration standards for service-specific platforms that rely on space capabilities. Lastly, SPC-IS recommends the USSF continue evaluating future and commercial technologies for integration and participate in both working groups and standards development groups.
- **Joint Warfighting** – The SPC-IS discusses the long-term role of the USSF in training, organizing, and equipping guardians to support the U.S. Space Command. The section also discusses the role of the Space Systems Command in acquiring combat-enabling capabilities.

- **Organization of Civilian Space Authorities** – The SPC-IS recommends that the White House's National Space Council coordinate and clarify the organization, roles, and responsibilities of the multiple federal entities involved in the national security, civil, and commercial space sectors. SPC-IS recommends partnering with Congress to limit Federal Communications Commission (FCC) authorities and unify public-facing communications and regulatory contacts of those disparate Cabinet agency authorities that remain to minimize bureaucratic compliance costs.
- **An Improved Regulatory Framework to Facilitate Foreign Military Sales** – SPC-IS recommends transitioning the prescriptive regulatory text of export control regulations to an adjudicative process that does not require the codification of specific technologies through a notice and comment rulemaking process. Streamlining this regulatory framework for space-related foreign military and dual-use sales could remove unnecessary barriers to domestic industry and the growth of space capabilities by close allies and partners.
- **Building International Coalitions** – SPC-IS recommends the United States expand resources for international space development and cooperation to counter the PRC's diplomatic efforts in international norms-setting bodies. The investment could provide an opportunity to bolster U.S. ally capabilities in space while gaining new space alliances in Africa, South America, and elsewhere.
- **Provision of War Risk Insurance** – SPC-IS recommends extending war risk insurance programs to commercial space industry that support defense operations.

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In-Class Speakers

- Capella Space
- LeoLabs
- Satellite Industry Association

Florida Site Visits

- Space Launch Delta 45 (Patrick SFB)
- Blue Origin
- Space Florida
- SpaceX
- United Launch Alliance

Tokyo, Japan Site Visits

- ALE
- Astroscale (Japan)
- Avatarin
- Axelspace
- iSpace
- Japan Aerospace Exploration Agency (JAXA) & Tsukuba Space Center
- Japan Institute for Space and Security
- J-SPARC
- Mitsui Fudosan
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- Space BD
- Spaceport Japan
- Strategic Planning Division, Bureau of Defense Policy, Ministry of Defense
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Dialogue Exchange

- Mount Fuji Dialogue (senior Japanese government delegation

Colorado Site Visits

- Advanced Space
- Aerospace Data Facility – Colorado
- Astroscale (United States)
- BlueStaq
- Colorado Lieutenant Governor
- Colorado National Guard
- Colorado Space Business Roundtable
- Lockheed Martin – Space
- Maxar
- Space Base Delta 2 (Buckley SFB)
- Space Delta 4 (Missile Warning)
- Space Delta 8 (GPS & MILSATCOM)
- Space Delta 9 (Orbital Warfare)
- Space Delta 15 (National Space Defense Center)
- Space Launch Delta 45
- Space Information Sharing and Analysis Center
- True Anomaly
- United States Space Force/Space Operations Command
- United States Space Command

Washington, D.C. Site Visits

- Eisenhower Executive Office Building (visit w/ EOP space policy leadership)
- Iridium
- Pentagon (visit w/ DOD space leaders)
- SES Space and Defense

Acronym List

ANPRM	Advanced Notice of Proposed Rulemaking
ASAT	Anti-Satellite
BRI	Belt and Road Initiative
CASR	Commercial Augmentation Space Reserve
CBP	United States Customs and Border Protection
CCDR	Combatant Commander
CFR	Code of Federal Regulations
CCL	Commerce Control List
COCO	Contractor Owned Contractor Operated
CRAF	Civil Reserve Air Fleet
CSIS	Center for Strategic and International Studies
CSO	Chief of Space Operations
DARPA	Defense Advanced Research Projects Agency
DHS	United States Department of Homeland Security
DOC	United States Department of Commerce
DOD	United States Department of Defense
DOT	United States Department of Transportation
EAR	Export Administration Regulations
EOP	Executive Office of the President
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FCC	Federal Communications Commission
FY	Fiscal Year
GCC	Gulf Cooperation Council
GOCO	Government Owned Contractor Operated
GOJ	Government of Japan
GPS	Global Positioning System
GSSAP	Geosynchronous Space Situational Awareness
INS	Immigration and Naturalization Service
ITAR	International Traffic in Arms Regulation
ITDS	International Trade Data System
JAXA	Japan Aerospace Exploration Agency
LEO	Low Earth Orbit
LH	Labor Hour Contract
MILSATCOM	Military Satellite Communications
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NDRF	National Defense Reserve Fleet
NPRM	Notice of Proposed Rulemaking
NSSL	National Security Space Launch
OIRA	White House Office of Information and Regulatory Affairs
OST	Outer Space Treaty
PNT	Position Navigation and Timing
PRC	People’s Republic of China

SATCOM	Satellite Communications
SCN	Satellite Control Network
SDA	Space Domain Awareness
SFB	Space Force Base
SpaceX	Spacecraft Exploration Technologies Corporation
SPC-IS	2023 Eisenhower School Space Industry Study
SSA	Space Situational Awareness
SSC	Space Systems Command
TacRS	Tactically Responsive Space Programs
T&M	Time & Materials Contract
ULA	United Launch Alliance
UN	United Nations
UNCOPUOS	United Nations Committee on Peaceful Uses of Outer Space
UNOOSA	United Nations Office of Outer Space Affairs
U.S.	United States
USML	United States Munition List
USAID	United States Agency for International Development
USD	United States Dollar
USSF	United States Space Force
USSF/CSO	United States Space Force Chief of Space Operations
USSPACECOM	United States Space Command

1 Introduction

The changing landscape of the space domain has altered the context in which the U.S. national security, civil, and commercial space sectors operate. The People's Republic of China (PRC) continues to accelerate its efforts to displace the United States as the preeminent global superpower, including in space. The rapid buildup of adversary space forces and precipitous advancements in the commercial space sector have left the United States with an outdated defense space architecture, jeopardizing vital national security priorities. Three successive presidential administrations have focused significant effort on addressing the dilemma; however, the situation requires continued bold action by the government across an array of issues. To ensure continued U.S. space superiority, the United States should continuously review the current state of its space architecture to identify strengths, weaknesses, challenges, and opportunities. At the same time, U.S. leadership must not lose sight of issues related to its broader and longer-term space enterprise, including ways to strengthen space sustainability, governance, international partnerships, and investments for the future.

This report analyzes the current defense space architecture. It then makes recommendations on how the United States can prepare for both the fight tonight and the fight tomorrow with a focus on transforming the defense space architecture and effectively utilizing the tools of the broader space enterprise.

1.1 Defense Space Architecture

An architecture is defined in simplest terms as a "unifying or coherent form or structure."[3] It is the whole of many connected, unique, and specific parts in a system. In the case of a space system architecture, an introductory astronautics textbook defines it as follows:

> Space system architectures are composed of several "segments," a collection of components that make a space mission possible. The three primary segments are the satellite, the ground, and communications. The physical satellite is the orbiting element being used or directed to conduct a space mission. The ground segment is the antenna network, the command and control, and the network between them. The ground segment encompasses the personnel, equipment, and procedures required to receive and monitor data on the spacecraft's health and command the

> spacecraft daily. The communications segment manages the telemetry, tracking, and command between any ground element and the satellite in both uplink and downlink directions.[4]

A broad space enterprise supports each part of the space system architecture, including key activities in both the government and industry. Government is responsible for promulgating regulatory policies, establishing regulatory bodies and oversight organizations, setting fiscal policy to support industry, determining types and levels of taxing, and enabling the growth and development of an industry.[5] Industry includes the companies and entities responsible for designing, manufacturing, operating, and enabling space-related hardware and services.

1.1.1 A New Defense Space Architecture: Changing Context for Space Operations

The United States has entered an era in which its military space assets must withstand, fight through, and recover from attacks. In any conflict with the PRC, the United States can expect early military strikes against its space assets through kinetic, non-kinetic, electronic, and cyber-attacks. The Department of Defense (DOD) must urgently field the space systems, trained personnel, strategies, and warfighting doctrines needed to ensure unimpeded military space operations despite increasing threats. These objectives are critical to the entire U.S. warfighting community and the daily lives of all Americans. This new era requires a transformed military space architecture capable of carrying out tactical orbital warfare operations while simultaneously defending the core space architecture to continue supporting terrestrial joint warfighting operations. The United States may not be adequately prepared.[6]

The original U.S. military space architecture was built with the primary mission of defeating Soviet ballistic missiles. The United States originally invested in large, exquisite satellites with dedicated ground sites to control the spacecraft and receive the intelligence they collect. Requirements-driven federal contracts to large defense primes dominated the space industry, which led to technological changes focused on strategic national security objectives. The U.S. military space architecture gradually evolved to focus on support to conventional military operations in all warfighting domains. OPERATION DESERT STORM set a precedence

for future warfare, demonstrating how air, sea, and ground warfighting operations were transformed by the advances in U.S. space capabilities.

These advances in military space technology gradually created dramatic spillover effects in the broader economy. Little by little, robust civil and commercial space applications emerged, fueling dramatic growth in the domestic and international space economies. As commercial and civil space activities flourished, the number of space-faring nations has exploded. What began as an existential technology contest between two superpowers has become more accessible and global; by 2022, more than 275 nations or consortiums have had a satellite in orbit, launched from 37 sites worldwide.[7] This has created a space domain that is increasingly crowded, with constant competition for the best technology and economic positions. The great powers dominate, with the United States, Europe, Russia, and China having the most assets on orbit and more being added. But the space domain has changed dramatically, becoming markedly more commercial, with many more participants.

The effect of U.S. space capabilities on warfighting operations, especially the lessons of OPERATION DESERT STORM, stoked PRC ambitions to build its own space capabilities. The PRC's rapid ascent to great power space status was punctuated in 2007 when it suddenly launched an anti-satellite (ASAT) ballistic missile live test against a satellite in low earth orbit (LEO).[8] This successful demonstration completely upset the status quo and was the harbinger of a new era of contested space operations, requiring all space-faring nations to re-plan their space architectures and account for vulnerabilities to conventional warfare attacks. Since 2007, PRC space capabilities have continued to increase at a dizzying pace, in both numbers and levels of sophistication. According to a recent Center for Strategic and International Studies (CSIS) report, the PRC has "doubled its number of satellites in orbit between 2019 and 2021, from 250 to 499." [9] It has also successfully launched very sophisticated spaceplanes, one orbital and one suborbital.[10] The PRC is now the pacing threat for the United States.

Russia's military space capabilities trace back to the Soviet Union, with roots in Cold War applications. After the fall of the Soviet Union, the United States enjoyed a brief window of

cooperation with Russia on space initiatives. However, that period was short-lived. Today, Russia has renewed its pursuit of modernized space technologies, coupled with aggressive and irresponsible space activities frequently condemned by the international community. Russia has engaged in a focused acquisition of communication and Global Positioning System (GPS) jammers, along with conducting its own direct-ascent ASAT test, which created debris challenges for all space participants.

The rapid pace of PRC advancements and the sustained development of Russian capabilities have dramatically changed the threat to U.S. military space operations. This urgently pressures the United States to transform its military space architecture. Figure 1 depicts the current U.S. military space architecture. In the space segment, large, exquisite systems for remote sensing, satellite communications, and satellite navigation characterize the U.S. military space architecture. Though the current space segment architecture is efficient from an engineering point of view, it is not resilient. It creates easy targets for counterspace attacks and lacks operational military-owned redundant capabilities in orbit.

The significant number of commercially operated spacecraft in the U.S. space industry carrying out reconnaissance and remote sensing missions represents a degree of resilience for space imagery. Substantial contracts are already in place for commercial imaging data from Maxar and Planet Labs. Commercial imagery is contracted on a Fixed Priced basis by the National Reconnaissance Office (NRO) and is integrated into products developed by the National Geospatial-Intelligence Agency.

The satellite communications and navigation portions of the defense space architecture represent greater risks. The exquisite systems in orbit lack redundancy and are subject to kinetic, electronic, non-kinetic physical attacks, and cyber-attacks.[11] These multiple forms of attack, if successful, could catastrophically impact the U.S. capability to project power and military operations. The mission sets of satellite communications and navigation have thus rightly been early focus areas for DOD architecture transformation. The general strategy has been conversion

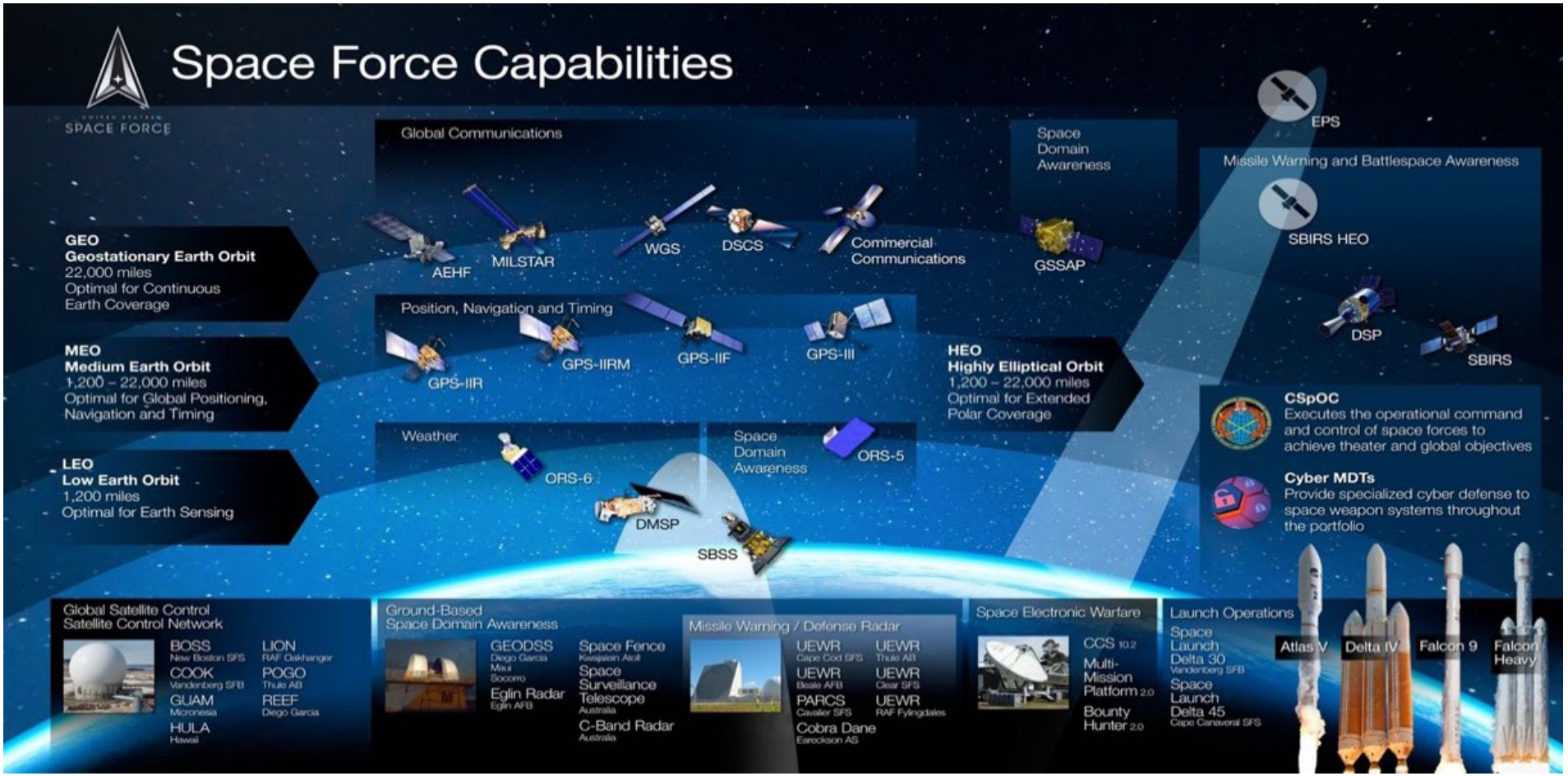

Figure 1. The U.S. military space architecture as of 2022. In the space segment, geostationary orbit has been the traditional choice for military communication satellites (protected and wideband) and missile warning detection, with on-orbit SDA spacecraft recently added. Low-earth orbit has been the customary choice for earth-pointed remote-sensing satellites for weather, with on-orbit SDA spacecraft recently added. Medium-earth orbit has routinely been used for position-navigation-timing satellites and missile warning detection over high latitudes. The ground segment is comprised of a global network of satellite control stations, as well as radars devoted to both the missile warning and SDA missions. Photo courtesy of Space Operations Command. "Space Force Capabilities," Space Operations Command, accessed May 15, 2023, https://www.spoc.spaceforce.mil /Multimedia/Photos/igphoto/2002988205.

of these at-risk portions of the defense space system architecture to a proliferated LEO constellation structure with resilient and redundant capability in orbit.

This strategy places a premium on transforming the relationship between DOD and the rapidly changing commercial space industry. To better understand the growth occurring in commercial space industry, it is necessary to analyze the economic factors affecting the industry.

1.1.2 Space Industry Analysis

The pace of change in the space enterprise is not limited to the government sector. The commercial space industry, which is now valued at $279 billion globally, has been experiencing rapid change and growth.[12] For example, the number of active satellites in orbit has increased 233% over the 5 years ending in December 2021.[13] All space segments, including ground, link, and space, have seen revenue growth. This growth has been coupled with decreases in per-unit costs in satellite manufacturing. Importantly, the cumulative effect of changes in the U.S. commercial space sector represents a growing re-alignment of roles between the government and the space industrial base. In some areas, commercial space capabilities are outpacing those of the government. Commercial space capabilities now represent a vital resource, capable of helping to quickly field the updated space architecture needed to achieve U.S. national security objectives in the evolving counterspace era.

Prior to 2010 the space industry was dominated by government-driven innovation and investment. A space industry renaissance began in January 2010, when U.S. company SpaceX successfully launched its Falcon 1 rocket into space, becoming the first commercial company to do so.[14] SpaceX also introduced broader pricing transparency and less expensive launch costs that lowered barriers to entry for start-up satellite and space services companies.[15] These changes ushered in a flurry of investment, creating new capabilities and markets that had been only ideas before. As SpaceX perfected its ability to launch quickly and effectively, while making its capital-intensive launch hardware largely reusable, it rapidly began to surpass government-developed offerings in the launch market. The launch market transformation

represents a trend in the space industry. U.S. commercial space capability is catching up to or surpassing U.S. government offerings in nearly all but the most exquisite satellite technologies.

Historically, a combination of government regulations, limited market demand, and nascent technology and innovation limited the threat of new entrants for the space industry writ large. The few substitutes available in space markets limited buying power for both government and commercial buyers. High capital investment requirements, specialized skilled labor requirements, and the need for detailed knowledge of government processes created very high barriers to entry, discouraging new companies from entering the industry. What changed?

In the early 2000s, the National Aeronautics and Space Administration (NASA) began transforming its acquisition and industrial base strategy for a range of space products and services. Rather than setting detailed requirements and overseeing the specifics of acquisition programs, NASA shifted to a series of "buy as-a-service" contracts, while providing investment and technical assistance. Soon, growth in venture capital investment in the space industry followed. This influx of capital lowered the barriers to entry and increased the threat of new entrants and substitute products and services. Increased competition had the desired effect, with seller pricing power decreasing and buyer power increasing, and prices fell. A domino effect progressed through the U.S. launch industry that went far beyond the rise of SpaceX. Motivated in part by SpaceX's successes, the Federal Aviation Administration (FAA) eventually streamlined its launch and reentry regulations, paving the way for even lower barriers to entry in the launch market. A flood of small, innovative launch providers has since entered the launch market, including Firefly, ABL, Relativity, Rocket Labs, and Virgin Orbit. In the core U.S. national security space launch (NSSL) market, the decade-long monopoly ended for United Launch Alliance (ULA). DOD has now named both SpaceX and ULA as NSSL providers. In this new era of increased competition and reduced barriers to entry, launch cost per kilogram has dropped by an amount approaching 10x in a little more than a dozen years.[16]

Lower launch costs have been a major market disruptor, spurring investment and growth in other portions of the space value chain. All market segments have been transitioning away

from the monopoly end and further toward the competitive end of the spectrum. Most major markets are now competitive oligopolies, particularly in the infrastructure sector. Particularly in the launch and satellite manufacturing segments of the infrastructure sector, markets continue to retain monopsonistic tendencies in terms of revenues, with the federal government remaining a powerful buyer. However, it is now joined by a growing number of commercial customers driving requirements, innovation, and revenues in launch, manufactured satellites, and downstream service markets.

As mentioned above, private capital has driven much of this growth in recent years. SpaceX and other billionaire-backed space ventures like Blue Origin and Virgin Galactic led the way in initial investments, which then attracted attention from startups interested in the potential space offered. From 2009 to 2019, five hundred nine startups raised $24.6 billion.[17] This venture capital funding has turned the space industry into a juggernaut— creating new capabilities on a wide array of platforms, such as cube and micro-cube satellites, proliferated constellations, and reusable rocket technology, to name a few. The commercial industry is now creating technology and capabilities that the government can use for its own architecture transformation needs, without paying the very expensive development and engineering costs previously required.

2 Winning the Fight Tonight

As mentioned above, in any conflict with the PRC, the United States can expect to face kinetic, non-kinetic, electronic, and cyber threats against its space assets. The first order of business articulated by U.S. space warfighters in this scenario is to "exploit what we have" to meet the threat scenarios. This is part of a mantra developed by Space Systems Command (SSC), the United States Space Force (USSF) acquisition office, to prioritize actions in the order of "exploit, buy, build." Essentially the strategy is to first "exploit" current systems and consider how to better use them. Next is to explore how to rapidly "buy" commercial-grade products or services. Finally, only if military space requirements justify it, "build" classic military-unique

systems. The first step, exploit, focuses on changing tactics, techniques, procedures, and operational war plans, and is outside the scope of this industry-focused analysis paper.

Assuming an extension of the "fight tonight" timeframe to "what can we get to the fight in the next 24-months," U.S. strategists must also continue to develop their "buy" commercial plans. This part of the SSC strategy focuses on those acquisition and procurement priorities needed to help urgently bolster resilience and plug capability gaps in the U.S. military defense space architecture. The following section of the paper will focus on these "fight tomorrow" priorities, extending to the 24-month time horizon. That will be followed by a section on SSC's "build" activity related to achieving the large-scale architecture transformations and policy overhauls needed for the longer term.

2.1 Buy What We Can

2.1.1 Space Domain Awareness

Defending the entire space architecture, from ground stations and links to satellites in orbit, is the central tenet of the U.S. Space Command (USSPACECOM) mission. While the United States may not achieve full space domain awareness within a 24-month window for the fight tonight, there are steps the United States can take to augment its current capabilities beyond its baseline within that timeframe.

According to both the U.S. Space Force Chief of Space Operations (USSF/CSO) and the Combatant Commander of U.S. Space Command (CCDR/USSPACECOM), priority number one for mitigating risk to U.S. military space operations is improved space domain awareness (SDA). General Dickinson's testimony to Congress on the FY22 Priorities and Posture of the U.S. Space Command further expanded on why this is so important. He said, "China desires to use space to supplant the U.S. as a global economic and military leader. Russia seeks to degrade U.S. space capabilities to prevail in future conflicts. Iran and North Korea continue to develop and expand their counter-space capabilities. Other nations and commercial expansion are increasing opportunities and challenges in space."[18]

The USSF's Space Capstone published in August 2022 defines SDA as follows: "Space Domain Awareness encompasses the effective identification, characterization, and understanding of any factor associated with the space domain that could affect space operations and thereby impact the security, safety, economy, or environment of our Nation." The term SDA is evolving in current doctrine and literature to encompass space situational awareness (SSA) as a subset of SDA[19]. Space traffic management, a U.S. Department of Commerce (DOC) mission area, encompasses aspects of SSA and elements of SDA.

Historically performed by government entities and defense contractors, the SDA mission capabilities leverage various ground-based and space-based capabilities. As depicted in Figure 1 above on the U.S. space architecture, various ground-based technologies are used to track and characterize on-orbit objects. These include radars, optical telescopes, and passive radio frequency sensing. Space-based surveillance systems provide proximity to space objects without disturbances weather or atmospheric distortions. Space-based capabilities include the USSF Geosynchronous Space Situational Awareness Program (GSSAP) satellites in a near-geosynchronous orbit regime. The GSSAP collects SDA data for accurate characterization of space objects by maneuvering near satellites of interest, enabling characterization for anomaly resolution and enhanced surveillance while maintaining flight safety.[20]

2.1.1.1 Commercial SDA in Support of U.S. National Security

The 2021 United States Space Priorities Framework states that the United States will build a more resilient national security space architecture in part by strengthening U.S. SDA and the ability to detect and attribute hostile acts in space.[21] New and emerging commercial space capabilities and services will play a critical role in meeting these national security interests. For the United States, resiliency in SDA provides protection, attribution, and deterrence.

Further, SDA architectures depend on the capabilities of the military services and the commercial sector to ensure proliferated and resilient architectures.[22] To achieve this goal, the USSPACECOM Commercial Integration Strategy seeks to "Establish a framework for how

USSPACECOM will collaborate, integrate, and partner with the U.S. commercial industry to enable USSPACECOM to mitigate capability gaps while improving and maintaining advantages over competitors."[23] Similarly, the NRO's 2021 Strategic Commercial Enhancement Framework under the Commercial Systems Program Office is leveraging commercial SDA capabilities to "build capacity, agility, speed and resilience" into procurement and operations.[24]

A proliferated and resilient SDA architecture of civil, national security, and commercial assets, along with those of select allies and partners, adds significant capacity and capability. Additional sensors on the ground and in space allow more accurate tracking and the ability to respond to attempts to deny U.S. access to space and freedom to operate in space. Commercial SDA helps close potential gaps in U.S. coverage and can support the integration of new capabilities more quickly than traditional government acquisition processes can build. Smaller start-up commercial SDA firms can build new cost-effective space systems to scale faster than the government and often faster than the large, established national security defense contractor firms. Larger national defense contractor firms have the expertise to integrate new start-up firm SDA capabilities into multi-domain architectures required by the U.S. federal government.

2.1.1.2 The Space Industry Environment for SDA

The change in the power dynamic of space superiority is driven by technology development and innovation in the commercial sector. The entire global SDA market, including all government, civil, and commercial mission areas, was $1.5 billion in 2021 and is expected to grow to $1.8 billion by 2026.[25] This market estimation includes space object tracking and surveillance, space weather monitoring, collision avoidance tracking, and individual country space object characterization for space, ground, and link segments.[26] The majority of this market is funded by U.S. national security and civil activities and dominated by major U.S. defense contractors. The U.S. federal government investments in defense and civil space sectors are incentivizing the creation of new commercial space markets increasingly funded by private investors. These markets grew from the U.S. federal government's continued investments in

scientific exploration and the evolution of national security space missions dating back to the early days of satellites to protect the United States from the Soviet nuclear threat.

A 2022 report by BIS Research titled *Space Situational Awareness Services Market – A Global and Regional Analysis* analyzed 22 commercial service providers of space domain awareness.[27] The growing commercial markets segments include mission operation support, collision avoidance and tracking, interference avoidance, rendezvous support, and space weather impacts on satellite tracking.[28] These commercial services and data providers are creating value by employing ground and space-based sensors, and developing unique software analysis tools and services. As this market space continues to mature, the USSF needs to identify which capabilities show the most promise and integrate them into the space architecture.[29]

2.1.2 Telecommunications and GPS Redundancy

From strategic leaders to tactical commanders, the ability to communicate with forces across the globe is a core tenet of military operations. To ensure this critical capability, the United States should continue to expand its communications resiliency by further leveraging the services of commercial providers such as Starlink, Iridium, OneWeb, Eutelsat, and Inmarsat and incorporating lessons-learned from the Russian invasion of Ukraine.[30] Following a policy of deliberately partnering with multiple providers increases the number of assets an adversary would need to target with counter-space weapons, thus raising the cost and effort. Most of these providers build substantial resilience into their commercial architectures, such as Iridium's use of crosslinks and connected network of space satellites on orbit. This ensures its network can "see" every inch of the globe and deliver reliable service to warfighters.[31] Of note, each commercial entity brings with it unique ground station requirements. Fortunately, most providers have simple commercial off-the-shelf equipment, allowing users to connect to their satellites. For example, Iridium offers a user-friendly device tied with an application called Iridium GO!, which connects users to its satellite network globally.[32] Leveraging this capability involves procuring or

contracting for ground station terminals. As speed is a critical factor, DOD must anticipate and plan for any surge requirements for such global telecommunication devices for warfighters.

Finally, from targeting enemy positions to precisely locating U.S. warfighters, position, navigation, and timing (PNT) remain critical across the tactical, operational, and strategic levels. Thankfully, the United States recognizes the need for pre-staging GPS satellites, working with the manufacturer, Lockheed Martin, to permit launching spares within weeks, should conflict erupt.[33] In addition, multiple military branches and agencies are developing assured PNT solutions, designed to operate in a GPS-denied environment.[34]

In 2021, the Defense Advanced Research Projects Agency (DARPA) awarded Northrop Grumman a $13.3 million contract for Phase 2 of the Blackjack program. This program aims to allow the company to "advance its Position, Navigation, and Timing payload through emulation and Critical Design Review, and build PNT payload units destined for space flight." While DARPA appears to be focusing on anti-jamming abilities and military-procured redundancy through Blackjack, it should consider additional contracting with companies operating GPS-like systems that can be used for redundant warfighter navigation support.[35] Through decades of research and innovation, the U.S. company Satelles developed a highly secure satellite-based time and location service as an alternative solution to the standard GPS satellites the United States operates today.[36] In addition to serving as a reliable backup for navigation purposes, Satelles systems can penetrate areas where traditional global positioning systems cannot reach by leveraging different bands on the electromagnetic spectrum.[37] With U.S. reliance on PNT services in nearly every device, protecting this innovative and critical resource is imperative.

Finally, information is only effective if it is accessible by the right people at the right time, so identifying software solutions that support effective data fusion capabilities is critical. The firm BluStaq, for example, has developed a unified data library that breaks down information stovepipes and centralizes various data streams into one marketplace, helping address issues such as achieving true space situational awareness.[38] The United States, in partnership with commercial firms and public institutions, receives imagery and analysis in a

central, unified, and user-friendly data library, providing decision-makers the input they need in a timely fashion.[39]

2.1.3 Defense Acquisition Strategy for the Fight Tonight

2.1.3.1 Commercial Integration

Continuously transforming military acquisition processes to be conducive to commercial integration is pivotal to preparing for an impromptu fight with the PRC. In that scenario, warfighters must concentrate efforts on protecting critical assets in the U.S. space architecture while continuing to fulfill other national defense priorities. The commercial sector becomes a force multiplier, if properly engaged early and often during operational planning to augment key capabilities. To this end, it is important to understand commercial contract types and how to employ them in a fight tonight scenario.

2.1.3.2 Contract Types

Historically, government requirements drove the focus of commercial companies that supported space architecture segments, but that paradigm has shifted. As mentioned previously, NASA spearheaded this by changing their commercial space industry relationships to Firm Fixed-Price contracts for commercially defined services in 2005 after the findings from the President's Commission on Implementation of the United States Space Exploration Policy. That report determined "NASA's role must be limited to only those areas where there is an irrefutable demonstration that only government can perform the proposed activity." [40] This prompted NASA to embark on a period of buying launch operations as a fixed-price service. The launch portions of the space system architecture were mature and could support this contract structure.

The maturity of the technology and its relationship to the contract structure is an important distinction for commercial contractual relationships with commercial companies. That seems an overuse of the term commercial, but it is important to understand how the usage is different. Cambridge Dictionary defines a "commercial company" as "a company that is organized to make a profit."[41] The definition of a Commercial Item is more nuanced.

When market research is conducted for any contractual requirement, the Federal Acquisition Regulation (FAR) directs the Head of Agency to give preference to Commercial Items where available and ensure prime contractors and subcontractors do the same.[42] Section 2.101 of the FAR thoroughly defines a Commercial Item, but in short, Commercial Items have two salient characteristics: 1) they are used regularly by the public or nongovernment entities for non-government purposes; and 2) they must have been sold, licensed to the public, leased, or offered for sale, license, or lease to the public. The fact that a commercial company provides performance is an insufficient basis to determine an item is a Commercial Item. If the item is sold only to the government, it is not a Commercial Item.

The decision of whether something is a Commercial Item impacts available contract types and structures. A Commercial Item determination limits the contract types to Firm Fixed-Price and Fixed Price with Economic Price Adjustments. Time and Materials (T&M) or Labor Hours (LH) are two other unfavorable choices in DOD. If commerciality cannot be determined, we can select from six variations of the Fixed Price contracts and five variations of the Cost Reimbursable contracts, along with T&M and LH. The contract type selection is significant and indicates the level of risk, who is assuming risk, and the plan to incentivize performance. The definitions of both contract types are the following:

> FAR 16.202-1 Description.
>
> A firm-fixed-price contract provides for a price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract. This contract type places upon the contractor maximum risk and full responsibility for all costs and resulting profit or loss. It provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon the contracting parties.
>
> FAR 16.301-1 Description.
>
> Cost-reimbursement types of contracts provide for payment of allowable incurred costs, to the extent prescribed in the contract. These contracts establish an estimate of total cost for the purpose of obligating funds and establishing a ceiling that the contractor may not exceed (except at its own risk) without the approval of the contracting officer.[43]

Space Command and the USSF seek to quickly address resiliency shortcomings and ensure access to the space domain, and leveraging commercial items makes sense. The Assistant Secretary of the Air Force for Space Acquisition & Integration stated in an October 2022 memorandum that the priorities for purchasing space systems are driving speed in acquisitions, making the architecture resilient, and integrating space architecture with other domains.[44] This was followed with later comments from the Assistant Secretary to, "build small, …use existing technology, and reduce nonrecurring engineering. You take advantage of commercial capabilities, and you execute."[45]

These are worthy goals to follow, but caution is advised when determining whether the "commercial capabilities" are truly Commercial Items. If they are, pursuing a Firm-Fixed Price contract is sensible. A Fixed Price contract places risks predominantly on the contractor. There are no mechanisms to recoup cost overruns, renegotiate costs, or request change orders. The contractor's knowledge and experience in commercial sales and procuring a product is leveraged to manage the costs, schedules, and performance necessary to produce the commercial item. Further, the government is limited in the oversight of performance on Firm-Fixed Price contracts, which allows the contractor to act quickly and efficiently.

A second area for caution in the short term is the disparate technology maturity levels within the space value chain. The space value chain encompasses satellite manufacturing, launch services, lease or sale of satellite capacity, value-added services, and consumers.[46] There are companies providing existing and mature Commercial Items like launch services, space-based telecommunications, and imagery. These companies are positioned to excel at Firm Fixed Price contracts. Yet, emerging companies with high-risk technology and precarious financial positions are on that same value chain. A centralized decision to use firm fixed-priced services can unintentionally impact the survivability of these companies. These companies lack the operational experience and knowledge of their cost base, which impacts their ability to determine a fair price. They will either set prices high to hedge against underpricing, or the company may

fail to make timely deliveries due to a shortage of funds. Both outcomes are untenable for ensuring unimpeded access to the space domain in the short term.[47]

2.2 Improving Immediate Surge Capabilities

2.2.1 Tactically Responsive Space Programs

Given urgent space threats, U.S. Space Command must continue emphasizing the need for speed in acquisition and procurement across all elements of the space industry, including launch services. With only four fixed government launch sites and an under-resourced launch cadence, the Command must look to alternative solutions to put assets on orbit rapidly in a lead-up to or during the initial stages of conflict.

Leveraging tactically responsive space (TacRS) programs, currently underway by the USSF, enables the warfighter to move at the speed of relevance. According to Arthur Grijalva, Program Manager for TacRS in the Space Force's Space Safari office, "Tactically Responsive Space consists of three lines of effort when considering launch options. First, the [Space Force] needs responsive access for stored space vehicles. Second, we need responsive launch options. Third, we need responsive launch pad manifesting to support launch opportunities."[48] Ultimately, TacRS aims to "place satellites and other spacecraft into orbit at much faster rates as a countermeasure" to the PRC's bid to win space.[49] The program has launched multiple successful missions to date and is now focused on requiring commercial satellite manufacturers to prepare for launch within eight months and deliver a payload to orbit in 24 hours.[50] Furthermore, the firm ABL demonstrated a parallel capability earlier in 2023, where it used a mobile launch vehicle to place a satellite into Low Earth Orbit from a standard concrete pad in Alaska.[51] In a fight tonight scenario, momentum and mobility are deadly weapons against an adversary, and the ability to react quickly in a contested environment drives the need for a TacRS ecosystem.

Contingency communications operations in Ukraine highlighted the ability of private industry to fill governmental gaps rapidly. Ukraine quickly realized it needed access to satellite communications to coordinate and maneuver counter offensive operations. At the start of the

conflict, Starlink received praise for offering free, reliable satellite access to Ukraine,[52] However, as the war continued, unilateral decisions on Ukraine's continued use of Starlink[53]and requests for funds with no contract in place highlighted the need for the United States to pre-coordinate with industry partners possessing critical wartime capabilities.[54] While both issues have since been resolved, with USAID and international governmental payment for satellite usage and hardware,[55] such instances underline General Dickinson's emphasis on the "importance of shared understanding between commercial service providers and their customers and users"[56]

2.2.2 Establish a Commercial Augmentation Space Reserve

To prepare for a potential conflict, U.S. Space Command needs activation authority for a fleet of commercial space capabilities. This capability has been proven in the air and maritime domains via the Civil Reserve Air Fleet (CRAF) and National Defense Reserve Fleet (NDRF). CRAF provides resilience in the military airlift program through pre-established contracts with commercial aircraft carriers.[57] NDRF provides similar capabilities for strategic sealift operations. Space Systems Command is developing a space equivalent with the Commercial Augmentation Space Reserve (CASR). However, funding is not anticipated until fiscal year 2025.[58] Given the need to fully mobilize all sectors in a conflict, the United States must prioritize funding for CASR through reprogramming or other actions for this initiative to foster commercial integration within the broader space enterprise and secure access to critical space capabilities.[59]

2.3 Cyber Defense

Compared to on-orbit antisatellite operations, cyber-attacks are relatively low-cost, easy, and will likely be launched immediately should conflict arise. U.S. adversaries have demonstrated significant capabilities in cyber warfare and should not be underestimated. Further, the PRC has consistently used cyber operations as the tip of the spear, regularly testing and challenging Taiwan's cyber defenses, even in a time of official peace.[60] Defending the entire space architecture, from ground stations and links to satellites in orbit, is a crucial tenet of U.S. Space Command. If we are unable to secure our defense space architecture from immediate

cyber infiltration, we have already lost the fight for space and will be forced to engage in conflict without the ultimate high ground. Organically, the USSF is embedding Cyber Mission Defense Teams and intel analysts throughout their operational squadrons under U.S. Space Command.[61]

Additionally, to counter the electronic warfare threat, the USSF is bolstering its offensive and defensive options across the electromagnetic spectrum.[62] While both initiatives show incredible promise, gaps remain in the architecture that an adversary can exploit. Like the initial challenges faced by the Air Force in defending multiple weapon systems, cyber defenders of space assets will inevitably face similar challenges given the sheer number of satellite payloads in orbit. Thankfully, multiple cyber mission defense teams are defending the Satellite Control Network (SCN), the backbone of this fundamental architecture responsible for tracking, telemetry, and commanding U.S. satellites.[63] However, as new payloads come online and the aging SCN is modernized, leaders must prioritize today's resources to keep this critical link fully functional in a fight tonight scenario.[64]

3 Winning the Fight Tomorrow

U.S. space leaders are right to prioritize the fight tonight – exploiting the current space architecture, rapidly buying commercial solutions, and making key enterprise changes to address immediate space warfighting needs. However, the United States must also work towards long-term goals such as the wholesale transformation of its space architecture and the broader space enterprise. The analysis below is focused on key steps the U.S. must take to transform its space enterprise for the long-haul, in the time horizon beyond 24 months.

3.1 Defense Space Acquisition Strategy for the Fight Tomorrow

3.1.1 Structural Changes to Government-Commercial Relationships

As the DOD seeks to quickly operationalize and contract for ever more capable commercial capabilities, choosing in the long run between the government owned-contractor operated (GOCO) and contractor owned-contractor operated (COCO) models is necessary. Both operational models are commonly used for the management and execution of federal

requirements. GOCO relationships leverage the strengths of both entities. The government can establish the mission focus and provide the equipment and infrastructure for the mission, while the contractor implements the mission using best business practices, their own employees, and their own management. The COCO model equates to buying capabilities as a service. The contractor owns the facilities, determines the business focus, and solely determines operational factors. The government becomes a customer like anyone in the public.

The COCO model leverages the expertise of commercial firms, but there is a calculated risk in transferring critical mission requirements to a commercial system that will not allow government intervention or requirement changes. Further, there is an inherent risk that the company may choose to stop providing services based on its internal business plans. Yet, the COCO model allows quick implementation for the near-term fight tonight scenario. In addition, capitalizing on capabilities already in orbit immediately complicates the targeting equation for an adversary, adding one element of improved resilience. Based on a deterrence framework, this model imposes significant costs on the adversary via economic means.[65] Instead of only targeting a select number of U.S. government satellites or ground stations, the PRC must contend with an overwhelming number, causing it to pause and recalculate its decision.[66]

3.1.2 Platform Needs

As DOD plans to acquire future capabilities to expand existing architectures, the USSF must ensure it produces and distributes integration standards for capabilities that support the terrestrial fight. The USSF is tasked with procuring satellites, ground command and control equipment, and antennas to support the link between the ground and satellites, as well as for getting those satellites into orbit. While there have been debates about whether the USSF should also acquire service-specific ground equipment, a better option is for each service to acquire its versions of ground user equipment and build space connectivity into its individual acquisition strategies and budget requests. For example, the Air Force should design the latest stealth antenna technology for 6th- and 7th-generation aircraft to integrate satellite communications and

GPS signals, the Navy should ensure ship integration, and the Army and Marines should be responsible for incorporating ground user equipment into their vehicles and units. In the build of the service acquisition programs, the services must ensure their initial acquisition strategies and budget requests account for space connectivity. The services need to ensure they continue to prioritize fully resourcing programs to ensure connectivity.

3.1.3 Acquisition Strategies and Outreach

As previously noted, the USSF has shifted to an acquisition approach of "exploit what we have, buy what we can, and only build what we must."[67] Commercial on-orbit servicing startups show promise for exploiting what we have. The possibility of refueling an otherwise functional satellite, having future modular satellite buses that can be upgraded and refueled indefinitely, and docking an old satellite with a new one to continue the mission would not only help with resilience but also reduce costs by providing longer lifespans for exquisite satellites. The USSF should begin evaluating future technologies such as these to further optimize funding expenditures and resilience. The federal government should participate in relevant working groups and standards development bodies as the technologies mature.

Increasing the number of companies competing for government contracts requires better outreach programs and aggressive use of contract flexibility. Large prime contractors are savvy at lobbying for, finding, and responding to government requirements. Smaller companies, however, struggle to overcome barriers to entry and lack the resources required to compete for contracts. Proactive efforts by the government to reach these companies can include organizing outreach programs such as industry days, attending industry conferences, and publishing business opportunities early and often. Better marketing and focusing on reaching new companies are the first step to reaching a greater competitive pool.

3.2 Joint Warfighting

Space capabilities strengthen operations in other warfare domains and reinforce every Joint function; in short, the United States does not project or employ power without space.[68]

Since 2019, the USSF has established and solidified its role in space operations and Joint Warfighting. The USSF organizes, trains, and equips Guardians to provide combat power to U.S. Space Command. Space Command, in turn, works with allies and partners to plan, execute, and integrate military space power into multi-domain global operations to deter aggression, defend national interests, and, when necessary, defeat threats.[69] Operations in space under the authority of Space Command include space domain awareness, counter reconnaissance operations, rendezvous proximity operations, enhanced battlespace awareness, and offensive space control operations. Flying and operating satellite constellations, including GPS, SATCOM, weather, and the Space Development Agency's transport layers, are the responsibility of the USSF. These combat-enabling capabilities are critical to the joint fight and allow the United States to project power globally at the time and place of our choosing. The USSF relies on the Space Systems Command, based in Los Angeles, California, to acquire these combat-enabling capabilities.

3.3 Organization of Civilian Space Authorities

A thriving and supported space industrial base is key to transforming U.S. defense space architecture. As is typical in the case of a nascent commercial industry, the regulatory environment is underdeveloped and still finding its way. The government faces a significant challenge of coordinating its approach to the industry to maintain open and fair markets while preserving national security and ensuring the government does not unnecessarily hamper trade, growth, and innovation.

The White House's National Space Council (Space Council) was initially established in 1989 in the NASA Authorization Act but defunded in 1993. The Trump administration re-established the Space Council in 2017 and placed it under the chairmanship of the Vice President. Continued in the Biden Administration, the Space Council is tasked with "providing objective advice to the President on the formulation and implementation of space policy and strategy."[70] The Space Council, as a central coordination body, should continue to serve an important role in leading and coordinating space policy across the Executive Branch by working

to clarify the organization, roles, and responsibilities of the multiple federal entities involved in the national security, civil, and commercial space sectors.[71] In particular, several significant policy concerns have arisen as the commercial space industry has grown and has taken on new significance in both civil and military applications. These include the number of agencies involved in the regulation of space commerce – and often the perceived lack of coordination and shared expertise between those agencies.

3.3.1 The Challenge of the FCC

While not unique to space commerce, the regulatory authorities governing the industry span a wide array of federal agencies, rather than having a single agency with authority to regulate the entire space industry. Navigating the federal regulatory environment represents a significant barrier to entry for less legally sophisticated start-ups. Among these many agencies, the role of one independent agency – the Federal Communications Commission (FCC) – has grown significantly, and is at times publicly at odds with the White House. Going forward, the Space Council should decide whether and how to partner with Congress to explicitly limit FCC authorities to regulate orbital debris – thereby improving coordination and industry-wide consistency – as part of unifying public-facing communications and regulatory authorities for the many disparate Cabinet agencies, to help minimize bureaucratic compliance costs.

At the second meeting of the re-established National Space Council in 2018, then-Administrator of the White House Office of Information and Regulatory Affairs (OIRA) Neomi Rao presented a blueprint for regulatory policy. The Trump administration's efforts to consolidate space policy suggested a framework that foresaw the DOC establishing a new bureau that would become a one-stop-shop for all space-related commercial policy, save authorities to license launch and reentry which would remain with the Federal Aviation Administration (FAA) in the Transportation Department (DOT). The proposal was bold, and the appeal was easy to understand. A one-stop shop dramatically reduces bureaucratic friction for the public and within

the Executive Branch itself. But the effort was also doomed by the bureaucratic realities of reorganization, authority, and inertia.

Recently, the FCC unilaterally announced new requirements for deorbiting telecommunications satellites, using a timetable that differs from that established by NASA, the agency officially tasked by the Space Council to provide commercial deorbiting guidance. The FCC also launched its Office for International Affairs and Space Bureau, further calling DOC's leadership into question, despite FCC only claiming authority to regulate the telecommunications portion of the industry. Further, the bipartisan leadership of the House Science, Space, and Technology Committee has written several letters to the FCC, calling into question its authority to regulate orbital debris and debating whether the FCC's involvement in such regulation is ultimately warranted or desired.[72] Meanwhile, DOC established an Office of Space Commerce that represents a significant downscale of the original intentions for the one-stop-shop.

The organization and coordination challenges before the Space Council are significant, and overcoming these challenges would be a pivotal step in ensuring a robust, competitive, and growing industry. Fortunately, the Space Council can draw upon a wealth of experience from other industries facing a similar patchwork of regulatory authorities. First, however, it will have to work with Congress to establish an appropriate role for the FCC.

3.3.2 Suggested Organizational Strategy

The role of the FCC in the regulation of space commerce presents a considerable challenge to the coordination of space policy within the Executive Branch. As an independent regulatory agency,[a] the FCC operates beyond the traditional sphere of direct influence the White House enjoys over Cabinet agencies. While the regulatory actions of all Cabinet and other non-independent agencies are overseen and coordinated across the interagency by the White House's OIRA prior to publication, those of the FCC are not. This lack of pre-publication coordination

[a] The term "independent regulatory agency" is defined at 44 USC § 3502(5) and establishes the FCC as one of several independent agencies that, through the application of the definition, fall outside of the full scope and purview of White House management and coordination.

prompted NASA to comment publicly on the FCC proposal to require deorbiting of telecommunication satellites within five years of their end of life. NASA, which leads Federal orbital debris efforts under the guidance of the Space Council, did not support the FCC's specific proposal and pointed out the significant increase in burden a 5-year limit would have on scientific cube satellites, which rely on natural deorbiting timelines. NASA also noted its belief that a 5-year limit could significantly hinder space exploration, science, and innovation in low-cost accessible cube satellites.[73]

The White House has limited influence with independent agencies and is restricted in its ability to shape their policy outcomes. As most independent regulatory agencies have control over a limited issue-set, with little to no overlap with other agencies, this does not typically represent a significant coordination issue. In the case of the FCC's regulation of orbital debris, however, the overlap with other agencies is considerable and causes significant confusion and inability for the National Security Council to adequately coordinate a unified vision for space policy that considers the full scope of federal and commercial equities.

Part of the challenge lies in the fact that the FCC does not have specific authority for satellite deorbiting. As previously noted, the FCC claims it derives its authority in this area from its 1934 organic statute, the Federal Communications Act, despite the law having been written more than two decades before the launch of the first man-made satellite. In the Federal Communications Act, the FCC is given authority to regulate the allocation of radio spectrum "in the public interest." It is this "public interest" clause the FCC has come to rely on for the creation of its entire space portfolio outside of radio spectrum licensing and allocation.[74] Such questionable authority, particularly given the public letters from Congress call into question the rule's viability if tested in the courts.

This uncertainty and confusion, compounded by the seemingly redundant FCC Office for International Affairs and Space Bureau, must be clarified. The Space Council, working with bipartisan leadership in Congress, must firmly establish a role and limitations for the FCC. While legislation limiting the FCC's authority to regulate space vehicles outside of spectrum allocation

and licensing would be the most procedurally viable in terms of centralized coordination going forward, clarity is needed regardless of the decision. The Space Council and Congress must work to ensure that whichever agency leads Federal efforts to create orbital debris policy, that authority is clear, collaborative, and without conflicting or overlapping authorities in other agencies.

If the Space Council can work with Congress to provide clarity on the role of the FCC, its next step should be to address the perception of an uncoordinated cadre of federal agencies separately regulating the commercial space industry. While authority consolidation within DOC no longer appears to be the goal, there are still ways the federal government can make itself operationally function with one voice – at least as far as regulated entities are concerned. Choosing not to consolidate, so long as there is a renewed effort at improved coordination, is ultimately a good choice. When the Executive Branch has consolidated authorities previously, it has struggled to ensure that authorities and institutional know-how remained connected.

This is part of the reason why the Homeland Security Act of 2002, which consolidated and reorganized many federal authorities and agencies to create the Department of Homeland Security (DHS), chose to separate the concept of a unified operational perception (from the perspective of the regulated entity) from the authority to set and establish policy. When a person arrives with or without taxable goods at a U.S. port of entry, they are processed by U.S. Customs and Border Protection (CBP), a component of DHS. From the perspective of the entrant, all interactions at the port of entry are with one agency of the Federal government.

But CBP is a consolidation of the Department of Justice's legacy Immigration and Naturalization Service (INS), which performed immigration and passport control functions; the Department of Agriculture's legacy Agricultural Quarantine and Inspection Service, which conducted agricultural inspections; and Customs officers from the Department of the Treasury, who collected taxes, duties, and fees. While the INS was disbanded in its entirety and reformed within several DHS components, both the Department of Agriculture and the Department of Treasury (and, importantly, their respective Congressional Committees) retained authority over

their respective roles in the entry process. Congress instead only transferred *operational* authority to CBP, thus maintaining the institutional knowledge in policymaking while allowing for a seamless, unified operational process for the public.

Other successful strategies have involved extensive co-location and single-window processing. In co-location, the operational entity is a joint agency venture allowing the public to interact with a central, unified, *interagency* touchpoint within the federal government. However, the individual agencies still retain the operational and policymaking authorities they previously held. The agencies' efforts to physically co-locate their employees, with the authority to carry out their individual missions, allows them to facilitate transactions together using the same systems and the same data submissions from the public. Alternatively, in industries and processes overseen by a significant number of federal agencies, the federal government will employ a "single window" approach. In the case of cargo entry into the United States, for example, nearly 50 federal agencies regulate goods coming into the country. Rather than require the public to file separate import documents to comply with the regulatory standards of each of the agencies, CBP owns the International Trade Data System (ITDS), which is a single platform that allows an importer to file *all* relevant information for *all* relevant agencies in one form that is then shared with every relevant agency without additional effort on behalf of the regulated entity.

While consolidation may be the theoretical gold standard for coordination, it risks separating policymaking from the institutional and human knowledge embedded in the agency that originally held the authority. The Space Council is wise to have dropped its pursuit of complete consolidation within DOC, but it should look to the successful examples from elsewhere in the federal government on how to successfully retain institutional knowledge and the authorities of agencies and their Congressional committees while functionally presenting a unified front to regulated entities. Any of these coordination techniques could help reduce the barriers to entry in this quickly growing industry.

3.4 An Improved Regulatory Framework to Facilitate Foreign Military Sales

As the PRC and Russia are increasingly isolated from other major players, the two space powers have gravitated towards a *de facto* – if not more formal – alliance. Such close relations between the two key nation-state adversaries in an assumed future conflict, if anything, increases the likelihood that space will be a key contested domain. Such an alliance also leaves the United States in a position to which it is unaccustomed: that of going it alone. A champion of cultivating allies since the development of the League of Nations, the United Nations, and the North Atlantic Treaty Organization, the United States has put considerable effort into building the capacity and interoperability of its allies to ensure a united front against encroachment and attack. Such alliances also strengthen the U.S. case for the legitimacy of its actions in international discourse.

Yet, despite their sophisticated and advanced militaries, not one U.S. ally has a notable military presence in space. The Government of Japan (GOJ), realizing the important role space would play in a potential future conflict with the PRC over Taiwan, has begun to embrace the need to build its space capabilities. In the GOJ's first-ever National Defense Strategy, "space" was referenced no fewer than 27 times as the document emphasized the need for Japan to build its capabilities to counter PRC efforts to cut communications and disrupt Japanese and Taiwanese efforts to defend against a potential PRC incursion.[75] The United States supports GOJ efforts to develop militarily useful space capabilities, but Japan lacks the space defense industrial base necessary to build its capabilities organically – at least in the near term. To facilitate the growth of military space capabilities in Japan and other allies, the federal government should focus on ways to streamline its regulatory frameworks concerning foreign military sales and international commercial sales of dual-use space technologies.

Unfortunately, the space industry suffers from long-established regulatory structures that contain self-imposed *procedural* barriers to modernization. The U.S. export control regime is not an exception. Policy outcomes aside, the form of the export control regulations themselves create barriers to flexibility and can unintentionally impede our ability to ensure allies have access to advanced U.S. space technology. The combined structure of the U.S. Munitions List (USML;

under the international traffic in arms regulations (ITAR), regulated by the Department of State) and the Commerce Control List (CCL; under the export administration regulations (EAR), regulated by DOC) is overly prescriptive in a manner that reduces agency flexibility as technologies evolve from military-specific (ITAR-controlled) to commercially relevant dual-use technologies (EAR-controlled). Technologies are currently listed in their respective categories, codified *in the regulatory text* as either an ITAR technology on the USML or as an EAR dual-use technology on the CCL. This structure means DOS and DOC must jointly engage in a rulemaking process, including notice and comment adjudication, every time a technology should move from the more restrictive USML to the CCL.

In a fast-moving industry, the administrative processes of rulemaking reliably cannot keep up. In 2019, DOS and DOC jointly issued an advanced notice of proposed rulemaking (ANPRM) requesting input from the public on whether there are technologies on the USML that have moved into international commerce in such a manner that the technology (particularly for export control purposes) should be considered dual-use. Failure to move a technology from the USML to the CCL by the time it is available internationally on the commercial market does not serve a purpose beyond creating unnecessary barriers to U.S. international commerce in that technology, hampering the acquisition efforts of U.S. allies. Regulated entities came back with consistent lists of satellite technologies that had become dual-use since the prior revision of the USML and CCL for satellite technologies. Yet, four years later, the agencies have not issued a notice of proposed rulemaking (NPRM) to propose changes to the lists.[b]

The federal government has begun to rethink what adjudicatory and prescriptive text does and does not need to be contained within the regulatory text itself (i.e., within the codified language of the regulatory "law"' promulgated by an agency). In the case of ITAR and the EAR, a modernization effort that removes prescriptive lists from the regulatory text could considerably

[b] DOS and DOC have also not publicly indicated a desire to move forward with an interim final rule, which would be more challenging now than it was in 2014, legally, given intervening case law on the procedural question of regulating domestic industry under the foreign affairs clause of the APA.

speed up the ability of DOS and DOC to transition technologies from one list to the other. This would reduce the negative impact such policymaking friction has on innovation and the U.S. ability to compete in commercial markets with dual-use technologies. To do so, the agency would structure the regulation as one that outlines an adjudicative process.

The process would be a determination based on clearly specified criteria, agreed to by the Secretaries of State and Commerce (perhaps with consultation with the Secretary of Defense), that would allow a fact-based adjudicatory process to move goods from the USML to the CCL without changing the Code of Federal Regulations (CFR). While each list itself would no longer be codified in the CFR, the location of the lists will be, so a controlling and legally binding version of the lists exists. The criteria for moving goods from the USML to the CCL would include considerations such as: 1) whether the same or similar good is reasonably available on the international commercial market already; 2) whether market projections indicate the technology will soon be available commercially on international markets where U.S. companies may want to put their products on the market first; and 3) whether there are any objections from the Secretary of the Department of Defense or other relevant officials to more limited controls of the technology under the CCL. And lastly, the regulatory text would include a timeline in which adjudications would take effect as well as petition, engagement, and appeals processes for the public to be able to maintain its formal *ex-parte* consultative role in these decisions.

Such a structure would allow the agency to move rapidly evolving space technologies from the USML to the CCL with minimal delay and limit formalized process aside from interagency, fact-based adjudication. Once a decision is made, there would not be a need to update the CFR before such changes take effect.[76]

3.5 Building International Coalitions

The United Nations Office of Outer Space Affairs (UNOOSA) and United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) have been critical from a historical perspective in shaping global space governance. The UN General Assembly adopted

five treaties from 1967 to 1979 designed to establish and clarify space law. The most widely signed "Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space including the Moon and Other Celestial Bodies," more commonly known as the Outer Space Treaty (OST), obtained 113 signatories,[77] while the other four treaties were not as universally accepted. The United States led the charge to develop the Artemis Accords in 2020, but with only 24 signatories,[78] none of whom have independent crewed spaceflight capabilities, it would be difficult to consider it established space law. Notably, the Artemis Accords lack the signatures of both the PRC and Russia, two of the world's three largest space powers. To influence the development of global space governance in international bodies moving forward, the United States will need to continue its efforts to work with allies and build a strong international coalition.

As the PRC has grown its space program, it has also conducted outreach and development, particularly in African nations, where the United States could otherwise stand to gain allies and critical votes in the long game of global space governance. According to Dr. Julie Klinger of Johns Hopkins University, "China is not displacing the U.S. in satellite cooperation with African countries due to the simple fact that there have been very few U.S. programs to displace. Space cooperation with African governments has not been a priority area for contemporary U.S. foreign policy."[79] Between cultivating African and Gulf Cooperation Council support, the PRC is positioning itself to be invaluable to emerging space-faring nations. Two of the goals of the UN's Space2030 agenda are improving access to space for all and strengthening international cooperation in space and global space governance.[80] Between space development assistance and traditional Belt and Road Initiative (BRI) programs, the PRC is seeking to wield influence over the United Nations Human Rights Council,[81] which may expand to influence over norm-setting through UNOOSA, UNCOPUOS, and subordinate UN standards-setting bodies (e.g., the International Civil Aviation Organization and similar multilateral organizations).

To counter the PRC's diplomatic push to garner influence and gain support for its vision of space governance, the United States must expand its efforts on international space

development and cooperation to build the necessary coalitions to counter the PRC's diplomatic efforts. As an added benefit, strengthening international cooperation and space development could provide an opportunity to bolster U.S. ally capabilities in space while gaining new space alliances in Africa, South America, and elsewhere. General Raymond has stated, "we want to build this coalition [as] friendly from the beginning to allow our international partners to invest."[82] While there is room for the United States to work with its current military allies to increase their space capabilities, the strategy could also aim for something much larger. The United States should be careful not to exclude emerging space-faring nations that do not have the funding to invest in space operations. The United States Agency for International Development (USAID) is the federal government's principal assistance organization, but while its digital strategy discusses sectors that rely on space assets, it does not identify space cooperation as a development priority.[83] However, USAID and NASA have a memorandum of understanding (MOU), providing an existing pathway to address the cooperation gap. At a minimum, offering space development assistance would give emerging space-faring nations a choice of whom to align with instead of partnering with the only ally available.

3.6 Provision of War Risk Insurance

The space industry is a high-investment, high-risk endeavor. Commercial space service providers that work with the federal government must accept that their collaboration potentially puts the company's space-related assets at risk in the event of war between the United States and a sophisticated space actor. However, the lack of war risk insurance coverage for space companies who support DOD operations presents a policy gap that, if not fixed, will result in an untenable position for companies that must balance creating shareholder value at acceptable risk. As David Gauthier, GEOX's chief strategy officer, pointed out in a recent *C4ISR* article, "The hardware, the satellites that are commercially owned and operated, are continuously at risk in that environment. So, the second the companies announce that they are working for the military and doing business there, they are under constant threat."[84] When commercial airline and

maritime companies support DOD operations, their assets are covered under an agreement between the Secretary of Transportation and the Secretary of Defense known as war risk insurance.[85] This is a vital ingredient for DOD to access commercial capacity because most, if not all, private insurance excludes war-related losses. The war risk insurance program must be extended to the space industry to ensure future support for DOD operations.

4 Conclusion

As the PRC continues to accelerate its efforts to end the U.S. strategic advantage in space, the United States must rapidly adjust its approach to building a new defense space architecture. Where historically the United States focused on efficient, exquisite systems relying on natural orbits and limited numbers of capital-intensive, exquisite satellites, it must now confront the modern reality that competitor ASAT technology significantly threatens those assets. To maintain its advantage in space, the United States must instead invest in a highly maneuverable, redundant architecture to build greater resiliency and provide space domain awareness. Fortunately, explosive growth in the space industrial base means that the United States can look to the private sector as an important tool in both its short- and long-term efforts to rebuild the defense space architecture. By focusing on efficient acquisition strategies, improved governance, international partnerships, and investments for the future, the United States can renew its defense space architecture while it identifies opportunities to accelerate its progress through investment in the broader space enterprise.

Annex - Using U.S. Space Diplomacy and Development to Counter BRI

We live in a new space age where novel technologies, innovation, and competition have created exciting opportunities for civil, commercial, and national security uses of space. Space-based assets are helping governments address challenges such as food insecurity, climate change, and natural disasters. Worldwide, countries are seeking ways to advance their national interests through space. No exception, the People's Republic of China (PRC) has integrated space into its Belt and Road Initiative (BRI), posing both celestial and terrestrial challenges to the United States, its allies, and its partners. To counter this, the United States should leverage its space expertise and leadership to intensify diplomatic engagement with the international community, expand space partnerships, and create programs to assist the developing world on space matters.

Launched in 2013, BRI is the PRC's signature statecraft tool. Ostensibly a trade and infrastructure program, its true intentions are much more ambitious: "to develop an expanded, interdependent market for China, grow China's economic and political power, and create the right conditions for China to build a high technology economy."[86] Pursuit of these objectives through space-focused BRI programs poses both near- and long-term threats to the United States, its allies, and its partners. PRC companies already build and sell satellites abroad and offer launch services, particularly targeting developing countries. These economic ties support the Chinese space industry and directly compete with U.S. and allied companies.[87] In addition to providing revenues to its companies, the PRC also uses space BRI programs to enmesh itself further into foreign economies. The PRC's 2018 deal to provide Nigeria funding to buy two Chinese-built communications satellites in exchange for an equity stake in Nigeria's state-owned satellite communications company is one such example.[88] The PRC has also launched its 35-satellite BeiDou navigation network through BRI to unseat the U.S. Global Positioning System (GPS). Like GPS, BeiDou is offered free to users. However, rather than simply emitting signals that devices use to determine location, as GPS does, BeiDou both sends and receives signals from receptor devices, allowing the system to track users and posing serious security risks.[89]

Geopolitically, the PRC is using space to curry influence and garner support for its model and activities. The China National Space Administration claims the PRC "has signed 149 space cooperation agreements or memorandums of understanding with 46 national space agencies and 4 international organizations."[90] The PRC is using these to support the space ambitions of many countries, particularly in the developing world, and promote its own interests. PRC assistance enabled Egypt to develop its aerospace industry by constructing a satellite manufacturing, installation, and testing facility.[91] It is helping other African nations develop their nascent space programs, furnishing satellites, and winning launch contracts. In 2018, the PRC built its first overseas BeiDou ground station in Tunisia.[92] Further, two Chinese firms and the Government of Djibouti announced a deal to build a $1billion spaceport in the country in January 2023.[93]

In South America, the PRC has constructed 11 ground stations in five countries. While all pose potential surveillance threats to the United States and its allies, one in Argentina is raising particular concerns because the firm operating it is owned by the People's Liberation Army and the agreement stipulates Argentina will "not interfere or interrupt" any PRC activities.[94] Beyond the intelligence potential of these activities, the PRC can use the influence it garners through BRI programs and economic ties to build support for its interpretation of existing international space law and new PRC-led initiatives to shape space governance to benefit its national interests.

The PRC has declared, "Outer space is a critical domain in international strategic competition."[95] As such, the United States should increase space-related outreach with allies, partners, and potential partners alike to counter malign PRC activities. The 2020 Artemis Accords, drafted by the National Aeronautics and Space Administration (NASA) and the Department of State (DOS), provide a framework for such engagement. They recommit the United States to returning humans to the moon with international partners and present a "practical set of principles, guidelines, and best practices… intended to increase the safety of operations, reduce uncertainty, and promote the sustainable and beneficial use of space for all humankind."[96] The Accords seek to expand upon existing international treaties and guidance, such as the foundational 1967 Outer Space Treaty. Importantly, the 24 current signatories – with

more joining – represent a coalition to counter PRC attempts to alter current and future space governance in international fora and build consensus on new norms and rules that will govern how member states operate in the new space age.

The United States must dedicate more resources to fostering stronger international ties on space issues and venture beyond established space nations to partner with the developing world. DOS should bolster its modest Office of Space Affairs (OSA) to build a cadre of personnel who understand the complexities of space policy as well as the statecraft of diplomacy. Working through existing regional Science and Technology officers, the U.S. Mission to International Organizations in Vienna, where the UN space agencies reside, and U.S. embassies around the world, they can engage directly with countries seeking to increase their space activities. The strengthened OSA can promote the commercial space industry to nations seeking U.S. space hardware, software, and services instead of PRC offerings. Additionally, DOS should increase and sharpen the focus of its space-related exchange programs and better incorporate the private sector. Finally, NASA, which maintains liaison personnel in Paris, Moscow, and Tokyo, should create regional positions in Africa, the Middle East, Latin America, and South Asia.[97]

Although global, BRI focuses heavily on the developing world. In these regions, our greatest asset for countering the PRC and helping countries benefit from space activities is the United States Agency for International Development (USAID). USAID established the Famine Early Warning Systems Network in 1985 in partnership with NASA to use satellite data and analytics to provide early warning forecasts of acute food insecurity.[98] The two partnered again in 2005 to form Servir, which uses earth observation and data to assist governments in addressing complex environmental challenges. USAID's Partnerships for Enhanced Engagement in Research program provides grants to scientists and engineers from 80 partner countries to work with researchers from U.S. agencies such as NASA on global development issues.[99]

USAID success in partnering with U.S. agencies and developing nations to address terrestrial problems through space demonstrates the ability to provide better alternatives to BRI. As such, the National Space Council should create a working group comprised of DOS, USAID,

NASA, the Department of Commerce, and other relevant agencies to focus specifically on space and development. USAID should expand its digital development portfolio to include space-related programs in its strategies, hiring, and budget requests. Dedicated funding would allow USAID to expand its partnerships with NASA and could also support diplomatic efforts, such as using space-related foreign assistance as an incentive for nations to join the Artemis Accords.

The PRC remains committed to becoming the preeminent global superpower and intends to contest the United States, its allies, and its partners in every domain, including space. Through BRI, the PRC strengthens its economy and space industry base while supplanting U.S. firms, further entangles its commercial interests into those of other nations, and acts as a counterweight to U.S. diplomatic and development leadership.[100] Fortunately, the United States still dominates space and possesses the expertise, tools, and technology to counter BRI. However, space diplomacy and development must first be adequately prioritized and resourced.

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