The Eisenhower School
for National Security and Resource Strategy

Academic Year 2022
Space Industry Study

Final Report:

The Need for Speed:
Leveraging Commercial Space Markets to Accelerate U.S. National Interests in Space

20 May 2022

National Defense University
Fort Lesley J. McNair
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EXECUTIVE SUMMARY

The United States' space superiority is being challenged by the pacing threats of China and Russia.[1] Both countries understand the United States' economic dependence on space and the degree to which American military advantages rely on space-based assets. They have, in turn, developed capabilities and strategies to deny use of these advantages in the event of conflict. At the same time, a revolution is underway in the commercial space industry that has led to an explosion of new companies, capabilities, and business models that are democratizing access to space and rapidly increasing the opportunities available to the U.S., our allies, and partners.

Figure 1 – SSC "Focused on the Threat" Banners
SSC displays these banners around the command to raise threat awareness

Figure 1. Space Systems Command (SSC) "Focused on the Threat" Banners[2]

To meet these challenges and take advantage of these new opportunities, the 2022 Eisenhower School Space Industry Study (SPC-IS) recommends that the U.S. Government (USG) redouble its strategy to develop and deliver new concepts and capabilities for "speed to the need." This calls for creating a more agile USG space enterprise to rapidly increase industry capacity, promote intra- and intergovernmental collaboration, and develop human capital potential. It will also require breaking down legacy stovepipes and unresponsive acquisition processes. Another key element involves transforming cooperation with allies and with the private sector, especially by leveraging rapidly developing commercial capabilities.

Specific recommendations related to this strategy are presented along three broad Lines of Effort (LOEs). LOE #1 centers on DoD leveraging a "space as a service" model to rapidly add commercial space capabilities, as well as establishing a Joint Interagency Task Force to better coordinate USG efforts. Classification guidelines also need revision to successfully increase cooperation and collaboration. LOE #2 outlines approaches to achieve speed and resilience by leveraging allies' and partners' capabilities. This is underpinned by investing in open-source sharing, augmented by reformed export controls. LOE #3 presents innovative approaches to strengthen the civilian and military space workforce.

RECOMMENDATIONS UP FRONT

LOE 1: Leverage Space as a Service

1) Employ a "space as a service" sprint procurement effort **(Space Systems Command)**
2) Establish a Space Joint Interagency Task Force (JIATF) to coordinate operations **(U.S. Space Command)**
3) Re-evaluate how the USG manages space system information control, how it shares information with allies and partners, and how it increases awareness of and cross-cues across compartmented programs **(DOD, Intelligence Community (IC))**

LOE 2: Leverage Allies and Partners

1) Incorporate alliance and partner expertise at both state and industry level into the space acquisition process **(USSF, OSD, DOS)**
2) Reform ITAR to create a new mechanism that controls data sharing and sales in a manner like the intelligence sharing arrangements **(DOS, DOC, DOD)**
3) Maximize NSIB capabilities by contracting for and broadly sharing unclassified information with partners using the Ukraine example **(IC, Combatant Commands)**

LOE 3: Leverage all Space Talent and Expertise

1) Establish a Space Technical Corps **(USSF)**
2) Implement a Bounce-In, Bounce-Out (BI/BO) Model **(USSF)**
3) Adopt Continuous Evaluation (CE) for Clearances **(DOD, IC)**
4) Grow with Neurodiverse Talent **(USSF)**

FIELD STUDY VISITS AND MEETINGS

February – March – Local DMV Speakers and Visits
April 10 - 16 – Colorado Field Study Trip
April 18 - 22 – California Field Study Trip

White House Space Leaders
- Chirag Parikh, Dept. Asst. to the President and Executive Secretary, National Space Council
- Audrey Schaffer, Director for Space Policy, National Security Council
- Matt Daniels, Assistant Director of OSTP for Space Security & Special Projects
- Jeff Crowder, Director for Space, OMB

Pentagon Space Leaders
- Lt Gen Nina Armagno, Director of Staff, U.S. Space Force
- John Hill, Deputy Assistant Secretary of Defense for Space Policy
- Kevin Sherman, Acting Director, Defense Intelligence & Security Programs & Resources
- Shawn Barnes, Deputy Assistant Secretary for Congressional Budget, and Appropriations
- Kevin Ruce, Director Battlespace Awareness & Security Programs, OUSD(I&S)

Military Space Leaders
- Gen Dickinson, Commander, USSPACECOMMAND
- Brig Gen Tim Sejba, Program Executive Officer SDACP and BMC3
- Space Force Deltas 2, 8, 9 (Peterson, Schriever, Buckley)
- Space Force Space Systems Command (Los Angeles SFB)

Intelligence Community Space Leaders
- Peter Muend, Director, Commercial Systems Program Office, NRO
- Alberto Valverde, Commercial Data and Analytic Solutions, NGA
- Philip Chudoba, Associate Director for Capabilities and Component Acquisition, NGA
- Mark Munsell, Deputy Director, Data and Digital Innovation, NGA
- Brent Strong, USN, NRO

NASA Space Leaders
- Alvin Drew, Defense Liaison
- Phil McAlister, Director Commercial Crew
- Patrick Besha, Senior Policy Advisor
- Dr. Zachary Pirtle, Program Engineer, Science Mission Director
- Dr. Erica Rodgers, NASA S&T Partnerships Office
- Dr. Christyl Johnson, Deputy Center Director, NASA Goddard

Regulatory and Licensing Space Leaders
- Kevin Coleman, FAA, Deputy Associate Administrator for Commercial Space Transportation
- Scott Leonard, DOC, Special Advisor Office of Space Commerce

- Karl Kensinger, FCC Division Chief International Bureau Satellite Division

Industry Analysts / Academics / Think Tanks
- Tom Stroup, President, Satellite Industry Association (SIA) w/ Bryce Technology
- Dr. Jeff Decker, Program Director Hacking for Defense, Stanford University
- Todd Harrison, Center for Strategic and International Studies
- Peter Garretson, American Foreign Policy Council
- Russ Rumbaugh, Aerospace Corporation

State & Local Space Officials
- Colorado Office of Economic Development, Lt Gov Dianne Primavera
- Colorado National Guard
- Catalyst Campus, Colorado Springs

Venture Capital Space Leaders
- Tom Loftus, Razor's Edge, Chief Technologist
- Asher Kraut, Starburst, Global Dealflow Manager
- Ric Mommer, Defense Innovation Unit, Commercial Space Portfolio

Space Start-Ups
- Capella Space
- Hawkeye 360
- LeoLabs
- Microsoft Azure
- Virgin Orbit
- Rocket Labs
- Relativity Space
- Slingshot Aerospace
- Astroscale
- Advanced Space
- Blue Staq

Major Commercial Satellite Operators
- Iridium Satellites
- SES Government Solutions
- Maxar

Major Space Manufacturers
- Lockheed Martin Space
- Boeing Space
- Northrop Grumman Space
- Aerojet-Rocketdyne
- SpaceX

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Thank you, Clark. Thank you, Lourdes. This semester was an amazing, eye opening, and challenging experience. We don't know that we're all rocket scientists, yet, but we have definitely learned and grown as professionals and plan to take and employ the lessons you taught us with us for the rest of our careers. Your knowledge, support, good humor, and (we'll admit it, sometimes necessary) patience were instrumental in building a collaborative and supportive learning environment.

You pushed us to learn and debate and while we can never put into words all that we learned and achieved, we hope this product does all your efforts justice in offering our humble opinions on how to better help the U.S. government and Space Industrial Base better cooperate and collaborate and take advantage of one another's abilities to advance U.S. national interests.

We also could not have done this without the senior government officials, local representatives, industry leaders, experts, and academics who took time from their busy schedules to meet with us and to enthusiastically engage us through an open and honest discussion. We are grateful for everyone's efforts to inform our knowledge of the U.S. government's efforts, industry strengths and challenges, and the opportunities available to the United States in the Space Domain. This is truly a collaborative space enterprise and together we are confident that we can and will do more.

The visits to firms and agencies in the National Capital Region and travel to Colorado and California were instrumental to the success of this Industry Study. These visits truly helped us fulfill Bernard Baruch's vision to "have a little school…to preserve experience, keep in touch with industry."[3] U.S. national security is intrinsically tied to the success of the industrial base; this was clear throughout our engagements with the space industry. The innovation in commercial markets is driving the expansion of capabilities and opportunities for the U.S. government and creating tens of thousands of well-paying jobs for Americans.

The advances and progress being made by the Department of Defense and U.S. Space Force in the couple of years since its establishment is impressive and we are also grateful for the time and guidance from USSF, from General Dickinson to the NCOs on the Ops Floor. Your dedication to your mission and to your people is commendable.

Finally, we want to acknowledge the essential mission of the National Defense University and the Eisenhower School. As soon-to-be graduates we are dedicated to upholding the legacy and heritage of this incredible institution and to bringing the leadership skills and knowledge we have developed this year in service of the United States.

Thank you,

-- Seminar 16 aka Team "Big Muley" aka Space Tigers

Seminar 16 Eisenhower School Space Industry Study Team

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Ms. Cynthia Rafferty – DoS, Financial Management Officer
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1. Introduction

U.S. national security space operations, and the supporting industrial base, are facing historic developments. Throughout the world, space activities are rapidly accelerating, resulting in new opportunities in multiple sectors and new challenges to U.S. space leadership.[4] U.S. space superiority is challenged by the urgent pacing threats of China and Russia. Both nations have quickly expanded the militarization of space by integrating space and counterspace capabilities into their national and warfighting strategies to challenge the United States.[5]

In response, the United States Space Force (USSF) has deliberately set a strategy to transform space acquisition to achieve speed to meet the need. Lt. Gen. Michael Guetlein, commander of Space Systems Command (SSC), has publicly announced this strategy, placing the USSF on the path to urgent military space acquisition. He recently noted at the 2022 C4ISRNET Conference, "... we've been sounding the alarm on 2026 … to get ready for either a crisis or a conflict that our nation depends absolutely on space. We need to take advantage of the resiliency that we can get into our current capabilities…"[6]

At the same time, a revolution is underway in the commercial space industry, distinct from the government space trends. This has led to an explosion of new companies, capabilities, and business models that are democratizing access to space and rapidly increasing the opportunities available to the U.S., our allies, and partners.

The academic year 2022 Eisenhower School Space Industry Study (SPC-IS) has written this report analyzing how to meet the urgent military challenges and take advantage of new commercial space opportunities. Both factors are key to fulfilling the ongoing U.S. Government strategy for "speed to the need."

After this Introduction, the paper is organized into several major analytic sections.

- Section 2 examines the key military challenges to U.S. national interests in space created by the pacing threats of China and Russia.
- Section 3 highlights several macro trends unfolding in commercial space markets, and how the USG can leverage those trends to retain (and in some cases regain) space-domain advantage at the speed to the need.
- Sections 4-6 present details of the "speed to the need" strategy, along three major Lines of Effort (LOE) to Achieve Speed and Resilience by 2026:

    LOE-1) Leverage Space-as-a-Service

    LOE-2) Leverage Allies and Partners

    LOE-3) Leverage all Space Talent and Expertise

Annexes provide detailed analysis of key industrial factors, current USG efforts, and supporting material.

2. Strategic Context: Key Military Challenges to U.S. National Interests In Space

The United States historically has benefited from significant advantages as the unchallenged global leader in space, both commercially and militarily. However, adversaries took note of these advantages and have now developed strategies and capabilities to contest the United States' ability to leverage space to project power globally. Of special concern are offensive space capabilities developed by adversaries to challenge U.S. freedom of operations in space. The next subsections provide concise overviews of Chinese and Russian counterspace threats which drive the strategy to achieve military space resilience by 2026.

2.1 Chinese Counterspace Threats

According to a report by the China Aerospace Studies Institute, China is transitioning from "major space power" to "strong space power" intending to surpass the United States as the

leading space power by midcentury."[7] As a major part of this effort, China is developing military space capabilities to destroy and disrupt U.S. space operations. As depicted in Figure 2, the challenges posed by Chinese investments in counterspace assets range across the threat continuum.[8] They include reversible actions like denial, deception, and jamming, to nonreversible kinetic weapons intended to permanently degrade and deny U.S. space assets.[9]

Figure 2 – SSC Counterspace Threat Continuum
Describes the range of different capabilities that could disrupt the operation of satellites in space across a continuum from reversible to non-reversible

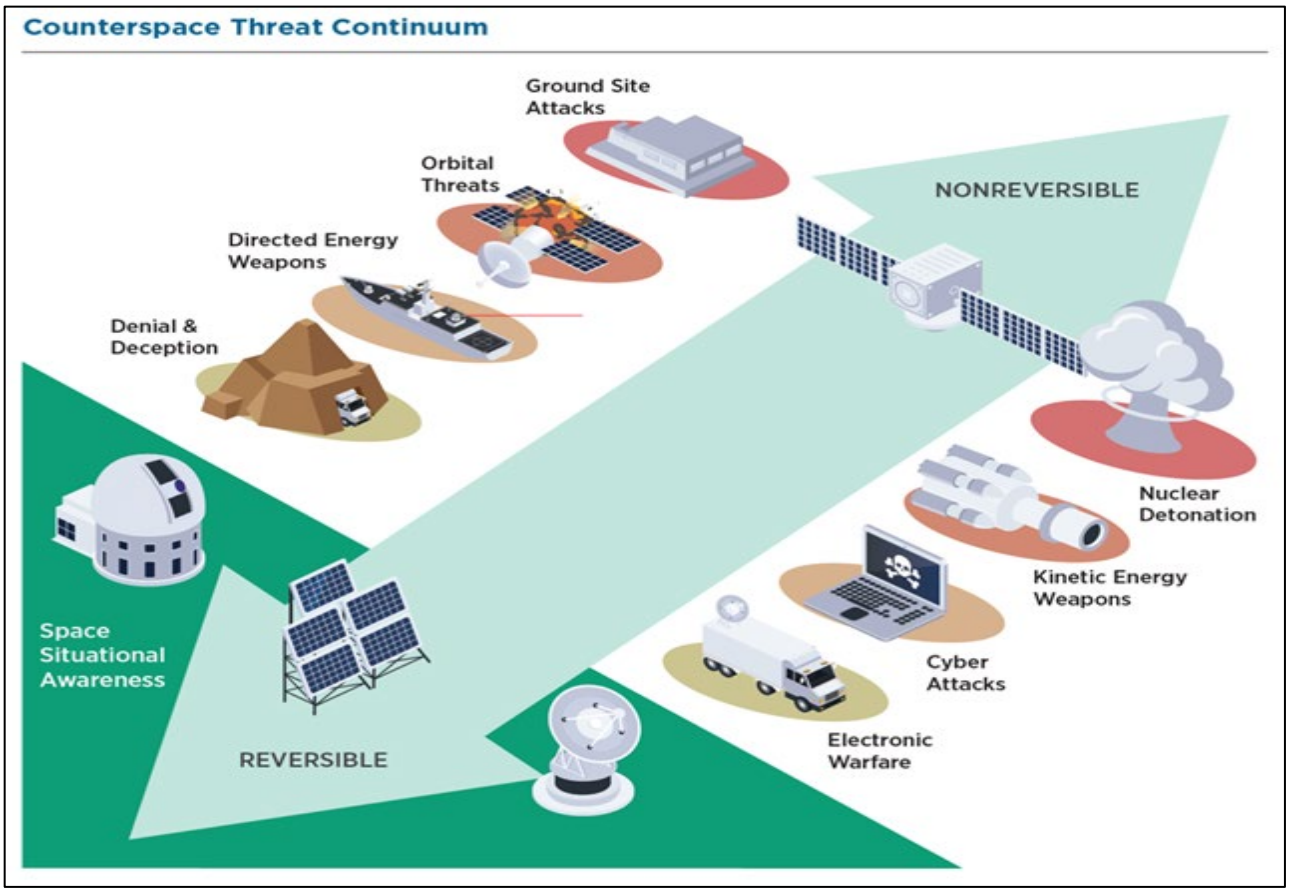


Figure 2. Counterspace Threat Continuum[10]

China's counterspace threats require urgent action by the U.S. military, since they have repeatedly demonstrated high degrees of operational readiness by multiple tests. The era of China's military threat to U.S. space operations began with their infamous 2007 antisatellite

missile (ASAT) test. A more recent example was their deployment of the Shijan-21 satellite, which in January 2022 demonstrated an ability to rendezvous and grapple with other satellites, intercepting a defunct BeiDou navigation satellite and moving it to a graveyard orbit.[11] They have also demonstrated jamming and spoofing electronic warfare capabilities they can use against both space and non-space targets.[12] Chinese cyber capabilities also present a threat up and down the reversible/non-reversible threat spectrum, to both USG and commercial space operations.[13] Additional details on China's counterspace activities are in Annex D.

2.2 Russian Counterspace Threats

Russia has a similar suite of capabilities to China across the counterspace threat spectrum. Russia demonstrated its direct-ascent ASAT capabilities in November 2021, by destroying an on-orbit satellite and creating thousands of pieces of space debris. They have also been actively using electronic warfare to jam GPS signals in the ongoing Ukraine conflict.[14] Russia has also claimed to deploy directed energy weapons, such as the Peresvet laser weapon, which the Russian Defense Ministry has labeled a new type of "strategic weapon" intended to "fight satellites in orbit."[15]

Of particular recent concern with respect to Russian space threats, U.S. officials have publicly warned commercial space operators to increase their cybersecurity defenses, in light of the conflict in Ukraine and the role being played by U.S. industry to support the Ukrainians.[16] These warnings followed the likely Russian cyber-attack on Viasat communications terminals in Europe which disabled tens of thousands of modems in the opening days of the conflict.[17] Annex A provides a more complete discussion of the role commercial space operations have played in the Ukraine conflict.

2.3 Threats to Ground Infrastructure

Threats to U.S. space capabilities are not limited to attacks on satellites in space. They also can be directed at ground infrastructure. Geography, history, and economics have conspired to create a limited set of ground stations for communication with satellites, including the USG's exquisite satellites. This reality creates a known vulnerability in the event of conflict. In addition to the potential threat of cyber-attacks on ground infrastructure or the terrestrial lines of communication connecting gateways to the rest of the U.S. network, in the event of an actual conflict, the potential exists for kinetic attacks on this limited ground architecture.

3. Reshaping Military Space Acquisition to Leverage Commercial Space Trends

3.1 Macro-Trends in Commercial Space Markets

Rapidly reshaping the U.S. military space architecture to be more resilient in the face of great power threats is requiring the USSF to make major adjustments in the way it partners with the space industry and the broader National Security Industrial Base (NSIB). A critical effort required to move toward a nimbler acquisition approach will be procurement of off-the-shelf commercial space capabilities using a "space as a service" approach. Space as a service promises to lower overall program costs while dramatically increasing the speed of fielding certain types of space capabilities.

For the foreseeable future, some national security missions will continue to require government ownership and operation of large, exquisite satellites, procured from specialized prime contractors using a traditional requirements-centric acquisition process. However, there are several macro-trends creating historic changes in the commercial space industrial base that offer hope for a different acquisition future, including the realistic leveraging of a space as a

service approach for military capabilities. The seminar summarizes the key macro-trends in the commercial space sector as follows:

- Rapidly expanding demand for space-enabled services, across multiple market segments
- A surge of new investments in commercial businesses to monetize space data services
- Innovative space technology trends, especially in launch and small satellite manufacturing

These developments are changing the game for everyone involved in space operations. Many new entrants are successfully leveraging innovative technologies and new business models, demonstrating the dramatic reduction in barriers to entry for space operations, in both the private and public sectors. Examples include reusable rockets driving down launch costs and the growth in the capabilities of small satellites. See annexes B and C for detailed information on business environments and dynamics in key space markets.

Together these recent developments have incentivized major commercial investment in new space companies, especially in the United States. This means in the U.S. key costs like technology research, product development, and space operations are shifting from the public into the private sector. Competitive forces create the efficiencies and business strategies needed for sustained innovation. The poster children for this phenomenon are the many space companies pursuing business plans using proliferated Low Earth Orbit (LEO) satellite constellations to supply broadband and earth observation services. These commercial business goals have created an entirely new space manufacturing sector, focused on mass production of high-capability small satellites. The end result of this virtuous cycle is the creation of more options for USG buyers, across the entire space value chain, at lower prices.

NASA has led the way in using innovative approaches to leverage commercial space contracts to meet government-unique requirements. They did this by modifying their acquisition strategy for certain mission sets, moving from owning and operating spacecraft to procuring space services supplied by commercial companies. These companies raise their own capital, own their space assets, and follow commercial business plans. NASA just buys the services. The key example of this is their Commercial Cargo and Commercial Crew contracts for resupply of the International Space Station. NASA's use of these space as a service contracts has reduced government requirements, dramatically lowered costs, and led to SpaceX quickly rising as a dominant launch supplier. This serves as an excellent example for this approach.[18]

While the macro-trends cited above have led to an expanding revolution in the commercial space sector, challenges remain on how the Space Force can leverage these developments. The next subsections examine challenges facing military space acquirers as they work toward a new partnership with the industrial base.

3.2 Gap Between Government and Private Sector Incentives

A persistent issue that hinders government initiatives to achieve rapid defense acquisition is the major gap in incentives between government officials and business leaders. Government acquisition officials must generally follow high-compliance, low-risk decision making protocols, including significant documentation and reporting requirements, to fulfill myriad rules and regulations governing expenditure of taxpayer funds. In contrast, commercial business leaders are incentivized by the dynamics of market competition, competition for customers, and competition for capital from investors.

This gap in incentives is especially true for start-up companies. The business goals of these companies are urgent and short-term, often simply the need to survive on a shoestring

using seed funding or venture capital, until they can achieve market viability and steady revenues to support their longer-term business plans. In an attempt to help with this dilemma, DoD has created a variety of entities such as the Defense Innovation Unit (DIU), SpaceWERX, and other innovation organizations. These entities try to help bridge the gap by providing small-scale grants or contracts to allow the companies to demonstrate their capabilities. Demonstration of government interest can also help these companies raise interest from commercial venture capital investors. Some VC firms have emerged, such as Razor's Edge, and Starburst, who specialize in the space start-up sector. They also act as mentors to new start-up CEOs, helping them translate and navigate complex defense acquisition rules to assist them in pursuing the government as a long-term customer.

Even with these positive developments, the process is still difficult for start-ups to navigate. This is demonstrated by the new DoD innovation website www.ctoinnovation.mil that maps out the organizations supporting innovation efforts. The website is simply a list. It provides little guidance on how to navigate the process of working with these organizations, or insight into how to move from an initial small contract to a longer-term contract that can be used by a firm to justify further private sector investment.

3.3 Limited Surge Capacity and Supply Chain Challenges

Another challenge facing the DoD, and Space Force in particular, is how to partner with the NSIB to achieve surge capacity in the event of a crisis. Many bottlenecks exist in the space value chain which make sudden increases in capacity difficult, including the following: long-lead or high-demand elements in supply chains; limited throughput in production facilities; limited supply of qualified workers; constraints on cleared personnel; finite space operations capacity, especially at space launch facilities. During the Space IS visits, senior executives, factory

managers, and line personnel, from large prime contractors to smaller businesses, referenced challenges in their ability to significantly increase production of manufactured satellites or launch rockets, even in the face of increased demand and funding from the USG. In general, most expressed doubts they could ramp up production without months or years to prepare.

The ongoing stresses of the COVID-19 pandemic have demonstrated the general vulnerability of national supply chains, including for the space industry. According to the State of the Space Industrial Base Report 2021, electronics, and particularly semiconductors, were in short supply in the space industry.[19] In addition, the space industrial base is currently facing a workforce shortage in some key areas, even without surge demands. Behind this human capital shortfall are the two large trends of retirement of Baby Boomers, and a reluctance of new workers to enter the manufacturing industry.[20] Lastly, the increasing number of mega constellations going into orbit is currently stressing domestic launch capacity, with some relief potentially on the horizon with the advent of new launch vehicles like the SpaceX Starship.[21]

These issues especially challenge legacy space programs, following legacy acquisition processes, and working with legacy space industry partners. Achieving speed and agility seems unlikely for these programs. However, in some key areas, there may not need to be major new infusions of funding to achieve the goal (though more money makes strategy easier for the recipient). Instead, several key extensions of already ongoing acquisition reform efforts may make it possible for the USG to move faster, close to budget neutral, while capitalizing on existing trends in the space industrial base.

In the sections that follow, this report suggests three Lines-of-Effort (LOE) for achieving the goal of "speed to the need" for fielding space capabilities. Each LOE includes specific recommendations on how DoD, the USSF, and others in the national security space

community can adjust acquisitions, organizations, approach to partnerships, and personnel management to create the space enterprise required to meet the counterspace threat environment. Many of these reforms will take time for the government to implement and more time for the private sector to respond. The need is urgent.

4. LOE 1: Leverage Space-as-a-Service

Recommendations Up Front:

1) Employ a "space as a service" sprint procurement effort **(Space Systems Command)**
2) Establish a Space Joint Interagency Task Force (JIATF) to coordinate operations **(U.S. Space Command)**
3) Re-evaluate how the USG manages space system information control, how it shares information with allies and partners, and how it increases awareness of and cross-cues across compartmented programs **(DOD/IC)**

To respond to the surging military threats to U.S. space operations, the national security space community must quickly leverage all possible options to get space capabilities into the "fight tonight." The DoD has taken fundamental strides to achieve this goal with the recent creation of the USSF, and by creating the position of Assistant Secretary of Defense for Space Policy (ASD(SP)). These organizational changes increase the authority and span of control of decision makers who coordinate efforts within the Department to enhance space defense and lethality. However, continued focus on implementation is required to ensure the ability to deter, and if necessary, defeat adversaries. Three recommendations are outlined below.

4.1 Employ a "Space-as-a-Service" sprint procurement effort in key areas

As stated earlier, Space Systems Command has set a 2026 goal for achieving major improvements in the space architecture to retain military space superiority. This places the need for action within the current Future Years Defense Program (FYDP). This time horizon means potential solutions are limited.

One solution that shows great promise is augmenting USG military space capabilities with commercial services. The USSF has achieved some success in this direction by broadening access to non-traditional providers based on use of its Adaptative Acquisitions Framework, released in January of 2020.[22] Using these new authorities has led to progress in expanding the pool of contractors pursuing government contracts. This initiative is supported by the expansion of organizations designed to capture commercial innovation: Defense Innovation Unit (DIU), AFWERX, SpaceWERX, Kessel Run, Space Camp, and PlatformOne. These innovation incubators have helped small firms access Small Business Innovation Research (SBIR) contracts to develop new technologies.

Building on the successes of the new acquisition framework and innovation incubators, the USSF should now push hard for a specific space as a service procurement initiative to quickly get space capabilities into the fight. The organizational foundation for this already exists with the creation of the Commercial Services Office (CSO). The office should focus on procuring existing commercial space services within this FYDP. This is a different focus than small-value SBIR contracts or small contracts using Other Transaction Authority (OTA).

In the Program Objective Memorandum (POM) for the FY24 budget, the USSF should include a budget request for new commercial space as a service contracts. Each key mission area should have an associated Contractual Line Number (CLIN). Based on the new services

emerging in commercial markets, the following CLINs should be established for space as a service: Commercial Signals; Commercial Wideband SATCOM; Commercial Imagery; Commercial SAR; and perhaps others. Awards should be issued as indeterminate delivery, indefinite quantity (IDIQ) contracts, funded using annual O&M appropriations to keep the contract vehicle viable.

The annual base budget for the space as a service IDIQ contracts could be sized to support steady state COCOM requirements, plus large-scale military exercises, such as Red Flag, European Command's Austere Challenge, and Indo-Pacific Command's Terminal Fury, etc. These exercises support thousands of participants and have the added benefit of sizeable, allied participation. Another key benefit of these contracts becomes clear in crisis response scenarios. Once such contracts are in place, USSF could request from OMB and Congress emergency funds to surge space services to the warfighter, without the need for new contracting. Perhaps as important, the budgets underlying space as a service IDIQ would create sustained demand for expanded production in the commercial space value chain in the U.S. industrial base. Annex F discusses in expands on these concepts by examining current Intelligence Community initiatives in commercial space acquisition. This may provide additional insight into how USSF might better leverage commercial services.

4.2 Establish a Space Joint Interagency Task Force (JIATF) to coordinate operations

The number of USG agencies with a role in space has long been a challenge. Table 1 depicts agencies and offices involved, as well as their primary roles. This complexity makes speedy decision making difficult, creating a dilemma when speed is needed to meet urgent military threats to space operations.

Table 1 – USG Space Offices and Organizations
Lists the offices, organizations, and charters of key players in the USG that may support tactical functions in the space domain

Department	Space Office / Organization	Charter
Commerce	Office of Space Commerce	Grow space economy, SSA, space weather
Defense	Space Force	Defense
Homeland Security	N/A	Space CI/CR, cyber
White House	National Space Council	Space strategy
NASA	Numerous	Civil space
State	Office of Space Affairs	Space
Transportation	Office of Commercial Space Transportation (FAA)	Commercial space safety
ODNI/IC agencies	Numerous	Space threat/space JIPOE

Table 1. USG Space Offices and Organizations

DoD has made some progress with the creation of the USSF and ASD(SP) to help improve interagency coordination. There are also very high-level policy coordination offices, such as the National Space Council and the National Security Council. However, there is currently no ideal coordination forum to rapidly resolve operational space issues that affect the interagency.

The USG should stand up a JIATF Space by 2025, under U.S. Space Command. The charter of JIATF Space would be to facilitate timely interagency collaboration with those supporting facets in the space domain (see depiction in Annex E). The JIATF Space organizational structure should be like that of JIATF South, with a two-star director position reporting directly to the U.S. Space Command four-star commander, instead of a four-star geographic combatant commander. This would put the space JIATF Space commander on equal footing with the SpOC West Commander and Deputy SpOC Operations Commander. The current situation in which each organization needs to create embedded and/or liaison positions,

with authorities to act on behalf of said organization, is ad hoc and limited by an organization's interest in and willingness to contribute to this collaborative apparatus.

There is currently no real means to ensure coordinated tactical space operations, let alone coordinated space acquisition strategies, across the entire USG space enterprise. This creates massive slowdowns across bureaucracies and agencies, making it nearly impossible for decision-making to stay ahead of the pacing threat. In the event of an actual conflict, there is no one empowered and capable of coordinating activities across the USG and NSIB. Creating a JIATF empowered to coordinate critical activities between interagency partners and the space industry at the speed of conflict is crucial to overcoming the pacing threat.

4.3 Break Down Excessive Barriers in Space Security Programs

Over-classification of space programs through supplemental control measures and Special Access Programs (SAPs) creates significant barriers to speedy space acquisition. In addition, undisciplined space security practices create massive problems in interagency and international collaboration, and to innovation in the space industrial base. At a 2021 Air Force Association event, then Vice Chairman of the Joint Chiefs of Staff General Hyten proclaimed, "in many cases in the department, we're so over-classified it's ridiculous, just unbelievably ridiculous."[23] These comments came after many years as the commander of Strategic Command, where he often had trouble speaking with other senior DoD and interagency leaders. General Hyten recalled when he met with Admiral Harry Harris, then the commander of Indo-Pacific Command, even their three-star deputies were not authorized to attend due to requirements for additional program-specific access.[24] Only a select number of individuals across the entire government have access to all of America's space-based capabilities.

The sheer scope of the American space enterprise is a massive challenge. There may not be a single person living who simultaneously knows all the military, intelligence, civil, and commercial space programs that could potentially contribute to national security in the event of conflict. Diving into the tactical level of which platforms have specific technical capabilities becomes even more difficult. Adding the burden of undisciplined security practices makes the problem nearly impossible.

The current structures and processes for classifying and declassifying national security information are archaic, expensive, and not sustainable in today's age of digital technology. Especially concerning over the long run, current security practices discourage or exclude a large portion of the commercial space industry (especially startups) from participating in national security space support. Over classification is a barrier to achieving the goal of placing space capabilities in the hands America's warfighters at the speed to the need.

The USSF should also look at how the USAF manages highly classified capabilities in the air domain. USAF has an effective process for keeping the details of critical future programs secure, while allowing enough openness to ensure good interagency coordination, and deterrent effects on adversaries. The security processes used for the B-21 Raider bomber and Next Generation Air Dominance (NGAD) fighter are good examples for USSF to follow, of highly classified programs that balance effective security with openness. Both are SAPs, yet DoD has acknowledged their existence and discussed general capabilities to create understanding of their missions. The acknowledged details of both programs are sufficient to guide general strategy discussions, and to help deter China and Russia, while still allowing USAF to conceal key capabilities.[25] The security classification processes for USSF classified programs must consider not only the negative impacts of information leaks, but also the positive impacts of allowing end-

users to cooperate in planning to maximize the impact of fielding the capability, creating one more avenue to speed capability to the fight.[26]

5. LOE 2: Leverage Allies and Partners

Recommendations Up Front:

1) Incorporate alliance and partner expertise at both state and industry level into the space acquisition process **(USSF, OSD, DOS)**
2) Reform ITAR to create a new mechanism that controls data sharing and sales in a manner similar to the intelligence sharing arrangements **(DOS, DOC, DOD)**
3) Maximize NSIB capabilities by contracting for and broadly sharing unclassified information with partners using the Ukraine example **(IC, Combatant Commands)**

The U.S. approach to meeting security challenges has always centered on a coalition of allies working collaboratively. Military space collaboration has not developed as quickly as in other domains. However, a key part of a strategy to field space capabilities by 2026 now depends on rapidly integrating allied space capabilities, and more broadly sharing U.S.-based space capabilities and information.

5.1 Incorporate alliance and partner expertise at both state and industry level into the space acquisition process

Many partners and allies have already fielded highly capable operational space systems. A very promising pathway for speedily adding space capabilities to the fight is to simply push harder and faster for collaboration among allies at the operational level, especially in the Indo-Pacific theater as a counter to China's space aspirations. To foster a truly collaborative allied space network, the U.S. should capitalize on existing strengths, rather than simply encourage

redundant systems. In the Indo-Pacific region, Japan is a highly capable partner, with a full-spectrum space industrial base. Australia's recent commitment to growth as a commercial, civil, and national security space player, along with their Five Eyes Alliance (FVEY) membership, make it a strong candidate for greater collaboration. India should also be considered as a potential space collaborator, albeit with a view to the long-term and focused on mission areas of mutual interest and historical strength. Table 2 summarizes Indo-Pacific space partners' existing capabilities, space industry expertise, national space priorities, and obstacles to sharing in space.

Table 2 – Potential Indo-Pacific Space Partners
Lists the potential space partners in the Indo-Pacific (Japan, Australia, and India) and their supporting capabilities, expertise, priorities, and current obstacles to sharing

	Existing Capabilities	Space Industry Expertise	Priorities	Obstacles to Sharing
Japan 	- Space Situational Awareness (SSA) - ISR	- Operations - Services - NASA-JAXA civil ties	- Defense in Space - Counter China gray zone ops	- Lacks membership in major alliance groups (NATO, FVEY) - Nascent space defense policy/org
Australia 	- Ground Station Support	- Integrated w/U.S. Space Command - Wideband Global Satcom (WGS) system	- Build all sectors (commercial, civil, and national security)	- Limited industry, infrastructure, and capabilities - Nascent space defense policy/org
India 	- SSA - Remote sensing - Exploration	- NASA-ISRO civil ties	- Population support - Counter China	- Nascent U.S. partnership - Ties to Russia & China - Nascent space defense organization - Lacks space defense policy

Table 2. Potential Indo-Pacific Space Partners

A strategy to achieve speed in fielded space systems and services must also consider how to incorporate allied space capabilities via international sourcing of new services and systems. When developing space acquisition strategies, the United States mostly sources from domestic industry, due to the historically sensitive nature of space systems, their national security requirements, and policies intended to promote domestic sourcing, such as the Buy American Act. However, the growth of space industrial capability globally has opened possibilities for leveraging allied and partner commercial capabilities. Including the space capabilities of partners and allies can help build long-term, international resilience across a collaborative/shared space industrial base, including a greater surge capacity in the event of conflict.

The 2021 National Geospatial-Intelligence Agency (NGA) Commercial GEOINT Strategy, for example, supports and strengthens the National System for Geospatial Intelligence by working with commercial providers and "providing a capstone vision for greater unity of effort and efficiency through transparency and partnership." One of the four pillars of the GEOINT strategy is to diversify and expand capacity and create a supplier matrix—including international suppliers—to match verified commercial suppliers with buyers, and buyers with other buyers, to create synergies and efficiencies.[27] [28]

To inform this supplier matrix, NGA performs a routine annual assessment of domestic and international commercial satellite providers, which has led to some surprising results. For example, Finland's ICEYE offers the world's highest SAR revisit rate, but U.S. company Capella Space offers the highest SAR resolution, demonstrating potential synergies between international and domestic providers. Another example is Argentina's Satellogic which leads the market for multispectral imagery. As explained by Dave Gauthier, director of NGA's Commercial and Business Operations Group, "It's incredibly important to have allies and

partners with you to complement your strengths with their strengths."[29] Space Force's SpaceWERX innovation hub similarly demonstrated a recognition of the potential synergies in 2021 when it co-sponsored an International Pitch Day for U.S. and UK space industry startups.[30]

5.2 Reform ITAR to create a new mechanism that controls data sharing and sales in a manner like the intelligence sharing arrangements

Related to allied collaboration, export control reform is another avenue to optimize speed in fielding space services and systems. The International Traffic in Arms Regulation (ITAR) controls the export of software and technical data related to national security. The Export Administration Regulation (EAR) controls technologies and data whose commercial export could lead to military applications by other nations. These are the two primary mechanisms that regulate space-related sharing by the U.S. industrial base. [31]

Critics of ITAR deem it too vague in its definitions, too quick to decline requests, and too long in processing, to make it worth trying to sell space capabilities and services overseas. The Department of State frequently amends ITAR because it regulates a wide range of exports in addition to technology and data, and a current draft amendment seeks to better organize the purposes and definitions of the regulations. Nonetheless, ITAR critics claim the amendment simply moves ITAR closer to EAR (governed by the Department of Commerce) but does not address the underlying issues of long lead times and opaque processes.

A more ambitious reform of ITAR would create resiliency and tie allies and partners closer to the U.S. by benefiting from the lessons that others have learned and injected into existing policies. Agencies of the IC rely on negotiated agreements to govern what is shared between the U.S. and its partners. These agreements can take many forms, i.e., bilateral, multilateral, single agency or multi-agency, and each agreement defines its own scope of sharing,

creating a stratified dossier of intelligence sharing relationships rather than an up/down determination. ITAR would benefit from this type of approach for data and information sharing, perhaps aligning itself with the IC's existing relationships as a first step, that would give the private sector much more room to compete and clarify where and what they can sell. Establishing a standing dossier that sets the parameters for sharing would speed the decision-making process for the commercial sector by reducing routine individual requests and setting resource expectations for the process of identifying, requesting, reviewing, and deciding individual cases in the future.

5.3 Maximize NSIB capabilities by contracting for and broadly sharing unclassified information with partners using the Ukraine example

Although ITAR reform will be vital to unshackling the domestic space industry and enabling it to compete on the international market, these reforms will take time to materialize. The revolution in unclassified, commercial space sensing is already opening opportunities for our non-FVEY and non-NATO allies to gain rapid and improved access to the space-related capabilities of the U.S. NSIB. For example, the availability of commercial GEOINT has the potential to allow the U.S. government to share intelligence and targeting information more rapidly with partners and allies.[32]

This potential for unclassified GEOINT has been exceedingly evident in Ukraine. Despite constraints on the sharing of formal intelligence with Ukraine, there has been a flood of high-definition satellite images, in both the public domain and via unclassified channels, that has been provided to the government of Ukraine. These images come from private companies such as Planet or Maxar, with fleets of satellites that act as "private eyes in the sky"—or, in this case,

space.[33] Several other commercial space companies have also provided support to Ukraine. Examples include:

- SpaceX is providing Ukraine with Starlink terminals to keep the country connected to the internet, and it is demonstrating resilience by responding with a high level of agility to Russian electronic warfare attacks.[34]
- In early March, HawkEye 360 noted that its radio frequency monitoring satellites were able to detect GPS interference conducted by the Russian military around Ukraine during the four prior months indicating Russian preparations for invasion.[35]

The USG can capitalize on the capabilities and willingness of these companies to support national security objectives—like U.S. Space Command's recently announced commercial integration strategy[36]—so that intelligence agencies can focus on their unique capabilities while integrating private industry information whenever possible. Relying on commercial as a service for many missions that can be carried out by the private sector, most of which are in LEO, the USG can focus its limited resources on developing more distant orbits and more exquisite capabilities, to include efforts in cislunar and establishing a presence on the Moon.

6. LOE 3: Leverage all Space Talent and Expertise

Recommendations Up Front:

1) Establish a Space Technical Corps **(USSF)**
2) Implement a Bounce-In, Bounce-Out (BI/BO) Model **(USSF)**
3) Adopt Continuous Evaluation (CE) for Clearances **(DOD, IC)**
4) Grow with Neurodiverse Talent **(USSF)**

As a new military service with a fresh mandate, the USSF could lead in establishing a civilian service with the expertise needed to drive success in the space domain. To achieve its goals, the USSF needs its own civilian technical cadre to work with its uniformed service to acquire, manage, and operate defensive and offensive space capabilities. However, as the newest player in the space interagency, the USSF competes for talent with private industry, and government agencies such as NRO, NOAA, and NASA that have their own talent pipelines and talent management practices.

Learning from past experience, the USSF and the USG's entire space ecosystem must incentivize Americans to participate in the government's technical talent pool, which will in turn, have cascading effects on improving innovation and technical development in the larger, non-government NSIB.

6.1 Establish a Space Technical Corps

The USSF should organize its space technical workforce based on the Army Medical Corps model. The Medical Corps organizes healthcare experts and manages their careers across the Army's different organizations and subspecialities. A Space Technical Corps could have its own specialized personnel policies, guidelines for promotion, training resources, and certifications in emerging technical disciplines that will be recognized and accepted across the NSIB. Space Technical Corps employees would be able to focus their careers on specific technical tracks of interest, selecting from assignments across the interagency or even in the private sector to develop their expertise, eventually advancing to an industry-recognized "master" role in their sub-specialty. Working with the larger NSIB, this Corps would be able to manage the development of employees, provide them access to necessary tools and data, and grow technical expertise necessary for American innovation and technology development.

6.2 Implement a Bounce-In, Bounce-Out (BI/BO) Model

Another opportunity to take advantage of skilled personnel who want to serve their country is for the USSF to implement a Bounce-in, Bounce-out (BI/BO) talent management model. This concept would allow for space subject matter experts to join the civilian service in an entry-level job for a specific discipline, but not be tied to that job, organization, or the government for the rest of their careers. Rather, they would be encouraged to move around between varied jobs and agencies within the government thereby exposing the employees to a diverse set of experiences. If at some point they decide to leave the government, for example to start a company or join an ever-growing space economy, their career service should encourage this, and create a process that makes the fluidity between the inside and outside seamless. The same model could also be applied to an individual that starts a career in the private sector, but later decides to join the government service, which may require a unique approach such as Constructive Service Credit.

With the Constructive Service Credit program, a well-established commercial worker could enter the Space Force outside of the accession requirements and earn a wage for their service commensurate with what they could earn in the commercial industry. This would provide an attractive option for commercial talent to consider service to their nation by joining the Space Force. The program also allows for members to take breaks in service to rejoin the commercial force, and vice versa, if they so desire, helping create an atmosphere more conducive to today's tech workforce which does not want to work in one job or one organization for their entire career. The USSF could do more to take full advantage of this program.

6.3 Adopt Continuous Evaluation (CE) for Clearances

A hinderance to the recruitment and retention of a Space Technical Corps with career flexibility is the challenge of obtaining and holding a security clearance across jobs. This affects the ability for both the USG and the larger NSIB, which has trouble justifying the costs of employing personnel for months or even years while waiting for clearance adjudication. The process could be greatly enhanced by initiating the clearance investigation as soon as students enroll in educational programs at colleges, universities, and technical training centers with a commitment to join the Space Technical Corps. Corps candidates meeting government security qualifications for consideration could opt to enter into a continuous evaluation program (CE) similar to those already implemented by the Office of the Director of National Intelligence (ODNI) and in the Department of Air Force.[37] Through this CE program, candidates would be eligible to be adjudicated for a security clearance for jobs in the government's Space Technical Corps or within the larger NSIB. Through the implementation of a technical management framework in partnership with the larger NSIB, the government could begin to address the NSIB's talent gap while making our workforce and private sector more agile.

6.4 Grow with Neurodiverse Talent

Under Executive Order (EO) 13548, the USG has an imperative to employ and retain a workforce that is inclusive of individuals with disabilities. Expanding the workforce to include neurodiverse talent is a unique way to add data science, computer programming, machine learning, and artificial intelligence talent that would be interested in a long-term government career. The term neurodiverse is often used in the context of autism spectrum disorder, attention deficit/hyperactivity disorder (ADHD), or learning disabilities. In recent years, many leading companies, as well as the Australian Signals Directorate (ASD), and the Israeli Defense Forces

(IDF), have modified their recruiting, selection, and talent management practices to include neurodiverse employees. In 2020, the National Geospatial Intelligence (NGA) piloted a neurodiversity hiring program and is now trying to roll out an inclusive hiring strategy. The neurodiverse talent pool in the U.S. is under-employed. Fewer than 12% of adults with Autism Spectrum Disorder hold jobs and only three percent live on their own.[38] The ASD and IDF have found that neurodiverse employees are excellent candidates for working in jobs requiring security clearances. Since most neurodiverse people on the autism spectrum believe in strictly adhering to rules, they pose a low risk for violating the clearance agreement and inadvertent classified information disclosures.

Employing neurodiverse talent is not without its challenges. For employers new to working with neurodiverse employees, non-profits or firms that specialize in preparing neurodiverse adults for the working world and helping employers recruit, select, and hire candidates can act as "social partners."[39] Neurodiverse peoples' behavior sometimes goes against what are commonly accepted as characteristics of good employees such as good oral communications skills, emotional intelligence, persuasiveness, and the ability to network. These hiring selection criteria serve to screen out neurodiverse candidates. Many organizations that target neurodiverse talent have modified their recruitment, interview, and talent management practices hiring practice, from interviews to create an environment in which neurodiverse employees can thrive. The USSF can similarly take better advantage of unique skillsets and increase access to specialized talent.

7. Conclusion

The USG continues to evolve its space capabilities to stay astride with strategic competition in space. This report identified three lines of effort to move ahead of strategic

competition in space. First, given the pacing threat in space, the USG must operate with speed and agility to outmaneuver its adversaries. This requires leveraging commercial space as a service, improving the speed the USG interagency partners collaborate in space, and removing security barriers to increase sharing across national and international agencies.

Second, the USG needs to achieve speed and resiliency with international allies and partners. To accomplish this, the USG must incorporate expertise from allies and partners into U.S. space acquisitions, reform ITAR to maximize data sharing and sales with foreign partners, and increase sharing of unclassified data with the NSIB to greatly enhance its capabilities.

Third, the USG needs to optimize and retain space expertise. This can be accomplished by creating a space technical corps, championing a Bounce-in, Bounce-out model, utilizing continuous evaluation for security clearances, and expanding by recruiting neurodiverse talent.

Building a foundation that maximizes speed, increases international partnerships, and creates a large space talent pool in adherence to these three LOEs is crucial to outpace the pacing threats and challenges in space. Go Space Tigers!

Annexes

Annex A

Ukraine in Space

Overview

Ukraine's ability to resist Russia's invasion has depended, to a certain extent, on Ukraine's ability to leverage the space domain either directly or through the space capabilities of partner nations. The advantages space is providing to Ukraine are likely to continue through all phases of combat operations, stabilization, and the eventual recovery. From major space powers to developing nations, the whole world can see how space is supporting Ukrainian defenses and counter attacks, undermining Russian narratives and information operations, and keeping the Ukrainian government online and operational. The first *commercial* space war will change national strategies, doctrines, and commercial markets. Now is the time to adapt to take full advantage of the capabilities demonstrated by commercial space to further support Ukraine, undermine Russia, and advance U.S. national interests.

This annex looks through the lens of the Russian-Ukraine conflict at how the U.S. arrived at a unique convergence of space markets dynamics, geopolitical events, and U.S. foreign policy. The events taking place within these categories are creating new stressors for the space industrial base that are leading to increases in capability and capacity as well as creating opportunities for growth. When possible, this annex provides recommendations based on past performance, current demands and trends, and future unpredictability.

Years in the Making

The space defense industrial base (DIB) of 2022 is not the space DIB of the Cold War. The space industry has grown rapidly in recent years with an explosion of new entrants and massive growth, resulting in a space enterprise that is remarkably different even since the most recent U.S. National Defense Strategy (NDS) was published in 2018. In the current conflict in Ukraine, the space domain is playing a critical role, including through intelligence surveillance and reconnaissance (ISR), satellite communication (SATCOM), precision navigation and timing (PNT), and the broader economic and geopolitical dynamics given both Ukraine and Russia compete globally in space products and services markets. The conflict provides a number of opportunities to support Ukraine and undermine Russia while advancing U.S. national security imperatives.

Intelligence, Surveillance, and Reconnaissance

ISR is the most obvious space capability being used in Ukraine. While there is now an insatiable appetite for commercial imagery of Ukraine, the commercial space ISR market was relatively immature only a few years ago. Several ISR startups were having trouble establishing a competitive business strategy. They are all making money now; commercial ISR products and services have demonstrated their value thanks to their cost sensitivity (compared to the large defense primes) and operationally relevant capabilities (i.e., resolution and revisit rates) that have proven beneficial for the Ukrainians and also for information operations that have resulted in the release of much of this imagery to the public.

The commercial ISR market has also proven remarkably capable in providing data to support war crimes investigations in Ukraine, with both electro-optical and radar observations

available at high revisit rates. The veracity of this imagery combined with its releasability compared to governmental produced products makes it ideal for such use cases. In groundbreaking ways, companies like Cognitive Space, Maxar, Planet, BlackSky, and Capella Space have been generating troves of data useful to the United Nations and the International Criminal Court (ICC) investigations.[40] It will be important that many of these same companies continue to work hand-in-hand with the USG, international agencies, and Ukraine following the conflict to support the enormous disaster recovery and rebuilding effort that will be required.

Although these market developments benefit U.S. national security needs, the same outcomes would not have been possible five years ago, and the question remains whether these markets will be healthy and competitive five years from now. Commercial space-based ISR business strategies are generally built around rapid, inexpensive manufacturing using commercially available parts that results in less-hardened satellites with shorter lifespans and tighter time margins to bridge the deployment of next-generation constellations. Therefore, the confluence of events that resulted in robust commercial products available in 2022 could dissipate over the next few years if demand falls or the supply chain falters. From a policy perspective, the central question should be whether the current record high demand signal for space based ISR is in fact a new benchmark or a temporary bubble that needs to be characterized as such to the space DIB.

Reviews of operational plans should include an assessment of commercial ISR to create a demand signal for the private sector and help guide their investment strategies to keep these capabilities viable and on orbit. This assessment should be calculated based on the new understanding of how unclassified releasable imagery can shape partner operations without direct U.S. military engagement. The assessment could also look at beneficial uses of space ISR,

such as helping to rebuild Ukraine and possibly tracking and publicizing Russia's malign activity around the world to undermine their propaganda and ability to meddle in foreign countries. Although such plans may never be required and no individual contract is guaranteed, these assessments should be consolidated and shared with a consortium of commercial space based ISR companies to set a potential but more realistic future demand signal.

NRO's yet to be finalized Electro-Optical Commercial Layer (EOCL) Program is sending mixed messages to industry and confusing these demand signals for the commercial sector. The program had decided by the fall of 2021 to expand Earth Observation (EO) contracts beyond the existing Maxar contract to include competition from Planet and BlackSky but as of this writing the contracts are not expected to be finalized until summer of 2022.[41] While the reasons for the delay are not clear, multiple years of market analysis by NRO may already be out of date, given the extant demand for EO imagery related to Ukraine.

Commercial Synthetic Aperture Radar (SAR) imagery products, firms, and markets may have been assessed as untested for national security purposes prior to the Russian invasion of Ukraine. However, there should be little doubt now that commercial EO products alone are insufficient to publicly convey the characteristics of a dynamic, high-intensity conflict. SAR imagery has shown great utility for all-weather coverage over Ukraine, but limiting the EOCL Program to EO-only threatens the viability of the commercial SAR market. Although NRO signed contracts under the Strategic Commercial Enhancements Broad Agency Announcement (BAA) framework to "buy commercial space capabilities" beyond EOCL with Airbus U.S., Capella Space, ICEYE U.S., PredaSAR, and Umbra, the BAA sought modeling and simulation data and not the imagery which has proved so useful for the Ukraine conflict.[42] **NRO should**

expand its acquisitions strategy to purchase SAR imagery as a service along the lines of the planned EOCL Program.

Given the utility of some of the commercial space ISR products that were only being studied only a few months ago, combined with the diversity of roles of U.S. departments and agencies in the Ukraine conflict, it is worth asking if the role NRO plays as the central clearinghouse the best way forward? **While the NRO can and should continue to provide analysis of commercial services, track all contracts for space-based services, and offer the interagency the opportunity to contract through NRO mechanisms, it should not monopolize these engagements with the private sector or limit other departments and agencies from seeking separate contracts.**

Satellite Communications (SATCOM)

Although commercial space ISR markets were only starting to mature before the Ukraine conflict, the commercial SATCOM markets were mature. The commercial SATCOM market for fixed or mobile services has many players with different offerings. When Russia invaded in February 2022, Ukraine appeared to rely primarily on terrestrial communication services with SATCOM provided by KA-SAT (European-owned KA-SAT was acquired by U.S.-owned Viasat in 2021).[43] SpaceX's Starlink, a new entrant, provided an incredible opportunity to demonstrate the value of its technology. Starlink is providing high-throughput access through its LEO constellation as a beta service that can be reprogrammed on the fly and with ground terminals having dynamic/flexible characteristics.

SpaceX not only overcame the logistical hurdles of getting thousands of terminals into a war zone, but it updated software to be more resistant to local jamming and implemented design changes that increased the flexibility to power the ground terminal off-grid. If the U.S.

government and space DIB are still seeking an example of modern agility in the space domain, Starlink's provision of connectivity to 150,000 new users following a major cyber-attack, invasion, and broad communications degradation, demonstrates the future of COMSAT and of continuity of operations.[44] Ukrainian government officials have been clear that their ability to operate their government, exercise command and control over the military, engage with the outside world, and undermine Russian propaganda and information operations has become almost entirely dependent on internet access through Starlink.[45]

Position, Navigation, and Timing

Prior to the invasion, public access to GPS and increased market potential for space was prominent in Ukraine and Russia. Russian jamming of GPS signals has come as no surprise, but it demonstrates the degree to which PNT is a military capability and seen by Russia as a legitimate military target. In early March, space startup HawkEye 360 noted that its radio frequency monitoring satellites were able to detect GPS interference conducted by the Russian military around Ukraine during the four prior months indicating Russian preparations for invasion.[46]

Russian Space Retaliation

The international community's response to the Russian invasion of Ukraine, both economically and politically, has resulted in Russia's departure from a number of commercial and civil space projects, leaving gaping holes that the U.S. commercial space industry will rush to fill. Behind China and the U.S., Russia's launch industry had been both storied and strong, holding a steady position as launch provider to companies and countries across the globe. Since the invasion, however, these relationships have largely ended.

For example, OneWeb, a UK-based satellite broadband provider and rival to SpaceX's Starlink constellation, announced in March that it had terminated its launch agreement with Russian state-run Roscosmos and shifted their launches to SpaceX.[47] Despite Russian unwillingness to refund payments, more launch customers are likely to choose to move toward less politically fraught providers who are not subject to American and European sanctions. Launch demand is at record high levels, leaving SpaceX poised to benefit from the Russian withdrawal as the provider of roughly two-thirds of the global launch demand by weight (the bulk of the remainder belongs to China).[48] More broadly, both the traditional launch providers like United Launch Alliance (ULA) and newer entrants like Rocket Lab, Astra, ABL, Firefly, Virgin Orbit, and Astra all stand to benefit. These companies will also benefit from the expected boost in satellite services as demand increases by customers who have now seen the value of various space-based services in the ongoing conflict.

In a retaliatory move, Russia terminated rocket engine sales to the U.S., a dependency that Congress has been advocating to eliminate since 2015. Ironically, 'peace dividend' budget cuts and post-Soviet Union anti-proliferation efforts created such enduring dependencies and gaps in our launch capabilities and expertise. Development of advanced liquid propulsion engines, such as the Aerojet Rocketdyne J-2X, MB-XX or more recently the AR-1 were repeatedly curtailed for budgetary and other reasons. ULA turned to Russia for RD-180 engines for the Atlas V to satisfy National Security Space Launch (NSSL)[49] requirements, as did Northrop Grumman (NG) with the Russian RD-191 engine for its Antares 200-series rocket used for International Space Station (ISS) resupply missions.[50]

Coincidentally, the first stage for the Antares 200 is manufactured in Ukraine by Yuzhnoye SDO and Yuzhmash, leveraging the extensive rocket development expertise and familiarity with integration of Russian engines resident there. While NG's Antares-launched Cygnus missions were intended to reduce dependency on Russia for ISS resupply and strengthen the U.S. space industrial base, the invasion of Ukraine has likely stymied this effort—at least in the short term. The legacy U.S. propulsion provider, Aerojet Rocketdyne, and a slew of newer entrants to the U.S. liquid propulsion market will undoubtedly offer alternatives, while support to Ukraine's space industrial base post-conflict has the potential to play an instrumental role in the resurgence of the Ukrainian economy.

ULA's decision to cease production of the Russian engine-dependent Atlas V and move to the more advanced Vulcan rocket with Blue Origin BE-4 first stage engines is a blow to Russia's Energomash engine producer and a boon for one U.S. propulsion producer. Overall, however, the U.S. propulsion industry is fragmented and at risk of losing its specialized human capital expertise and exquisite capability without an informed, deliberate public-private partnership to reinvigorate propulsion development and train the next generation of propulsion engineers. **The current geopolitical situation offers an opportunity to finally close these key U.S. rocket engine gaps and displace Russia's long-held position as preeminent supplier in this class through restoration of development funds for engines such as the AR-1, the J-2X, the MB-XX or equivalents within the U.S. space industrial base.**

While the U.S. has proven the speed and financial advantages of the NASA Commercial Cargo and Commercial Crew programs in mitigating that dependency with respect to the ISS, Dmitry Rogozin, the head of Russia's space corporation, has repeatedly intimated that Russia

may pull out of the ISS partnership sooner rather than later, leaving the U.S. and other international partners with some significant challenges and decisions.[51] Other international missions are seeing operational impacts from the war in Ukraine as well. For example, the European Space Agency suspended its planned launch of its ExoMars rover which was due to launch in the fall of 2022 on a Russian Proton rocket.[52]

Ukrainian Space Industry

Russia may have learned the dependency lesson years ago when, following the breakup of the Soviet Union, they peered across their border into Ukraine only to discover that Ukraine had inherited the fourth largest aerospace industry in the world.[53] Ukraine's National Space Agency manages a space industry consisting of 30 enterprises, scientific research institutes and design offices that collectively employ more than 16,000 and can boast ownership of a significant number of world-leading technologies in the space domain.[54] The industry produces roughly 100 rockets per year and has a number of ties to the U.S. and European space launch industries, such as providing portions of Northrop Grumman's Antares and ESA's Vega rockets and co-development work with various startups in the U.S., U.K. and Italy.[55]

Post-conflict, this robust space industry can play an important role in the rebuilding of Ukraine's economy as well as their national security, but while (as of this writing) the Kyiv and Dnipro hubs of the Ukrainian aerospace triangle have remained in Ukrainian control, the Kharkiv region is heavily contested. The space production facilities in these locations have been spared significant damage, possibly because Russia hoped to capture them intact, but if these fragile facilities, valued at billions of U.S. dollars are destroyed, significant resources and support will be required to rejuvenate this segment of the economy and bolster their national security.

Conclusion

When all is said and done, it is likely that we will look back on the Russian invasion of Ukraine as a landmark in the use of the commercial space domain, with corresponding impacts to the U.S. space industrial base. From establishing the use case for commercial optical and radar imagery and analysis to diplomacy and public awareness before conflict breaks out, to reinforcing the value of high revisit-rates and releasability during a conflict, the business cases for these small companies and many like them have been secured. While there will certainly be some trade space between these commercial providers and the more specialized and exquisite capabilities at the government level, the result will almost certainly be more complementarity between national missions and the commercial sector with positive impacts to resiliency and the pace of technological development.

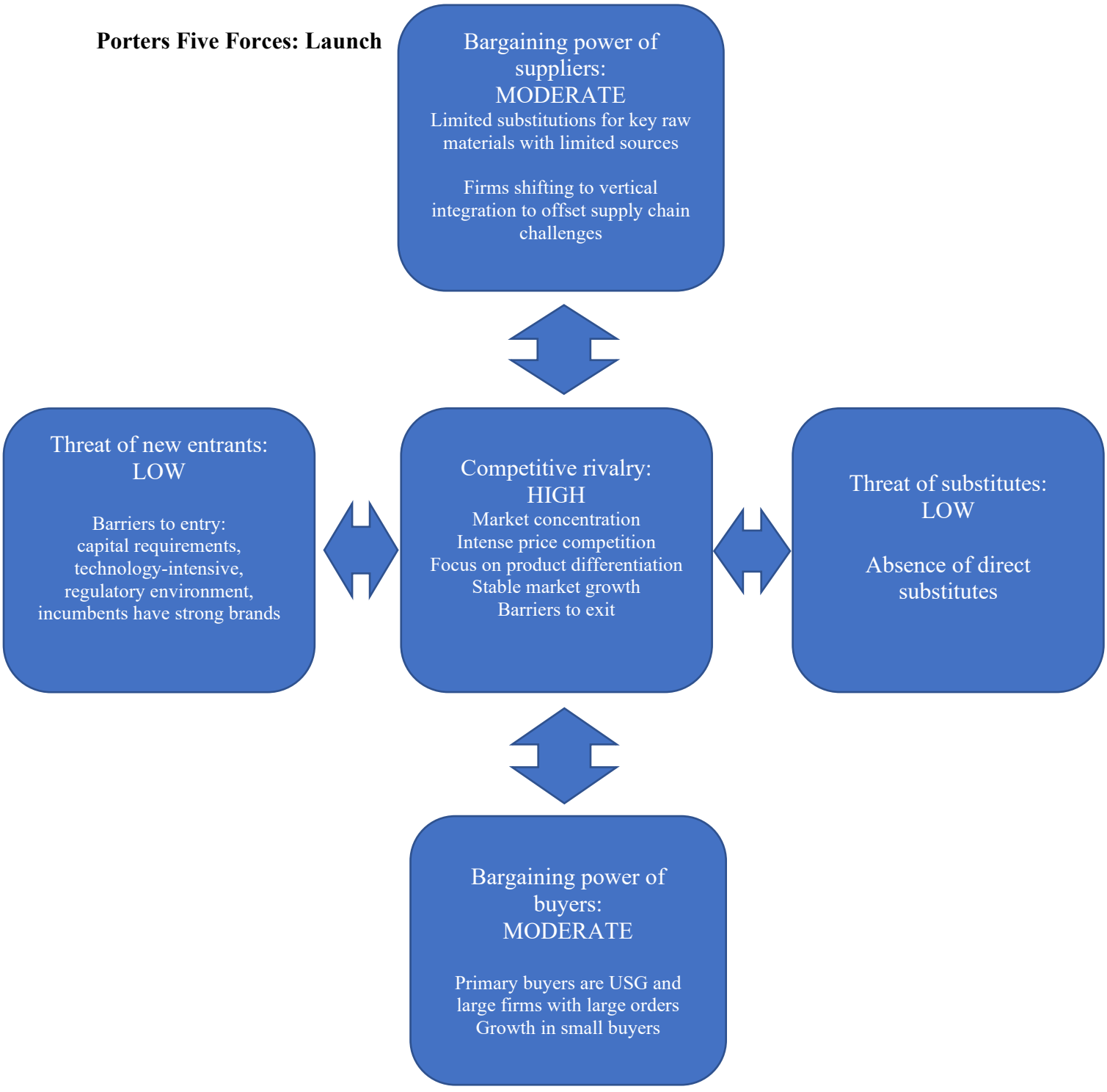
These developments can be catalyzed by continuing to build out the space infrastructure that provides the foundation for a burgeoning space economy, by supporting more public-private fixed-price partnerships like the Commercial Cargo & Commercial Crew (C3PO) and Commercial Lunar Payload Services (CLPS) programs, and by ensuring that U.S. space policy retains a focus on eliminating potential external dependencies while simultaneously maintaining the leadership role in advocating for international cooperation in space.

Annex B

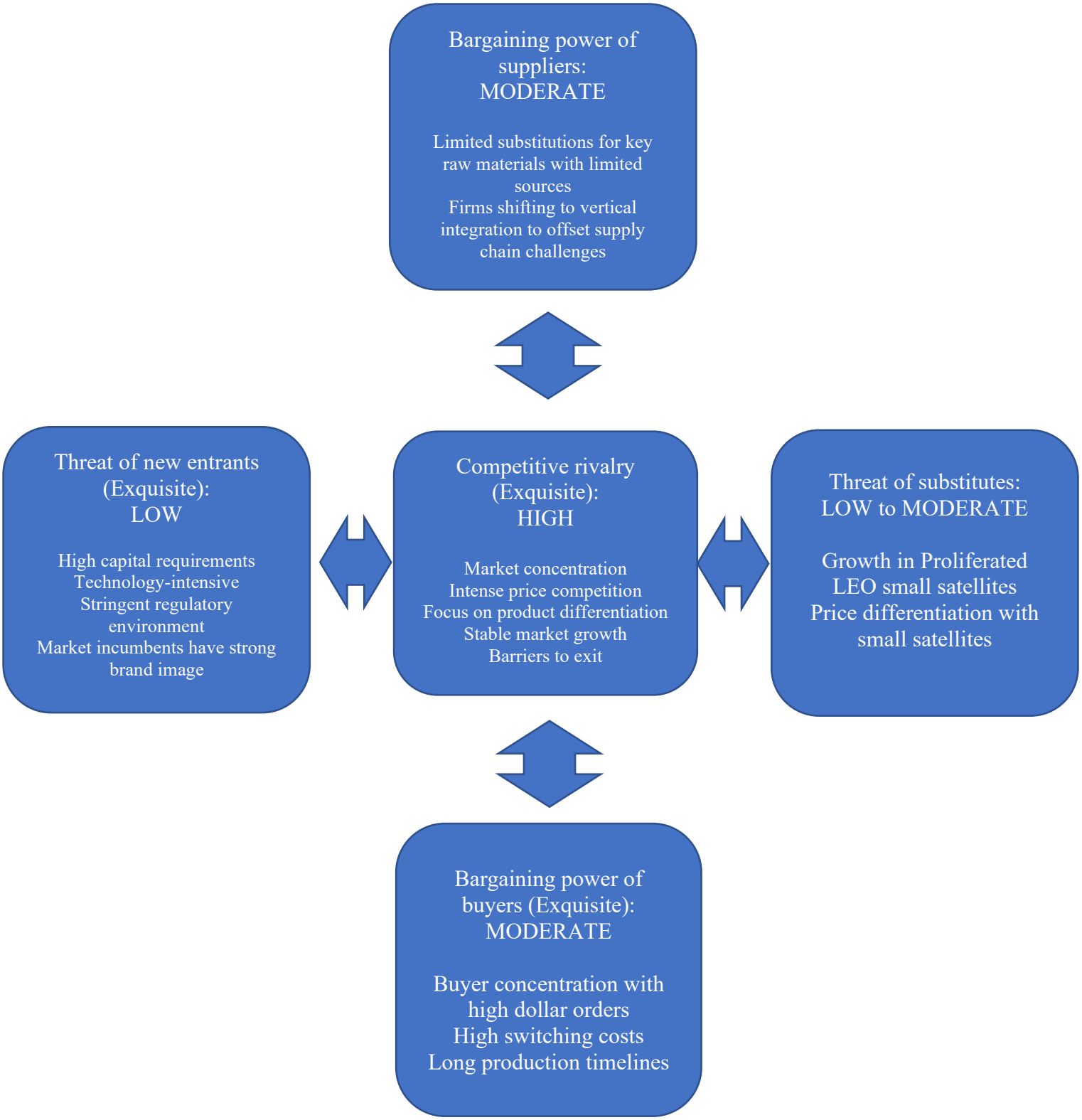
Porters Five Forces Analyses

This annex uses the Porter Five Forces model to analyze different space markets. Porters Five Forces examines how the bargaining power of suppliers, bargaining power of buyers, the threat of new entrants, and the threat of substitutes create competitive rivalry between firms. The markets analyzed are launch, satellite manufacturing, earth observation, and communications.

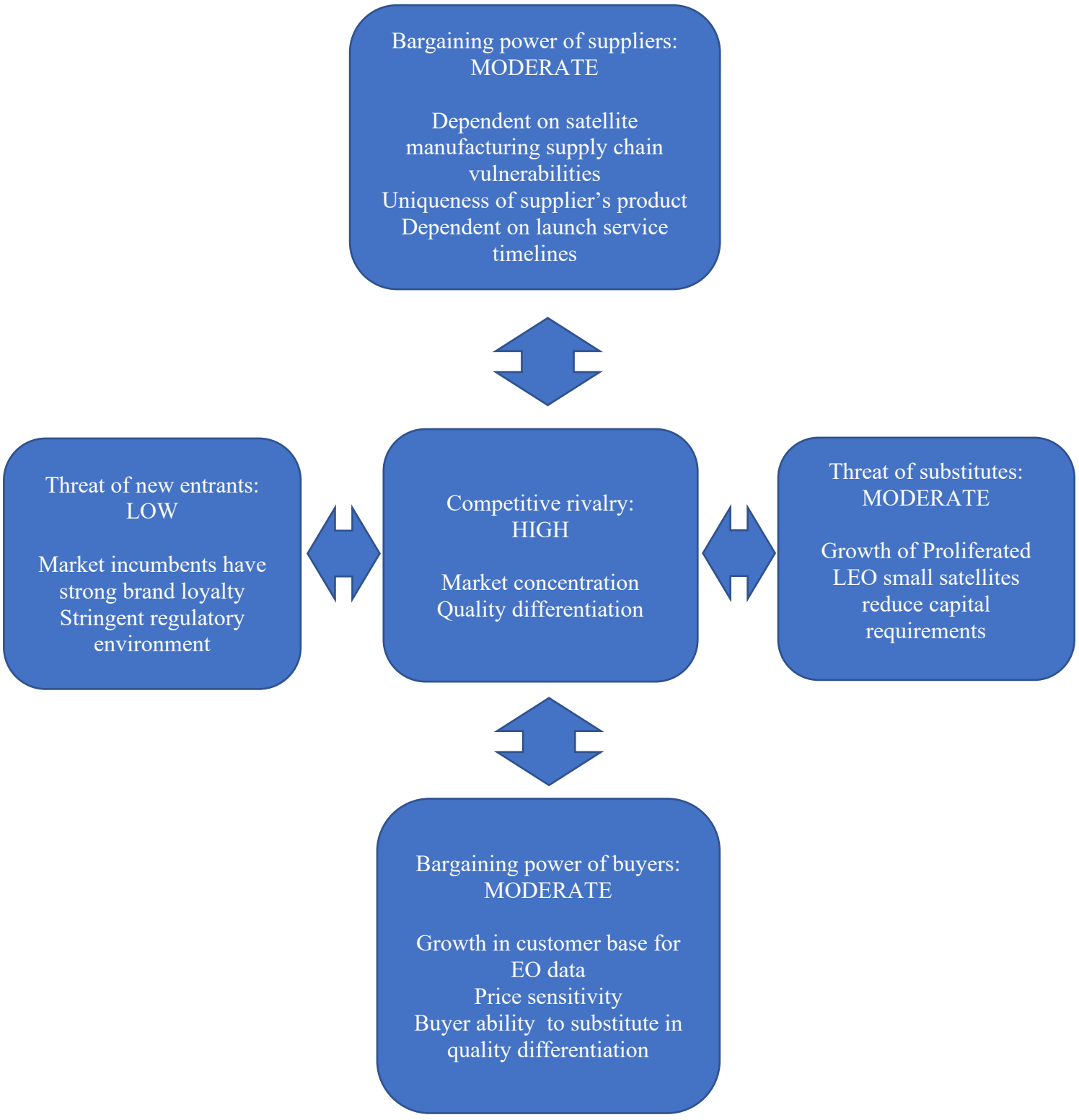
Porters Five Forces: Launch



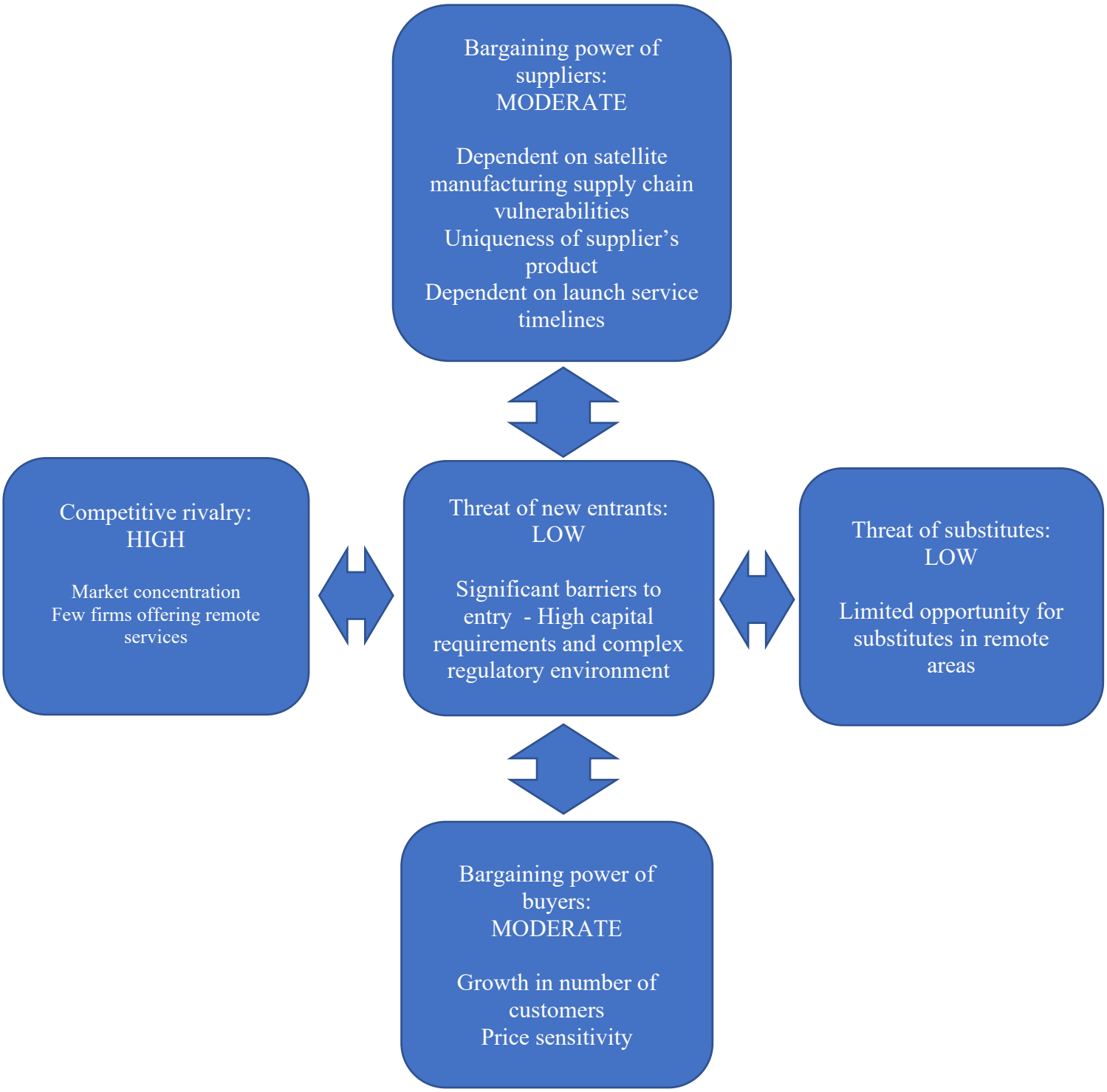
Porters Five Forces: Satellite Manufacturing



Porters Five Forces: Earth Observation



Porters Five Forces: Communications



Annex C

Stakeholder Interests, Structure-Performance-Conduct of Industry, Factor Conditions, Supporting Industries and Supply Chain

Stakeholder Interests

Space domain stakeholders are comprised of commercial firms and their suppliers along the space value chain, Congress, and various Executive branch offices and agencies, and military branches. All of these stakeholders possess unique individual interests which frequently compete and occasionally conflict.

Commercial interests include:

- Gaining or maintaining technological advantage over competitors
- Improving capability to maneuver through the complex regulatory environment for exports
- Receiving strong demand signals from public and private sector buyers
- Protecting against intellectual property (IP) theft and infringement, and
- Securing supply chains in an increasingly competitive geopolitical environment.

To mitigate risk to these interests, the commercial firms conduct lobbying, develop alternate supply chain options such as advanced manufacturing, and invest in research and development to bolster the competitiveness of product lines. Government entities, as customers of commercial sector products and services, must understand these commercial interests and how they intersect with agency or service interest.

National security interests demand that intelligence and executive branch entities maintain timely access to high-resolution imaging and other types of sensing data in key strategic areas. Government entities ostensibly evaluate how new commercial services can augment what

is provided internally by government products to provide a strategic advantage over pacing and emerging threats.

Defense interests prioritize maintaining space superiority to ensure the U.S. can continue to benefit from communications, ISR, PNT, and other space-based services, as well as sustaining a robust National Security Industrial Base (NSIB) to meet demand signals that support GPC advantage. The interests of defense-related entities supersede civilian interests that fall outside of the advancement of economic, science, and human exploration that support national security priorities. Defense entities monitor several key variables to determine if changes to these variables will impact defense space interests. These variables include industry trends and legislative deliberations to authorize and appropriate for space activities.

Legislative interests focus on economic growth drivers for congressional districts that support space activities and the interactions between private and public sector entities. Legislators typically act in the interest of their constituents – both commercial and individuals. The growth of the commercial sector, increased demand from the defense sector, and legislative efforts to support both sectors could strain the health and sustainment of the space industry and impact all stakeholders.

Structure – Conduct – Performance of Industry

Historically, the USG was the anchor customer in an *oligopolistic* space market dominated by a *few firms*. The large, primary firms of the aerospace and defense industrial base – including Boeing, Lockheed Martin, Northrup Grumman, and others – operated as "competimates" to efficiently and profitably build capabilities to meet the U.S. government's demand for high-end systems like exquisite and nuclear-hardened satellites and secure communications.

Today, there is a much more *competitive* space market with significant growth in the number and diversity of firms offering goods and services to *commercial and government buyers*, and the conduct of firms across today's space market differs significantly from that of the past. New entrants typically enter at the low-end of the market for spacecraft (e.g., small-class satellites), launch (e.g., low-earth orbit), and space-based services (e.g., commodity and back-up capabilities like low-resolution images and streaming data morale services) – aiming to win market share through the adoption of innovative technologies that enable them to deliver "good enough" products faster and at a cheaper cost.[56] To seize market share in the competitive commercial space market, these firms have adopted entirely different business models than those used by traditional space companies – namely, delivering capabilities as a service. To rapidly fulfill current demands for space capabilities, the USG should directly buy commercial services that meet government needs and requirements – without investing to build government-owned or government-developed systems. To take advantage of this opportunity, the USG must develop acquisition strategies, risk management approaches, and space force designs that integrate these commercial capabilities as services rather than government-owned systems.

Factor Conditions

Upstream components of the space value chain – including launch and large, exquisite spacecraft manufacturing – are *land*, *labor*, and *capital* intensive. However, recent *technological* and *entrepreneurial* innovations promise to reduce the factors required to produce these goods and services. For example, firms like SpaceX and Relativity Space use digital engineering, additive manufacturing, and autonomous robotics to print reusable rockets based on simple designs, driving down the cost, time, and resources required to build a rocket conceived traditionally as one-time use.[57] Improvements to *production efficiency* in launch and spacecraft

manufacturing make space more accessible and more affordable to public and private sector customers, such as companies downstream in the value chain whose business models depend on launch or spacecraft.

While downstream components of the space value chain—satellite communications and space data services—require less *land* and *capital* factors of production than launch and spacecraft manufacturing, they rely heavily on skilled *labor,* a factor in short supply across the space industry. Private and public sector organizations alike report a struggle to recruit and retain enough skilled staff to fill their billets and execute their missions. Although senior leaders in the USG often describe losing talented staff to the higher-paying private sector, the ubiquitous recognition of this "war for talent" suggests an industry-wide shortfall rather than a brain drain from government to industry. This talent shortfall is exacerbated by the convergence of short and long-term scientific, technical, and industrial priorities identified in U.S. national security strategy, including climate change, nuclear modernization, and the coronavirus pandemic.[58] Fulfilling national priorities to meet each of these challenges will overtax the same set of limited factors.

To summarize trends in market structure and production factors, markets across the space industry are becoming more competitive as increases in demand and lower costs of upstream services due to increases in production efficiencies create lower barriers to entry. This trend will cause the most disruption (and opportunity) in low-capital markets like space services. This trend will lag in factor-intensive markets like launch and manufacturing of exquisite and heavy-class satellites.

Supporting Industries and Supply Chain

Today, the space industry is completely interconnected with missions, technologies, and capabilities across industrial sectors. Space is an enabling capability for industries like global commerce, commercial air travel, and military missions across all domains. It is enabled by industries including manufacturing, information technology, and artificial intelligence (AI). Trends around the interconnectedness of space with other industries and domains are likely to expand in number and magnitude as the space industry continues to grow. For example, the decreasing cost of launch and proliferation of large constellations of small satellites in low-earth orbit will completely alter the relationship between the space and computing hardware and software industries. Historically, capabilities for on-orbit computing have been 20 years behind terrestrial computing because computers needed to be hardened for space and remained on orbit for the 15-year lifespan of the satellite.[59] However, satellites in proliferated LEO constellations will be replaced every 2-3 years by more advanced satellites. Additionally, advances in low-computing power algorithms like deep learning enable the development of – and demand for – satellites that operate autonomously with greater effectiveness. These factors are likely to have a direct effect on the computing hardware and software industries, stimulating increased demand for and accelerating innovation in on-orbit computers and AI.

Since the dawn of the space age, investments in space science, technology, exploration, and industry have benefited the security, prosperity, and vitality of life on Earth. Scientific and technological advances developed for space have been adapted to solve challenges in Earth-bound fields like health and medicine and the management of environmental and agricultural resources. Technologies developed for the harsh conditions and exquisite missions of space find alternative applications in consumer products like cell phones and drive productivity growth

more broadly. Estimates indicate that every $1 of investment in NASA returns $40 in value from modern technologies, businesses, and jobs.[60] Investments in space are dollars well spent toward strengthening U.S. science and technology capability to ensure U.S. economic prosperity and security.

Market structure and production factors for space markets

1. Satellite Manufacturing (Table 3)
2. Launch Services (Table 4)
3. Space Services (Table 5)

1. Satellite Manufacturing

Table 3 – Satellite Manufacturing
Market structure: Oligopoly moving toward perfect competition

Market Structure: Traditionally, ***oligopoly***; becoming more ***competitive***	
Seller Concentration	Few firms; trending up in small satellites sub-market
Product Differentiation	Highly differentiated
Barriers to Entry	High
Buyer Concentration	Traditionally mainly government (military and civil); growing number and diversity of commercial buyers
Growth Rate of Market Demand	Growing; growth is more significant at the low-end of the market (e.g., small satellites)
Production Factors	
Land	High
Labor	High
Capitol	Traditionally very high; significantly lower for cube and small satellites
Technology	High rate of technological innovation and change
Entrepreneurship	High rate of innovation in business models, e.g., Proliferated LEO

Table 3. Satellite Manufacturing Market Structure

Table 4 – Launch Services
Market structure: Oligopoly

2. Launch Services

Market Structure: ***Oligopoly***	
Seller Concentration	Few firms
Product Differentiation	Traditionally, identical products; trending up slightly with the growth of "rideshare" launch services

Barriers to Entry	High
Buyer Concentration	Traditionally mainly government (military and civil); growing number and diversity of commercial buyers
Growth Rate of Market Demand	Growing; growth is more significant at the low-end of the market (e.g., small satellites)
Production Factors	
Land	High
Labor	High
Capitol	High
Technology	Significant technological innovation and change, e.g., reusable rockets
Entrepreneurship	Moderate

Table 4. Launch Services Market Structure

Table 5 – Space Services
Market structure: Near-perfect competition

3. Space Services

Near-perfect competition	
Seller Concentration	Many firms
Product Differentiation	Highly differentiated
Barriers to Entry	Low
Buyer Concentration	Many commercial and government buyers
Growth Rate of Market Demand	Growing significantly
Production Factors	
Land	Low
Labor	High
Capitol	Low
Technology	High rates of technological innovation and change
Entrepreneurship	High rates of innovation

Table 5. Space Services Market Structure

Annex D

Table 6 – China's Counterspace Capabilities Tests
Describes China's testing through January 2022 of capabilities that could be used to disrupt the operation of satellites by other countries

Type	Year	Description	Comments
Direct Ascent	2007	KKV Test	
	2010	Mid-course ballistic missile defense test	
	2013	Mid-course ballistic missile defense test	
	2013	KKV test	Test to GEO. China called it "high altitude science mission."
	2014	KKV test	China called it ballistic missile defense test. U.S. called it ASAT test.
	2015	Unknown test	
	2017	Unknown test	
	2018	Mid-course ballistic missile defense test	
Co-Orbital	2010	Two Shijian satellites involved in close proximity operation causing slight change in one satellite's orbit.	
	2013	Three satellites involved in close proximity operation to test space debris removal and robotic arm technologies.	
	2016	Aolong-1 tested robotic arm to remove space debris	
	2016	Shijian-17 rendezvous with ChinaSat-5A	
	2019	TJS-3 satellite released probable subsatellite	
	2022	SJ-21 satellite docked with Compass G2 and pulled it out of geo orbit	China referred to it as debris mitigation test.
Cyber	2012	Computer network attack Propulsion Laboratory	Allowed "full functional control" over JPL networks.
	2014	Computer network attack against NOAA	
	2017	Computer network attack against Indian satellite communications	
	2018	Computer network attack against satellite operators, defense contractors, and telecommunication companies.	
Directed Energy	2006	Lased U.S. remote sensing satellite	Intent unknown.

Table 6. China's Counterspace Capabilities Tests through January 2022[61] [62]

Annex E

Creating a Space Joint Interagency Task Force

The USG space enterprise is balkanized with several different agencies doing vastly different things in space. No one has day-to-day insight or oversight into the various operations and activities. Clever adversaries, such as China, understand the limitations of key players supporting the space domain and operate effectively within the seams where there is no overlap in mission. Their fused approach across military and civilian space and between the public and private sector does not face these same challenges. Task forces, such as a JIATF, can be ideal organizations to bring the right offices and organizations together to act in concert to conduct missions quickly and efficiently at the speed of tactical operations. This effectively enables agile interagency engagement at speed while making impacts at the strategic level. Given the functional, budgetary, and statutory divisions among space operators, a JIATF is an ideal structure to take advantage of national interagency collaboration, and a shared resource burden that minimizes resource impacts on a specific agency. Ideally, the JIATF should be stood up in 2025 so it is prepared to manage space challenges by 2026.

The USG needs to overcome several barriers to managing global space challenges. It has created several organizations or offices that support various aspects of the space domain as depicted in Table 7. Individually, these offices and organizations only have minor impacts in the space domain, but together, these efforts can be timely and calculated to deliver power effects to those adversaries abusing the global commons. Certainly, strategic forums such as the National Space Council help to bring the right players to the table to discuss strategic challenges in space; however, this is not the appropriate forum to deal with real-time space crises moving at 17,000 miles per hour. A 24/7 JIATF with all the right players would be able to respond in real-time to

crises in space and share best practices and information across the civil/military/public/private divides.

Table 7 – USG Space Offices and Organizations
Lists the offices, organizations, and charters of key players in the USG that may support tactical functions in the space domain

Department	Space Office/Organization	Charter
Commerce	Office of Space Commerce	Grow space economy, SSA, space weather
Defense	Space Force	Defense
Homeland Security	N/A	Space CI/CR, cyber
Executive Branch	National Space Council	Space strategy
NASA	Numerous	Civil space
State	Office of Space Affairs	Space
Transportation	Office of Commercial Space Transportation (FAA)	Commercial space safety
ODNI/IC agencies	Numerous	Space threat/space JIPOE

Table 7. USG Offices and Organizations that Support Space

The Departments of Commerce, Defense, Homeland Security, State, and Transportation send representatives to support their respective missions in a JIATF as depicted in Table 7. Additional representatives from NASA, NOAA, the Office of the Director of National Intelligence (ODNI) and supporting IC agencies with stakes in space should also support the JIATF. These recommendations are based on offices and organizations that may have charters with tactical implications. It would fall under the U.S. Space Command and should be led by a two-star general. This would enable other agencies to send senior GS-15 or even SES Level V ranked personnel to represent and support their equities in the space domain. Additionally, this would put the space JIATF at a commensurate level with the SpOC West Commander and Deputy SpOC Operations Commander. The DoD would be the primary interface with the private sector due to its large growth of innovation centers and established touchpoints with the private sector.

Since the JIATF would be able to leverage additional resources from multiple national agencies; this creates burden-sharing that expends only limited resources from across several national agencies and organizations. Additionally, whenever it is time to submit the defense FYDP or other agencies' budget requests, the JIATF would require only minimal resources across the agencies. Therefore, this creates a minimal burden on any single agency or organization, but still creates a strong integrated force to combat adversaries in the space domain.

Annex F

Intel Community Efforts to Adapt and Integrate Commercial Space Services

The U.S. Intelligence Community (IC) has adopted and incorporated commercially derived earth sensing into intelligence production processes, as it can often be purchased *much faster* than traditional procurement processes for *a fraction of the cost* involved with imagery obtained through traditional 'exquisite' national intelligence collection satellites. To sustain this trend and leverage it to change IC business practices into the future, there have been fundamental changes in the way GEOINT-focused agencies view and utilize commercial satellite information services. In particular, the National Reconnaissance Office (NRO) and the National Geospatial-Intelligence Agency (NGA) have embraced the potential of commercial space services, giving significant attention to improving processes, both in acquisitions and in analysis and production, upending the status quo from when satellite-derived information was a highly guarded technology only available to the most powerful governments and intelligence agencies. The example set by the NRO, and the NGA could be a model for other agencies across the federal government to follow.

There has been a growing global trend toward the utilization of satellite imagery of the earth for civilian applications, which has only accelerated further in recent years due to a convergence of trends in the space industry that have led to the rise of large satellite constellations with remote sensing capabilities. These capabilities range from traditional Electro-Optical (EO) imaging, Synthetic Aperture RADAR (SAR) imaging, night-time imaging, infrared imaging, and Radio Frequency (RF) sensing.[63] These developments in commercial sensing technology, complemented by the advent of high-bandwidth LEO satellite constellation architectures driven by improvements in computing power and disruptive advances in launch

technology, have led to the 'democratization' of GEOINT we see occurring today. Ongoing trends in the space industry have allowed satellite service providers to increase capacity and competition, driving down the cost of satellite sensing as the civilian industry steadily adopts these technologies that had once only been available to space-faring nation-states.

The revolution of small satellites and LEO constellations could allow for near-real and real-time satellite imagery, making it feasible for global corporations to monitor all their assets at the same time and generate high-resolution visual data for individual companies, and governments, or those trading on global financial markets. The advantages of deploying small satellites for GEOINT services include lowered business entry barriers and faster deployments due to the reduced costs and improved surveillance capability made possible by the LEO constellations of small satellite 'swarms'. And there will be a swarm… before 2012, less than 100 satellites were being launched into LEO orbit. Since then, there has been a surge in activity, leading to a launch rate of hundreds in each of the past few years, with thousands more estimated to be ready for launch over the next 10 years.[64] By the end of 2021, NGA was tracking 111 different commercial imaging satellite constellations around the world (73 EO constellations and 38 SAR constellations). Those constellations represent more than 600 individual satellites, and by 2030, NGA predicts there will be more than 5,000 remote sensing satellites aloft as depicted in Figure 2.[65]

Figure 3 – Growth in Commercial Remote Sensing
Depicts the expected growth in global remote sensing over the next decade

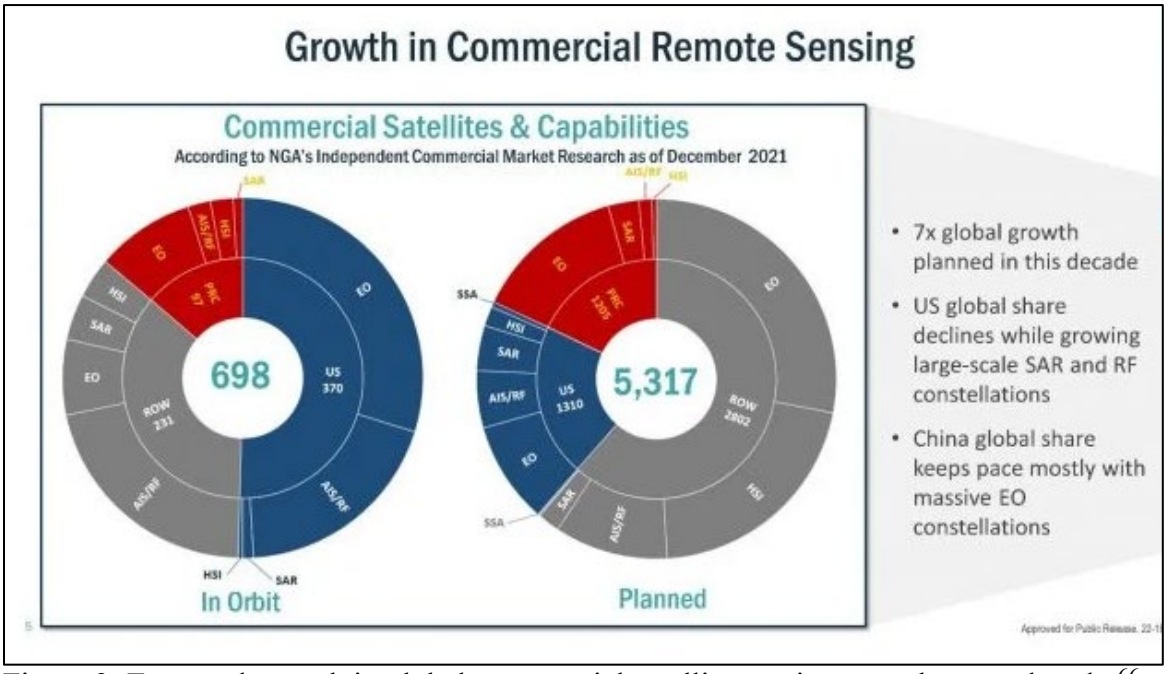


Figure 3: Expected growth in global commercial satellite sensing over the next decade.[66] *(Key: Rest-of-World=gray, US=blue, China=red).*

Fortunately, the Intelligence Community recognizes the potential for leveraging the explosive growth in commercial space capacity to complement its mission and is actively taking steps to embrace the revolutionary democratization of GEOINT. A new Commercial Space Council set up by the IC is designed to rethink how data and analysis are gleaned from commercial space systems to help speed intelligence products to users. There are five "standing members" of the council — the NRO, the NSA, the NGA, the DIA, and the CIA — plus "plenty of observers from other organizations."[67]

On the acquisitions side, the NRO, the main organization responsible for procuring and operating space-based collection systems in support of national intelligence requirements, is pursuing a major procurement called the Electro-Optical Commercial Layer program, which is currently in source selection. NRO has also introduced a Strategic Commercial Enhancements

Broad Agency Announcement (BAA) framework to establish a routine process for purchasing commercial space capabilities. The first contract under the BAA was awarded in early 2022 to five commercial SAR providers and will have six months of performance, with options to extend up to 30 months. According to Peter Muend, the director of NRO's Commercial Systems Program Office, the initial contract will focus on modeling and simulation data and a variety of specific concepts of operations, with the later stages of the acquisition process aimed at obtaining on-orbit data to validate the modeling and simulation assertions and may also have a mechanism for purchasing ad hoc imagery and data products. NRO ultimately plans to assess each company's radar capabilities and use the information as it develops new requirements, with the potential to lead to "operational contracts" and a program of record. While radar capability is the first focus area, the NRO is also looking at hyper-spectral imaging, RF sensing, and other emerging commercial sensing capabilities.[68]

On the analysis and production side, NGA has long championed efforts to expand its use of commercial imagery products to create a "hybrid" pool of up-to-the-minute geospatial awareness data and analyses for warfighters on the battlefield, as well as for the broader Intelligence Community. In the latest initiative on that front, NGA announced it had launched a new pilot program "to examine the viability of using commercial radio frequency geospatial data and analytics to support the agency's intelligence products." This pilot program is leveraging an NRO commercial integration study contract with HawkEye 360 to access commercially collected RF data for use by NGA. The RF-derived data is then integrated via NGA's Predictive GEOINT Prototype, which supports an agile development approach for exploring new commercial sources and analytics to support NGA's partners.[69]

The push toward 'commercial-first' has also been helped by another unexpected source – the COVID-19 Pandemic. David Gauthier, NGA's head of commercial space operations, stated a 'silver lining' of the COVID-19 pandemic has been that NGA has experienced "*a rapid cultural adoption of new commercial capabilities into our analytic workforce who traditionally because they're so overworked … have had a hard time adopting new sources*." As many analysts were working at home, he explained, they discovered what was easily available in the commercial arena. This change in the working environment created a new demand signal for some of these commercial services and new data types that didn't exist before.[70]

Carrying this 'commercial momentum' from the pandemic forward, NGA in particular has been aggressive about pursuing a commercial-first mentality, developing a new GEOINT Strategy that will direct agencies looking for GEOINT sources and products to use services offered by commercial companies before they consider government capabilities. This strategy is intended to be a paradigm shift in the way analysts and operators think about solving problems, by encouraging analysts to go against decades of historical intelligence community tradecraft that strongly prefers exquisite and highly classified systems, often disregarding open-source commercial sources.[71] Currently, it is estimated that more than a quarter of the imagery NGA uses today comes from commercial vendors, with an eventual goal to surpass 50 percent.[72]

In addition to raw imagery data, NGA has also been focused on commercial data analytic services. The agency has established three new service contracts in the last six months for commercial SAR analysis, radiofrequency emitter alerts, and economic indications and monitoring, respectively. The mentality is that if a commercial entity can provide analytic information as a service, it just becomes one more supply line of source information for NGA to conduct deeper intelligence analysis.[73] NGA has also leveraged a unique '*try before you buy*'

bailment agreement approach, which allows the agency to purchase commercial services for a brief period, test them out, and provide feedback to the provider. This has been particularly useful for more innovative experimental technologies, such as artificial intelligence and machine learning (AI/ML) solutions to help NGA analysts sift through mountains of collected data. A successful example was the Geospark Analytics contract for its AI/ML solution, which uses machine learning to process open-source intelligence—news reports, social media, economic data, weather, and more—to provide real-time insights and threat forecasts.[74]

Regarding the need for commercial AI/ML solutions—with the rapid proliferation of imaging systems, the sheer volume of available imagery now overwhelms human-centered exploitation. NGA's answer has been to use automated exploitation with algorithms designed for each unique remote sensing data type and each desired type of information. This creates detections of objects and activities that are of interest to intelligence analysts, instantly adding value to missions requiring change detection, area monitoring, statistical trends, and pattern analysis. As mentioned earlier, NGA has already launched its flagship multi-vendor contract for these services called Economic Indicator Monitoring, or EIM, and it intends to add more.[75] [76]

Finally, NGA recognizes the importance of *innovation* in the commercial space sensing services sector to continue developing new GEOINT capabilities at lower costs. To that end, NGA is leveraging the aforementioned bailment agreements to provide 'foot-in-the-door' opportunities for 'scrappy' space start-ups to begin working with the government immediately to test and evaluate new products and services for their potential mission utility. NGA calls this "*climbing the mountain*," depicted in Figure 4. Some of those companies will acclimatize to government needs and get the critical feedback necessary to make the next 'killer app' or high-demand analytic service that then gets purchased at scale for operational use. NGA has been

signing up approximately 12 companies per year with bailment agreements in pursuit of this goal.[77]

Figure 4 – NGA Pathway for Commercial Firms
Provides a defined pathway for companies to bring new services to NGA

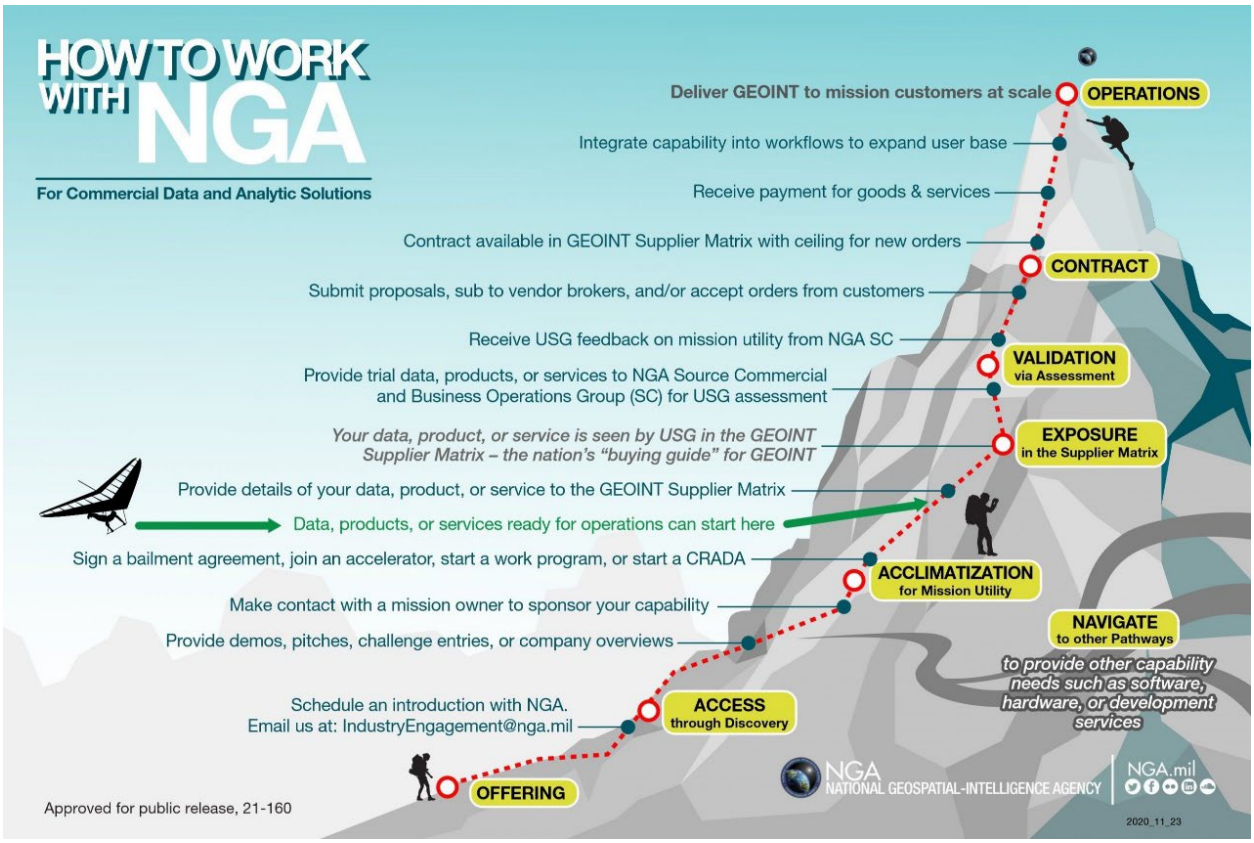


Figure 4: The Mountain - A defined path for companies to bring new services to NGA.

The massive growth in the commercial market for satellite sensing of the earth has resulted in the 'democratization' of GEOINT, as private industry steadily masters technologies that had once only been available to space-faring governments and nation-states. The US Intelligence Community has recognized the potential of leveraging this trend for efficiencies, cost savings, and to enable the rapid sharing of vital intelligence information at the unclassified level to partners and allies, traditionally a weakness of the Intelligence Community due to long-ingrained 'over-classification' tendencies. In particular, the NRO and the NGA have fully

embraced the potential of commercial space sensing, and are actively taking steps to improve procurement processes, promulgate strategies that prioritize commercial sourcing, and develop a process for collaborating with industry and encouraging further innovation in the commercial space sensing services, setting an example for other federal government agencies to follow.

END NOTES

[1] "Space superiority is the degree of control in space of one force over any others that permits the conduct of its operations at a given time and place without prohibitive interference from terrestrial and space-based threats. The purpose and value of space superiority is to provide the freedom of action in space in the pursuit and defense of national security interests."
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