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LEVERAGE AND PRESERVE: THE NEED FOR THE DOD TO STRENGTHEN SUPPORT FOR U.S. COMMERCIAL SPACE

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Executive Summary

Many U.S. commercial space companies have benefited from significant venture capital (VC) investment, including during the steady rise in VC investment beginning in 2008, which culminated in a spike in 2021. Since then, VC investment has fallen precipitously, dropping nearly 50 percent from 2021 to 2023. As U.S. defense space leadership seeks to use commercial space assets and services to a greater extent, the rise and fall in VC investment presents a dilemma and opportunity for the U.S. Department of Defense (DOD). The DOD can leverage commercial space assets and services that were paid for by other investors; however, given that some of the markets for commercial space services are immature, the DOD may need to serve as anchor tenant—being the biggest or main customer for a commercial capability—to ensure it can use these assets and services in the future.

For capability areas in which the market has not fully developed, such as remote sensing, space situational awareness, radiofrequency mapping, and alternative positioning, navigation and timing, the DOD should consider partnering with commercial firms that offer attractive defense solutions. In some cases, anchor tenancy may be a temporary approach to bridge the gap until a robust commercial market develops; in others, a commercial firm may be reliant on government revenue for many years. Government agencies may be reluctant to do this, but the DOD's costs in serving as anchor tenant should be weighed against the money that it would have needed to spend to build those capabilities itself. Additionally, the DOD's support for these firms would strengthen elements of the U.S. space industrial base that would be tenuous in the absence of government revenue. Leveraging U.S. commercial space assets and services to a greater extent could also mean preserving U.S. commercial advantages in space.

Introduction

The United States benefits from its accessibility to the largest commercial space sector in the world. Most of the active satellites in orbit are owned by U.S. companies, and the Satellite Industry Association's *2024 State of the Satellite Industry Report* estimates $180 billion in 2023 revenue from the U.S. satellite industry, more than 60 percent of the industry's global revenues.[1,2] U.S. companies span the spectrum of space capabilities—launch; ground services; satellite communications; electro-optical imagery; synthetic aperture radar; radio frequency mapping; weather; space situational awareness; and alternative positioning, navigation, and timing, among others.

The expansion and maturation of the U.S. commercial space sector has prompted the Department of Defense (DOD) to place greater emphasis on leveraging commercial space capabilities to meet the department's needs. Agencies and organizations within the DOD have developed commercial space strategies in recent years, including the first-ever DOD Commercial Space Integration Strategy and the U.S. Space Force's Commercial Space Strategy, both of which were released in 2024.[3] Even the DOD's 2022 National Defense Strategy notes the importance of the department's use of commercial space, the first-ever national defense strategy to reference commercial space.[4] While national space policy documents have endorsed the use of commercial space for decades, the DOD may be in the early stages of a step-function increase in both the breadth and intensity of actual utilization.

The DOD's push to leverage commercial space comes at a time when government demand may be particularly valuable for U.S. commercial space firms. A few years ago, commercial space companies benefited from significant public and private capital investment. However, that investment has fallen precipitously as a result of interest rate increases to tame inflation and the failure of several banks with significant venture portfolios, including Silicon Valley Bank, a leading source of venture capital (VC) funding. In aggregate, from 2021 to 2023, U.S. VC funding dropped nearly 50 percent.[5]

The current market conditions create compelling opportunities for the DOD. By making judicious and targeted decisions to sign long-term contracts for commercial services, the department can leverage past and future private capital and share the costs of supporting the continued development of the commercial space sector. This support could help ensure the DOD has access to a diverse, innovative set of commercial space capabilities when needed, while also help to position commercial space firms for sustained success amid changing market conditions.

Rise and Fall of Venture Capital

Over the last two decades, severe financial disruptions have led to significant U.S. government interventions in U.S. financial markets. In response to the global financial crisis in 2007-2008, the Federal Reserve and other global central banks supported the continued functioning of financial markets by dropping short-term interest rates to nearly zero. The Federal Reserve also bought mortgage-backed securities and other assets. This intervention led to a decade of historically low interest rates that made borrowing costs relatively low and investment capital broadly available, allowing companies with speculative business models to raise capital more easily. As a result, U.S. VC funding to startups rose steadily from 2009-2017, as reflected in Figure 1. These levels increased drastically between 2018-2020 before peaking in 2021 because of the government's large fiscal programs and a loosening of monetary policy in response to the pandemic.

This investment environment, along with other factors, converged to foster a rapid increase in the number of new U.S. commercial space companies. These companies benefited from increasing stock market performance and strong initial public offering valuations. The commercial space sector received additional capital through the use of special purpose acquisition companies (SPACs)—publicly traded vehicles that exist to acquire promising private companies, effectively providing those companies with access to public markets without going through an initial public offering, or IPO. SPACs have existed as niche financial vehicles for decades, but the low interest rate environment transformed them into significant fundraising vehicles beginning in 2020 (Figure 2). Several space companies that were founded just five to ten years prior

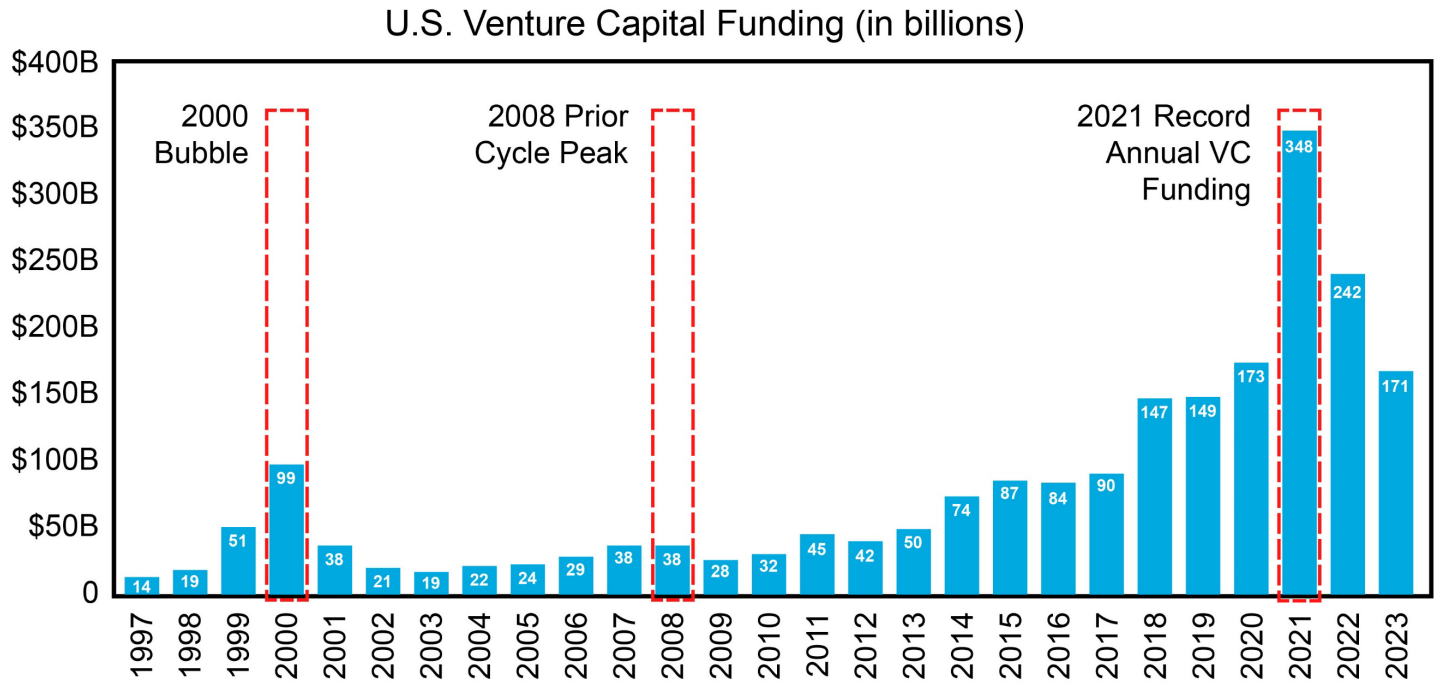

Figure 1: U.S. venture capital funding (in billions) from 1997–2023.
(Source: The Aerospace Corporation analysis using data from National Venture Capital Association, Pitchbook, Thompson Reuters, and PwC Moneytree.)

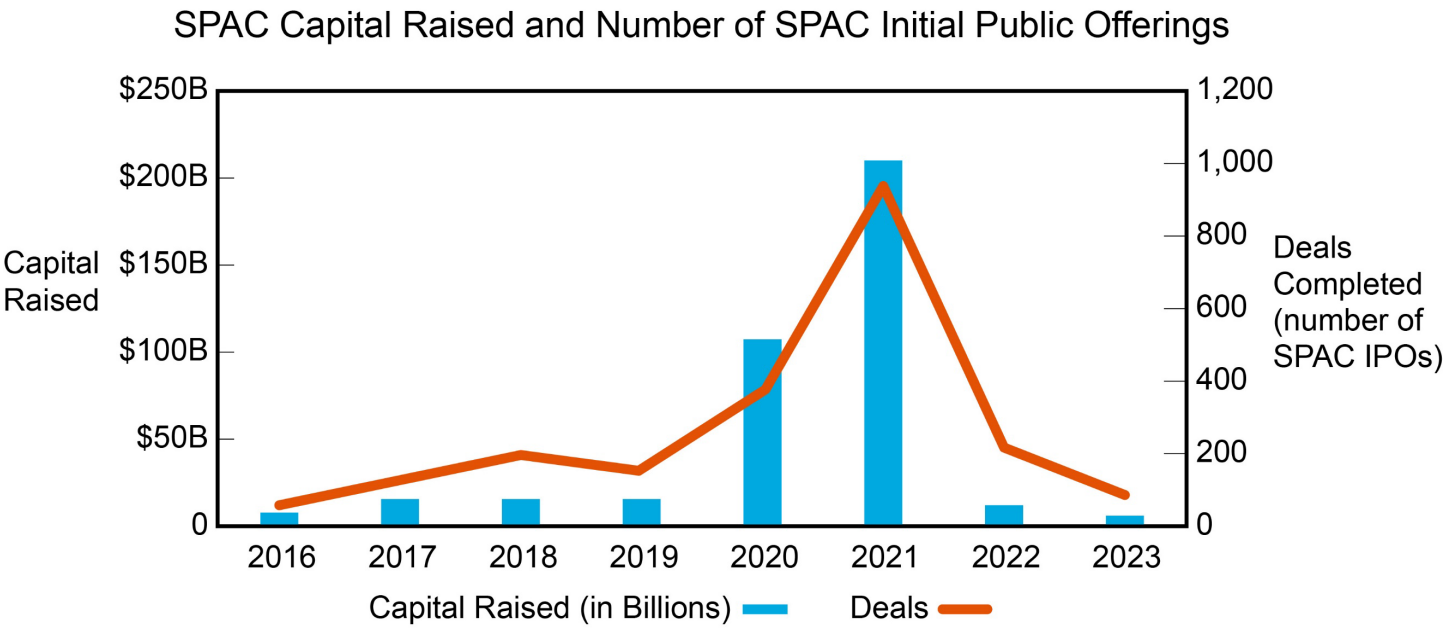

Figure 2: Special purpose acquisition company (SPAC) capital raising from 2016 to 2023.
(Source: The Aerospace Corporation analysis using data from Bloomberg Terminal.)

grew quickly and went public through SPACs, including Planet Labs (July 2021), Spire Global (August 2021), Terran Orbital (March 2022), and AST SpaceMobile (April 2021).

In 2021, inflation started to climb, which caused the Federal Reserve and other central banks to rapidly increase interest rates. Higher interest rates led to a cut in VC investment, exacerbated by the five bank failures that occurred during 2023.[6] As a result, as shown in Figure 1, VC funding dropped 50 percent from 2021 to 2023. Over this same period, SPAC funding dropped 97 percent, due to a combination of higher interest rates, poor performance of many companies acquired by SPACs, and regulatory scrutiny by the U.S. Securities and Exchange Commission. Collectively, these developments severely cut the amount of public and private capital available for space companies.

The challenge for space companies that received sizable VC investment is not simply that some of these investment sources have dried up but also the growing mismatch between what may be feasible for a space company and the expectations of VC investors. In a typical VC 10-year investment cycle, VC investors are looking for returns of 5 to 10 times their investment in that period. This demand for immediate returns does not lend itself to developing and manufacturing infrastructure or deploying satellites. As a result, many companies may be unable to deliver to their VC investors' expectations for returns and the timelines to achieve those returns, making it harder to rely on continued VC investment.

The Case for the DOD to Play a More Active Role

The rise and fall of public and private capital for commercial space companies presents both a pressing issue and an opportunity for the DOD. Based on DOD strategy documents and comments from U.S. defense space leadership, the department is poised to make commercial space capabilities an important component of how the DOD carries out its missions. To ensure that it can do this over the long-term, DOD will need to play a more active role in providing revenue for commercial space companies. Although taking such a position will pose tradeoffs and risks, the DOD should do this for principally three reasons:

1. Commercial space assets and services can provide valuable defense applications.

2. Paying for commercial space assets and services that exist, instead of building new custom-built space capabilities, will save the DOD money and time.

3. Many promising U.S. commercial space companies may not survive without significant government revenue.

Value of Commercial Space for Defense Applications. For DOD, commercial space assets can complement or replace custom-built defense systems, even if the commercial systems were designed primarily for commercial applications. The core function of many space systems is to collect and transmit information, which can be valuable for civil, commercial, and defense applications. For example, space-based electro-imagery companies can help oceanographers monitor the health of the seas, help farmers detect pests in their farms, and help military analysts track troop movements and other potential threats. Further, commercial companies have proposed intriguing models for particular missions. For example, for electro-optical imagery, commercial providers have focused on achieving excellent temporal resolution (rapid revisit rates) to be complementary to traditional systems that focus on achieving high spatial resolution (small pixel sizes).

Another advantage of commercial satellite capabilities and services is that the data can be shared more easily than data from government space systems. Electro-optical imagery, synthetic aperture radar collection, radiofrequency mapping, and space situational awareness companies (among others) all collect data, either on the Earth or in the space environment. It can be easier to disseminate commercial imagery or other data than information from government systems, whose capabilities may be sensitive. As seen in the war in Ukraine, this dissemination can be particularly powerful in certain

circumstances. The first images that many people saw of Russia's military buildup on the border of Ukraine and subsequent invasion were from commercial satellites. Increasingly, commercially available satellite imagery is being used for intelligence relating to military activity, but it is also creating new dynamics in global transparency by potentially being more credible to global audiences than information from government-controlled systems.

Saving Money and Time. Perhaps most importantly, buying commercial space assets or services can save money and time. Defense acquisition is a time-intensive and expensive process.[7] To the extent that commercial space capabilities and services exist that can satisfy defense needs, buying those capabilities or licensing those services would likely be a much more efficient use of resources than developing them independently. In fact, the DOD already buys commercially available products (e.g., computers and passenger cars) for many of its needs. It also pays for services, such as potable water, electricity, and telephone services from commercial providers. Another example are iPads, of which the U.S. military buys plenty. Imagine how much more difficult it would be for the DOD to hire a contractor to develop a comparable tablet than to simply buy iPads that are already mass produced.

In the case of commercial space, the DOD can benefit from the high capital investments made in the lead-up to the VC investment spike in 2021. Public and private investors spent considerable capital to build commercial space companies and capabilities, and the DOD can access those capabilities without having paid for their development. Ensuring that it can use commercial space services for the long-term could be a bargain for the department compared to developing and acquiring its own custom-built systems.

Preserving Commercial Space. Another reason for the DOD to take a more active role in providing revenue for commercial services is to help sustain those companies. The decline in public and private capital has not had a drastic effect on *all* commercial space capability areas. The satellite communications market, in particular, remains strong. In April 2024, the World Economic Forum issued a report on the space economy, which includes revenue calculations for commercial space across different sectors. For commercial space services and end-user equipment, the report estimates that more than 98 percent of the direct revenue generated in 2023 came from satellite communications and positioning, navigating, and timing.[8] Satellite communications has been a mature market for several decades and one in which government is one of many customers; positioning, navigation, and timing—albeit a different type of market—has existed for decades as well.

In contrast, for other emerging capability areas, the decline in public and private capital *has* affected the financial viability of commercial space firms. Commercial demand for space-based remote sensing, for example, is not yet sufficient for many of these companies to become profitable. Researchers at The Aerospace Corporation analyzed approximately 150 commercial remote sensing companies to identify how many would be profitable in the absence of government (U.S. or foreign) revenue. The answer was very few, if any.[9]

For commercial remote sensing and other areas in which the market has not fully developed, such as space situational awareness, radiofrequency mapping, and alternative positioning, navigation and timing, the DOD should partner with commercial firms that offer attractive defense solutions that are less expensive than what the government could achieve by itself.[10] In addition to ensuring it can use these assets and services, the department's support for these firms would strengthen elements of the U.S. space industrial base that would be tenuous in the absence of government revenue.

Defending Anchor Tenancy

To fully benefit from the opportunity presented by the current state of the space industrial base, the DOD will need to be willing to serve as an anchor tenant, being the biggest or main customer for a commercial capability, when doing so serves

the DOD's goals. Generally, there are several situations in which the government could reasonably decide to become an anchor tenant for a capability or a private firm:

- To invest in a technology or product that could provide far-reaching benefits.
- To avoid building a similar technology or product from scratch.
- To help mature that technology or product to advance national goals.

In the case of space, all of these rationales may exist for the DOD to support commercial industry. The early days of the aviation industry offers an example of the benefits of strategic investments and partnerships with industry. Prior to World War II, aviation companies relied on revenue provided by U.S. government air mail contracts, without which the airlines would have been unprofitable. As is the case with the airlines, government anchor tenancy may be a temporary approach to bridge the gap until a robust commercial market develops.

The DOD should also prepare itself in the event anchor tenancy is not a temporary or short-term condition. If the commercial market does not fully develop, a commercial firm may be reliant on government revenue for many years. Government agencies may be reluctant to do this, but the DOD's costs in serving as an anchor tenant should be weighed against the money that it would have needed to spend to build those capabilities itself. Further, in some cases, anchor tenancy may require the government to buy a service in order to avoid the burdensome requirements and acquisition processes associated with large-scale government development. The NASA Commercial Crew program was a case in which serving as an anchor tenant gave the agency more flexibility than a government-owned and -operated program would have.[11]

Serving as the main customer for a commercial capability area would also allow the DOD to help shape those assets and services. For example, in the case of semiconductors, the department served as the anchor tenant for integrated circuits in the 1950s and 1960s, which led to many of the products being built with defense applications in mind, even if the eventual intent was to reach broader commercial markets.[12] This is already happening to some degree in commercial space. The U.S. Space Force has introduced cybersecurity standards for commercial companies wanting to sell services to the DOD.[13] Further, the department has continuously coordinated with commercial firms on some of its needs, helping to shape commercial offerings. Thus, in places where the DOD establishes anchor tenancy, the department can more easily steer the direction of technology evolution and how responsive commercial firms are to these specific defense needs versus broader commercial needs.

Anchor tenancy should be considered as a middle ground between traditional acquisition and a fully mature market in which the government is simply one of many customers, as shown in Figure 3. Looking again at the semiconductor example, from 1962 to 1968, the average cost of integrated circuits went from $50 to $2. As these circuits became less expensive, their commercial appeal grew and the DOD had less influence over the semiconductor market.[14] The benefit of this for the DOD, however, was that the assets were far less expensive to buy. In the traditional acquisition process, the government hires a contractor to build a custom system designed to precise government

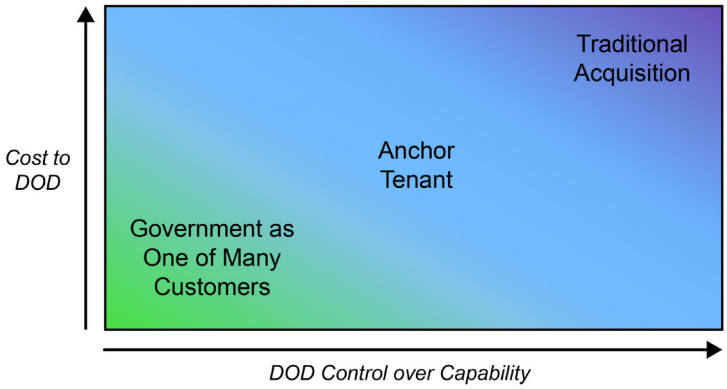

Figure 3: Anchor tenancy as a middle-ground approach to cost and capability.

Using Debt

Leveraging debt could be a creative approach for the DOD to support space firms. In traditional industries that require significant initial investment and infrastructure, debt is often the appropriate source of capital. Debt investors are compensated by interest and typically have less urgent deadlines for market development as long as the companies can pay their interest expense, pay off the debt at maturity, or rollover the debt into a new credit instrument. As noted, sustaining VC funding typically requires large and fast returns, which do not lend themselves to developing infrastructure and deploying satellites. Although the VC investment may have supported the invention of some of these commercial firms, debt may be more appropriate for scaling the companies.

The primary challenge with using debt for a commercial space firm is that debt investors do not typically want to take on significant market or technology risk. However, if the DOD were to provide loan guarantees and initial business for a space company, the risk would lessen. With the DOD as the guarantor, the company could more easily access credit markets with risk-free rates. The important question then becomes whether the company has enough cash flow to

- Support the debt, which would likely be less demanding than meeting VC expectations.
- Refinance as the debt reaches maturity.

In December 2022, the Secretary of Defense established the Office of Strategic Capital (OSC) to "attract and scale investment to national security priorities."[15] In July 2024, OSC announced a request for information to receive public input as it prepares to issue loans and loan guarantees for "critical technology and supply chain components."[16] Commercial space companies should be attractive options for OSC as it pursues this new loan program.

requirements; the government will have significant control over the design and operation of a system, but it will typically cost more than something that is commercially available. In contrast, serving as simply one of many customers, the government may not have much influence at all over the item's capability, but will likely be able to buy the item much more cheaply. Bottom line, anchor tenancy offers the government some influence over acquisition capabilities, albeit at a higher cost than the same item developed within a broad commercial market—yet not as expensive as traditional DOD acquisition methods. The DOD's preference is to serve as one of many customers of a commercial firm, but serving as anchor tenant—even for a long period time—may be preferable to traditional acquisition.

The DOD can also use its anchor tenancy to try to help commercial firms expand their commercial reach. Remote sensing companies have noted that clarification on future government revenue would help them raise private capital.[17] For the commercial firms that the DOD wants to partner with, it should discuss the contract mechanisms and terms that would benefit the commercial firms' financial viability while using U.S. taxpayer money judiciously.[18] In cases where companies operating in this arrangement do experience long-term success, sustained profitability is a valuable industrial by-product of the DOD's improved access to space capabilities.

Navigating Risk and Trust

Partnering more extensively with commercial players entails risk for the DOD. Even with additional government revenue, companies may struggle to become profitable. The department will need to make difficult decisions about where to invest and partner, recognizing that some of the companies that are left out will likely fail. In making these decisions, the DOD will want to consider financial variables, such as the company's financial make-up, economic trends, and business model; technical variables, such as current capabilities, development roadmaps, and integration challenges; and operational variables, including the company's management, workforce, supply chain, and strategy.[19] The DOD will need a robust framework to assess potential partner companies and understand the risk associated with these variables.

Another set of risks relate to the DOD's potential distortion of commercial markets. As with the rise of VC funding stemming from low interest rates and easy access to capital, significant DOD spending on commercial space services could create inefficiencies. In 2023, RAND published a report on leveraging commercial space services in which it warns that investing in capabilities with an "immature market risks the Department of the Air Force's long-term goals."[20] The report expands, "If commercial demand for a service is not sufficient to support sustained revenue for more than one or two firms, adverse outcomes may result. A weak commercial

market could result in higher costs to the DOD, vendor lock stemming from lack of competition, the consolidation of the industrial base, and reduction in the innovative potential that comes from meeting commercial demand." [21] Although the report does not say that the Air Force should not invest in immature markets, it does caution that the DOD's investment in capabilities with immature markets could leave it as the dominant customer, potentially eroding the market and limiting the "industrial base to a few commercial providers, or even one provider."[22]

There is validity to RAND's assessment that the DOD could be the dominant customer for some of the commercial space capability areas and that such investments could stymie competition. However, a greater risk is that, by being cautious and less active with these nascent sectors, some of them may not survive. In certain cases, particularly niche offerings or those that require heavy capital expenditures upfront, a weak commercial market may lead to a loss of capabilities and no addressable market without the initial presence of DOD investments. Many of these firms benefited from an exceptional VC environment that encouraged innovation and risk taking, resulting in new space capabilities and services valuable for the department. By taking a more active role, the DOD can leverage these capital-intensive space capabilities to strengthen U.S. advantages in space.

The DOD also faces risks related to foreign influence from within its suppliers and commercial partners. Identifying foreign influence can be challenging, particularly for start-up space companies that have received private capital. The department will also want to weigh risks of foreign control and influence to avoid partnerships in which potential adversaries could exploit the companies' critical technologies. Foreign influence could take the form not just in the leadership of the company but also in the private equity and VC firms giving it funding.

The complex task of identifying foreign influence should not dissuade the DOD from investing more heavily in commercial space. The department should be diligent in selecting partners, but it still should select partners. The DOD and the government have many organizations and mechanisms for making these assessments—including the Air Force Office of Special Investigations, AFWERX, Defense Innovation Unit, Office of Strategic Capital, Office of Commercial Economic Analysis, and the Committee on Foreign Investment in the United States (CFIUS)—and this would be a central element of any DOD program in this area.

Conclusion

The DOD should embrace partnerships with commercial space firms that offer attractive military capability. These partnerships can represent an efficient use of resources, helping to ensure the DOD's ability to use systems and services even though much of the capital and initial investment for them came from elsewhere.

This is not to say that taking a more active role in some commercial space firms and serving as an anchor tenant will not be free of costs. As noted previously, assessing the risks of foreign influence will remain a challenge, exacerbated by the complexity of the investor landscape. Further, as noted by RAND, the DOD's contribution to revenue in some companies could make it harder for other companies to compete. Additionally, some of these efforts and companies could fail, even with the department's added investment.

However, the risks of excess caution are greater. Without consistent government demand, many of the U.S. commercial space firms that offer valuable defense applications may not survive. In part, due to an exceptional VC and financial environment leading up to 2021, the United States has benefited from a bourgeoning commercial space industry that spans all space capabilities, resulting from high-capital investments made by other investors. With the right funding and approach, the DOD can ensure it can use these assets for defense purposes. Doing so will save the department the money and time that would otherwise be necessary to build additional custom systems and help preserve and leverage U.S. competitive advantages in space. If the DOD wants to ensure it can benefit from having the most expansive commercial space sector in the world, it may just have to pay more for it.

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