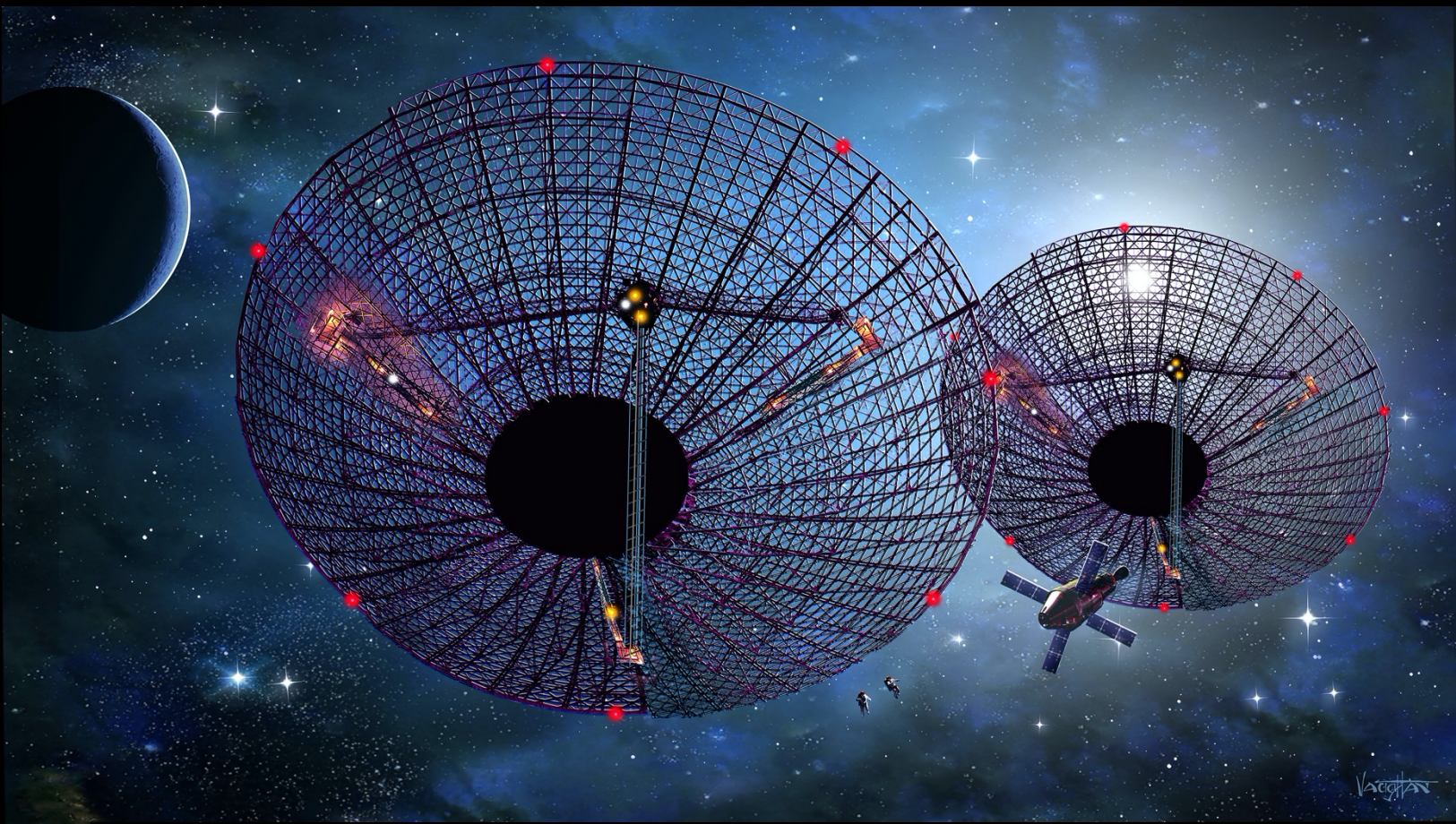


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Space Budgeting for Modern Times

Industrial Space Capabilities with less waste, delay, and obsolescence

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Conflicts of Interest Statement

Bruce Cahan is the designer and principal organizer of the Space Commodities Exchange referenced herein. (1), (2), (3) and (4) Otherwise, the authors have no conflicts of interest regarding the material contained in this Report.

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¹ The authors come from academic, civilian, commercial, military, and nonprofit backgrounds. They met through the annual State of the Industrial Base Workshop in May 2020 that addressed issues affecting the space industrial base. They continued to collaborate through ongoing research and discussions.

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Executive Summary

Operating in, to, and from outer space can build on U.S. operations on land, sea, in cyber, and in the air. However, the pace of innovations by industrial space companies² and the hypersonic speed of objects and threats in space - whether intentional or unintentional - from friendly and hostile sources – require rapidly revamping the bureaucratic processes used to acquire space capabilities, protect human life, the environment, assets, and sovereign rights on Earth and in space.

Speed, transparency, and accountability for functionality have not been the hallmark of government design, procurement, maintenance, and replacement of U.S. Department of Defense (**DoD**) assets, or the bespoke markets and supply chains used to produce them. Market concentration of traditional contractors perpetuates legacy technologies and sidelines innovation. Traditional contractors then rely on government influence, approved and subsidized contract extensions, loans, mergers and bailouts as business models. While market concentration may not increase how much the government pays for what it needs, numerous corporate examples show that dominant market power can and does limit the capacity or will to disrupt established product offerings, customers' patterns for using traditional products, and thus limits innovation in fast-changing industries like industrial space.

Government decision makers are not incentivized to undertake innovation. Who is incentivized to adopt the new system or capability proposed by the innovator when two-/four-year horizon games of campaign finance and Congressional District-determined budgeting have put the United States in a noncompetitive position, unable and virtually unwilling to keep pace with China and other space powers?

This report highlights the critical roles that the Office of Management and Budget (**OMB**), U.S. Treasury (**Treasury**), the Federal Acquisition Rules (**FAR**) and the Defense Federal Acquisition Rules (**DFAR**) play or have yet to play in creating a commonsense approach for the Executive Branch of the U.S. Government (**USG**) to consolidate, forecast, and meet its needs for space assets and the services and functions they provide for civilian agencies, national security, and other purposes.

If the nation grows its industrial space sector in harmony with allied nations, the federal budget for space will be affordable, and space services and interdependencies will be efficiently and effectively aligned as a “whole-of-government” system serving all federal functions. If the federal departments and agencies buy and budget for its space functions as *à la carte*, bespoke systems that cannot support or interoperate with other systems, then federal functions dependent on space and their budgets will be weighed down by a cascade of legacy systems, maintained separately by contractors demanding sizable funding to postpone inevitable technological obsolescence. Legacy budgeting and investment practices stymie the U.S. industrial space sector just when it needs to project U.S. economic smart power and leadership.

The economics of space-age government budgeting and procurement calculus and its implementing rules and practices government-wide should strengthen and democratize

² The terminology for private sector activities and investment in space has evolved from “new space” to “commercial space.” This Report introduces “industrial space” as a next phase in that evolution. If space is a critical infrastructure and essential to other critical infrastructures, then industrial space signals that the companies building and operating it are doing so permanently.

the space sector as a vibrant marketplace. Government should move from marginalizing innovators, to including them; from postponing technological evolution, to removing bureaucratic barriers preventing entry of new competitors and breathe life into the very rules-based markets for space that the U.S. government as first space customer and long-term space investor requires for national security and claims to champion as free enterprise. Legacy budgeting and procurement rules must be simplified to take advantage of space-based economics to best fulfill their original intent in today's and tomorrow's contexts which should be to encourage new companies to successfully compete with and reinvigorate innovations among traditional contractors, which in turn force markets to efficiently diversify and evolve. Until OMB calls for government procurements of space assets and capabilities to conform to a public-private, industry-driven consensus of interoperability for modularity of system components and functionalities, the government will be buying, and annually spending to maintain and cobble together, renewed versions of obsolescence.

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Preface

Space and the space economy challenge how we think about doing business. As a leading space customer and investor, the U.S. Government (**USG**) – civilian, intelligence and military – depend on space as critical infrastructure. Annual federal budget, appropriations and procurement processes rely on over a century of statutory, regulatory and custom within the Executive and Legislative Branches in order to obtain from well-developed commercial markets from companies backed by well-developed financial and insurance markets their required products and services. Historically, the federal customer was the first to define a market niche for a new technology, and added catalyst and early-stage funding to justify developing the airplane, the Internet and others in common use commercially today. The space economy, the companies building it and the financing and insuring of it are in their infancy today.

This Report takes as a given that the USG between now and 2060 will be a major customer, investor, regulator and ally of the space economy, the companies building it and their diversely talented human teams. If the USG is to be a reliable major customer, investor, regulator and ally over the next four decades, ongoing alignment of spending on and financing of governmentwide space requirements must be brought to bear as strategic and operational institutional leadership.

Every four years, the U.S. President, one-third of the U.S. Senate and the entire U.S. House of Representatives stand for election, which brings significant leadership change in setting priorities for USG Departments and Agencies. This Report focuses on two permanent institutional actors who will be in the position to provide permanent leadership for aligning USG space budgeting, finance and national security concerns: The Office of Management and Budget (**OMB**) oversees the preparation of the Presidential Budget, the rules for spending it and the alignment of budgeting for common infrastructure and capabilities used across the USG. The U.S. Department of Treasury (**Treasury**) finances USG operations, develops suitable financial market investment structures and monitors global issues of national security relating to the financial markets. Bottom line, whoever is elected through the political process to lead the nation, OMB and Treasury are permanently empowered to do so fiscally responsibly, efficiently, effectively, continually and transparently.

Academic and industry conference discussions of USG space policy typically focus on the U.S. Department of Defense (DoD), its service branches (Air Force, Space Force and others) and intelligence agencies (CIA, NRO), or civilian and science agencies such as NASA, NOAA and others. Discussions also analyze the market that responds to and supplies functional products and services to meet government space needs, including the market and political power of traditional prime contractors.

Rarely discussed is where OMB and Treasury fit into the dynamics of growing the U.S. space industry, and how to assert and leverage the roles that OMB and Treasury have and will have in assuring that space is invested in and grown as a “whole of government / whole of nation” effort to serve as critical infrastructure from 2021 – 2060, and beyond.

This Report explores precedent and rationale for OMB and Treasury leadership regarding space policy. Some readers may find that asking what OMB and Treasury can do, and how and why they should do it, represents a specific point of view, rather than being an agnostic technical or scientific exploration of the topic. The authors would invite such readers to suspend their hesitancy, and to ask how the national interests in a

vibrant space economy will be evolved by 2060 *without* OMB and Treasury knowing and using their roles. Other readers steeped in – mired in – the intricacies of government budgeting and procurement may find it odd to suggest that OMB and Treasury could serve as allies of aligning federal investment policy, budgets and program needs for space. The authors invite them to consider the federal budget and procurement cycles are akin to *The Truman Show* (5), wherein the main characters eventually realize that the artificial constraints on their ways of thinking and responding to stimuli by reference to centuries of terrestrial market economics and bureaucratic precedent as to “how it’s always done / how it’s never done” must change for space to be functionally available for public and private sector activities.

Historical Analogies and Inspirations for Space Budgeting

Not so long ago...

When railroads were laying track across our nation, separate companies, their bankers and investors sought to use different gauge tracks to dictate their monopolies over and within specific territories and the towns that would grow there.

Cities lit by candlelight and gas lamps, were electrified, so that the nights at home would be lit and warm, the days in schools, factories, warehouses and offices would be healthy and safe, and the mass transit connecting them would allow transportation for all at affordable prices.

Telephone companies, cellular companies and Internet providers sought to limit and gate whether and how people and businesses would access and pay for audio, video, and data.

As access to maps and location-aware services moved from paper to digital to mobile, companies transferring imagery and attaching meaning to landforms by adding street addresses and other data sought to use separate software specifications to keep information about cities and issues siloed inside legacy databases on systems that couldn't and were designed to never talk to each other.

Throughout history, the U.S. federal government has used its purchasing power and persistent requirements for the new functionalities to unleash the formation of commercial markets serving a wide variety of customers.

America's growth and dominance in the computer industry attests to the catalytic role of government funding:

Think back to 1999, when the U.S. style of competitive market capitalism attracted the world's attention—even its envy—and U.S. computer firms dominated the global marketplace. Today, it is difficult to recall and acknowledge that the federal government has played a major role in launching and giving momentum to the computer revolution, which now takes pride of place among the nation's recent technological achievements. Federal funding not only financed development of most of the nation's early digital computers, but also has continued to enable breakthroughs in areas as wide ranging as computer time-sharing, the Internet, artificial intelligence, and virtual reality as the industry has matured. Federal investment also has supported the building of physical infrastructure needed for leading-edge research and the education of undergraduate and graduate students who now work in industry and at academic research centers. (6 p. 1)

What if fifty years ago, in 1970, before widespread computer use, the federal government and its state and local governmental partners had foreseen, funded, and adopted industry-consensus open architectures and evolved interoperability for its computer systems, their databases, their cybersecurity, their privacy and public accessibility, and the software applications that reuse and update data in real time about the people, communities and scenarios agency functions and responsibilities mutually impact. (6) (7)

By analogy, the space sector of the 2020s will be the technological foundation for the

government to operate with efficacy and efficiency in 2060 and beyond. *Now, is the time to foresee and put in place the capital investment and technological frameworks for building and using such space interoperability.*

Interoperability. Standards. New Markets and market players. The confluence of many missions depending on real-time access to critical infrastructure, reliably maintained, secure and economically paid for and updated. OMB and Treasury have seen and addressed such technology challenges as opportunities many times before.

Today's OMB is the descendant of the Bureau of the Budget created in 1921. (8) Over the past century, OMB's evolving practices and roles have stewarded and preserved new ways for the federal government to do business, and invited OMB to continually evolve. (9) (10)

In geospatial data policy, budgets, and interoperability, 28 years elapsed from 1990 when OMB issued Circular A-16 to the enactment of The Geospatial Data Act of 2018. (11) The National Spatial Data Infrastructure (**NSDI**) (12) (13) became a critical information platform for commercial, government, nonprofit work, and research, permitting multiple domains of expertise and policymaking to see maps and geospatial analysis of how they might be separately or simultaneously impacting or neglecting specific domestic and global communities.

Development of OMB Circular A-16 and the NSDI, as they relate to geospatial technologies, and OMB Circular A-130, as it relates to U.S. government dependence and investment in information systems generally, (14) foreshadow the three decades that might be lost by the government if OMB and Treasury delay holistically inventorying, investing in, and fully leveraging a "whole-of-government" NorthStar policy and budget approach to space, (4) the assets, services, and dependencies in space critical to government functions, and the market structure and commercialization of space goods, services, and commodities that the government will need to buy. Already twenty years have elapsed since such "whole of government" leadership issues were identified for space operations. (15) (16)

Space - from Low-Earth Orbit (**LEO**) to cislunar, Mars, asteroid, and other locations -is yet another in the sequence of domains (geographic, technological, and inspirational) that the United States will grow into, expand, and come to use and rely upon.

OMB and Treasury's Role in Budgeting for Space

The U.S. government is the epitome of a long-term customer for the space industry, alongside ancillary industries – agriculture, banking, education, healthcare, insurance, mining, telecommunications, transportation and others - that depend on services in space. The government also is a special space customer, whose civilian agencies, state and local governments, and national security functions rely on space-based applications, data, and agility.

Like any long-term customer, the government needs the market to grow companies that develop, innovate, sell, and update useful and dependable products and services at reasonable cost. There should be enough companies to offer healthy competition without racing to the bottom to win government contracts at low-ball priced, tightly conditioned bids that require profiting from add-on or extras to make the products relevant. Companies should standardize the designs, interoperability, and specifications of how their products and services can be clustered to work together in normal or extreme scenarios to safeguard government investment in them to reduce risk, dysfunction, and obsolescence. Terrestrially, standardization grew U.S. and European economic, industrial, geopolitical and national security strengths. (17) (18) (19) (20) (21) Aerospace continues to add and update standards for its components, their supply chains and mitigatable risks. (22) For their part, companies must be managed and responsibly financed to assure that they can weather peaks and valleys in economic conditions amid domestic and global competition.

The government has served as major investor and guarantor of the space industry since before the Cold War. U.S. federal departments and agencies using space in their missions or for whom building and operating space assets and capacities in their mission (collectively, **USG Space Customers**) have enormous influence over the market conditions for space. Yet, they are constrained by legacy thinking about market structure, and traditions rooted in the 20th century industrial age. New global economic and market structures have expanded who can buy space functionality, at reduced costs with refreshed commercial versions offering enhanced capabilities faster than legacy contractors.

OMB and Treasury have important roles that are routinely overlooked in discussions of how the space market will develop over the near term (1 – 5 years) and longer term (6-40 years).

OMB has the authority and mandate to ensure that the federal government efficiently purchases, in bulk if necessary, the space functionality needed by federal departments and agencies over the near- and long-term horizons. For example, since at least 1992, OMB has asked whether government departments and agencies are using aircraft for government travel wisely. (23) (24) During commercial aviation's first 80 years (1918 – 1998), the federal government spent at least \$155 billion to help grow and sustain that industry. (25) OMB has yet to address government-wide use of space assets and capabilities, how space acquisitions are aligned or inconsistent, and how the bespoke, inconsistent, and unpredictable “feast or famine” nature of government space acquisitions may be undermining U.S. national leadership in space commerce and national security.

Under the *Foundations for Evidence-Based Policymaking Act of 2018* (26) and similar laws and Executive directives (27) to improve government budgeting, performance, and

accountability, OMB can hold federal department and agencies to account for the efficiency and effectiveness of their space purchases and investments. OMB can also assess whether the government’s purchasing activity is contributing to national security and global leadership by considering the shape, size, and diversification of the industrial space sector. Precedents exist for OMB to participate in or lead such space critical infrastructure assessments: For example, OMB has been directed to assess global supply chain and national risks to information, communications and technology infrastructure that might threaten USG operations. (28) (29)

Treasury has a very different role. Treasury finances the government and thus is as much in the position of a space investor as any private capital source would be. To grow a healthy industrial space market, Treasury could support government guaranteed or tax-deferred or tax-advantaged loans and grants to promising space technology sources and the companies creating them for sale. If a key defense contractor or other supplier of space functionality runs into business risks, unfair trade practices, or other challenges regardless of cause, the company or its bank lenders or market investors may be forced into bankruptcy, (30) (31) or attempt to pursue a federal bailout, (32) (33) (34) which may then cause the Treasury unexpected outlays. Thus, Treasury – on behalf of the nation – holds the role of long-term investor in the industrial space sector, and has a significant stake in its success.

Treasury’s *Strategic Plan for FY 2018 – 2022* frames goals that relate to the nation’s space investments domestically and in the international context: (35)

Strategic Goal	Treasury Commitment to Goal	Space Intersection with Goal
Foster Economic Strength and National Security (Goal 3 – Objective 3.3)	Treasury commits to restrain foreign ownership of U.S. assets that would pose a national security threat through Committee on Foreign Investment in the United States (CFIUS) reviews. (35 pp. 28-29)	This Goal and Treasury’s role in achieving it inherently requires Treasury to work with Department of Commerce and other space users in the USG to realistically assess and grow the domestic suppliers and market for space assets and services. Treasury is a primary guardian of U.S. financial markets and the security U.S. companies and their investors need to comply with restrictions on foreign ownership or control of space-based capabilities, supply chains and technologies. (36)

Strategic Goal	Treasury Commitment to Goal	Space Intersection with Goal
<p>Foster transparency and government-wide decision-making and accountability for federal program investments</p> <p>(Goal 4 – Object 4.1), (35 pp. 30-31)</p>	<p>Treasury commits to “improve the quality and availability of financial data for federal CFOs [Chief Financial Officers].”</p>	<p>Unless and until Treasury seeks data on government-wide spending, investment, and business function reliance directly or derivatively on space-based assets and services, such decisions will remain unaligned, driving up their costs, risks, and obsolescence.</p>
<p>Better manage and mitigate the debt that Treasury issues to finance USG operations and investments</p> <p>(Goal 4 – Objective 4.2) (35 pp. 32-33)</p>	<p>Treasury commits to “improve Treasury market analytics for greater accuracy and responsiveness,” and “develop new products that satisfy investors’ needs and help meet Treasury issuance goals.”</p>	<p>Financing space operations and assets will be cheaper and more dependable if the White House and Treasury designate space systems as “critical infrastructure” ((37)) to be financed for long-term growth, and participate in catalyzing new market investment vehicles such as the proposed Space Commodities Exchange and “space bonds.” (4)</p>
<p>Enhance the security, resiliency, and interoperability of finance services as critical infrastructure and as relying on and serving other critical infrastructures</p> <p>(Goal 2 – Objective 2.4) (35 pp. 22-23)</p>	<p>Treasury commits to review and take steps to enhance U.S. telecommunications, power, and other infrastructure.</p>	<p>With so much of banking and financial markets being conducted online, on mobile phones, and through datasets that must be persistently available, backed up, and cyber secure, space assets (such as satellites) and the power to maintain them as a network is becoming essential to the nation’s economic vitality.</p>

Strategic Goal	Treasury Commitment to Goal	Space Intersection with Goal
Improve federal financial management performance and use of innovative practices and tools (Goal 4 – Objective 4.3) (35 pp. 34-35)	Treasury commits to provide new tools and improve new ways to measure and report the financial management and ways to weigh government budget exposures, contingencies, and other concerns.	As government functions rely on space-based assets and services and attempt to link and layer commercially available solutions, Treasury could conduct studies, together with OMB, relevant CFOs, and others to determine the quality of effective competition and available offerings that the USG is expecting and creating in the industrial space and ancillary financial and other industries on which space companies and their government customers rely. (38) (39)

Other government departments and agencies are on the frontline of growing the industrial space sector: Commerce, Defense, State, and even independent regulatory agencies such as the Securities and Exchange Commission (SEC) as it works to set a level playing field for how capital can be raised, and the Commodities Futures Trading Commission (CFTC) by determining how space-based goods and services can be traded. But from a market structure, primary customer, and patient capital investor standpoint, OMB and Treasury occupy vital and very strategic roles in managing the nation’s future economic dependence on a thriving space economy.

2021 presents the moment to ask: *“How are OMB and Treasury supporting and innovating the USG’s needs for a vibrant industrial space economy, its financing and market structures?”*

How are USG Budgets for Space Created and Managed?

Any exploration of U.S. government budgets must start with the U.S. Congressional Appropriations Process that broadly maps the President’s Budget for the current fiscal year (FY), and as a legacy of decisions, prior and successive fiscal years. (40)

Once Congressional Ways and Means, Budget and Appropriations Committees authorize government tax, spending, and other actions, (41) the executive branch led by the Executive Office of the President operates two financial processes in parallel: Treasury, through taxes and other means collects the government’s revenues and issues government bonds and other forms of debt to finance government operations; OMB oversees and monitors that the funds are spent as authorized by statutes passed by Congress. But ultimately, it is Congress who legislatively sets the government’s budget.

The annual process of finalizing the USG budget is an unwieldy, unpredictable, and often delayed activity, with the House of Representatives, the Senate, and the President balancing what to fund against the politics of upcoming elections, national urgencies, entrenched interest groups, international treaty obligations, and numerous other factors.

Once a program is created by statute, there is often momentum to keep it, even if the original context and technologies for addressing it have vastly changed. (42) (43) Once the contractor(s) for the program are chosen and it obtains next FY funding, the federal system for denying renewal of the contract award inconsistently and rarely interposes to question why or whether contract renewal continues to serve the federal interest.

Existing contractors exert industry pressure, cultivate internal alliances, block program changes that would allow new entrants, directly and indirectly make campaign donations, “sponsor” campaign events, facilitate the hiring and promotion of spouses and children and dispense other favors for U.S. Representatives and U.S. Senators on key Ways and Means, Budget, Appropriations and other oversight Committees and Subcommittees.³ All such practices reduce the risk of change or innovation that might threaten established federal program contracts or competition for them.

Space budgets are subject to the same realities as other government program budgets. However, space budgeting requires taking multiple vantagepoints.

Vantage Point	Space Budgeting Significance
Long Horizon	The timeframe for building assets and clustering how they are used by government functions are akin to critical infrastructure (similar to airports, seaports, highways, bridges, tunnels) than programs that can be spun up and wound down every two-year Congressional election cycle.

³ Government and corporate employees and officials are bound by bribery, conflicts of interest and similar ethics laws and codes of conduct. (125) (124) (125) If discovered, the described activities would violate such laws and codes of conduct, and result in civil and criminal fines, reprimand and reputational damage.

Vantage Point	Space Budgeting Significance
Shared Domain	Space – similar to sea, land, and air - is a shared domain so that whatever activities are created or abandoned by the government in space affect how space powers – peer allies and adversaries – structure their space operations, budgets, and industries.
Critical Dependencies	Increasingly, like the Internet, nearly every government program is coming to depend on the persistence of access to space and relying on services available from space such as imagery, position/navigation/timing, and telecommunications. Gaps in space budgets or how they are deployed threaten the continuity, efficiency, and effectiveness of multi-purpose and interdependent communities of practice (civilian/commercial and intelligence/military/national security).
Complexity	Space is complex technically, and risky financially, so that the national economy, banks, insurers, and investors would perceive the unpredictability of government space budgets as amplifying waves of concern for which assets, products, services and activities in space are worthwhile for companies to pursue or third parties to fund.

Capital Budgeting for Space Infrastructure

Accounting in the federal government is not for the faint of heart. It is a mix of concepts known as the Generally Accepted Accounting Principles (**GAAP**) for the private sector as promulgated by the Financial Accounting Standards Board (**FASB**), (44) the GAAP for non-federal governmental and quasi-governmental entities as promulgated by the Governmental Accounting Standards Board (**GASB**) (45) and the layers of interpretations of federal budget guidance issued by the Federal Accounting Standards Advisory Board (**FASAB**). (46)

Whereas certified public accountants (**CPAs**) audit and certify financial reports of non-federal entities under FASB and GASB GAAP rules, federal accounts and financial systems are maintained under FASAB's GAAP rules – an island of tradition unto itself. Thus, tracing a dollar appropriated by Congress from the U.S. Treasury to a state budget and on to a private company's revenues requires traversing three separate GAAP accounting systems that label and relabel the timing and buckets of annual expenses and multi-year expenditures entirely independently. Such lack of traceability is particularly acute regarding the 16% of the federal budget spent on defense, (47) since the DoD has only recently been audited, (48) has failed three times to pass an audit, and claims to be unable to do so until 2027. (49)

The nuances of capital budgeting affect space infrastructure, how it is financed, on what timetable, and by whom. For example, the functional performance and financial condition of a federal asset or program should be benchmarked against its original goals, and disclosed to the public, taxpayers, and investors seeking to evaluate the asset's or program's likely future value and costs. The timeframe between the asset's or program's current fiscal year and the future fiscal years' enjoyment of a benefit or incurring expense is known as "interperiod equity."⁴ (46 p. 31) Thus, an argument could be made that the value of investments in space infrastructure today – owned by the government or private sector - can be recognized as generating or depleting "interperiod equity." (46 p. 31 fn. 11)

Terrestrially, federal capital budgeting is woefully inadequate, (50) and the financial systems used to track capital and program costs are woefully out-of-date and in need of modernization. (51) (52)

The federal government will make significant investments in capital assets to be owned, leased, and used over coming decades in space. **However, no OMB government-wide process exists for estimating, aligning, aggregating, and leveraging the capital plans of federal departments and agencies.** (53)

How such capital assets produce "interperiod equity" for government programs that demand space capabilities, and how they enable a vibrant industrial space economy owned, leased, and used by the government and private sector, is a manifestly unique opportunity to get the capital budgeting funding framework right at this early stage. Doing so will ensure that FASAB transparency and long horizon perspectives can be properly

⁴ In simple terms as used in this context, "interperiod equity" recognizes the inherent value of current year spending that builds the capacity to perform functions or to acquire goods and services cheaper or more reliably in the future. Were that value not recognized earlier, spending and investments that improve budget efficiencies and effectiveness would be less likely, and their true cost (current costs minus the present value of savings on future costs) inaccurately inflated.

implemented, and the necessary annual and multi-year investments made consistently.

Who creates, amends and can simplify the FAR / DFAR?

Most everything procured by the U.S. government - from paper clips to rockets – is bid, sourced, maintained, and disposed of pursuant to a uniform set of procurement rules-- one set for civilian agencies and a separate set for the DoD.

The civilian agencies responsible for major space-based systems and services are NASA, U.S. Geological Survey (**USGS**), Department of Homeland Security (**DHS**), Department of Interior (**DoI**), Department of Transportation (Federal Aviation Administration(**FAA**)), and Department of Commerce (**NOAA**). The principal DoD/IC agencies buying space-based assets are U.S. Space Force (**USSF**) and its Space Rapid Capabilities Office (**Space RCO**) (54) and Space Systems Command (**SSC**) (55) (formerly Space and Missile Systems Center (**SMC**)) (56) (57), U.S. Air Force (**USAF**) and its Rapid Capabilities Office (**DAF RCO**) (58) , U..S. Army and its Space and Missile Defense Command (**USASMDC**) (59), U.S. Navy and its Naval Network Warfare Command (**NETWARCOM**)(60), Space Development Agency (**SDA**) (61) , National Reconnaissance Office (**NRO**) (62) , National Geospatial Intelligence Agency (**NGA**) (63), Defense Advanced Research Projects Agency (**DARPA**) (64) and others in national security who design, protect and rely on space capabilities. (65) (66) (67)

The FAR's Parts 1 to 51 would print out as 1,992 pages, and laid end-to-end, (68) would span approximately one-third of a mile. The DFAR's Parts 201 – 253 would print out as 1,334 pages, or approximately another quarter mile. (69) Thus, USG space capabilities depend on navigating and surviving nearly a mile of FAR and DFAR rules.

“The proliferation of agency procurement regulations was such that, in its 1972 report, the Commission on Government Procurement stated that it had found ‘a burdensome mass and maze of procurement and procurement-related regulations’ within the federal government, and “no effective overall system for coordinating, controlling, and standardizing regulations.’ ” (70) Today, the USG buys more complex and interdependent products and services using technologies from companies with supply chains and nested ownership structures more diverse and essential than was the case in 1972 or in 2001 before the September 11th World Trade Center Attacks. (65)

The OMB's Office of Information and Regulatory Affairs (**OIRA**) routinely receives agency requests and monitors the necessity of FAR, DFAR, and other rulemakings. (71) Various means exist to amend the FAR. (70 pp. 11-15) A holistic assessment of which FAR, DFAR, budgeting, acquisition and program sunset and realignment activities should routinely occur to optimize USG and the nation's investment in space as critical infrastructure awaits OMB's active analysis, engagement and “herding of cats” management.

Should the FAR and DFAR be applied as is to the Space Economy?

The space sector is a distinct and relatively nascent market with participants who are developing the space economy to serve commercial, research, scientific, civilian, and national security customers. There is uncertainty as to whether the full burden of FAR/DFAR compliance will grow and expand U.S. industrial space sector or put American space companies at an artificially uncompetitive disadvantage compared to other foreign companies that provide space capabilities to United States and its allies.⁵

Testing the marginal utility of FAR/DFAR compliance burden is needed today, now, to assure industrial space companies are appropriately grown, not quashed. Advances in using Business model innovations, artificial intelligence, operations management statistical techniques are optimizing routing for logistics, pharmaceutical discovery, financial investment and legal outcomes. Similar advances can be applied as cutting-edge government technology (govtech), legal technologies (legaltech) and regulatory technologies (regtech) to analyze the historical relevance, suitability and impacts of compliance and noncompliance with FAR/DFAR rules on contractor performance and, more importantly, whether the intended benefits are received from the governmental function and program activity spending its budget on such contracted activities.

In short, the FAR/DFAR are the bureaucratic legacies of operating the USG's acquisition processes over the past century, primarily terrestrially. In 2021, OMB must ask which rules have served the nation well in creating and buying from our terrestrial economy, and which would serve the nation well in growing and buying from the space economy? (72) (73)

The FAR's Guiding Principles assume markets that are largely mature and well-financed, for which precedent of government procurement is readily available directly or via analogy. Space is developing its market and financial infrastructure currently, in real-time, largely from scratch.

Space acquisition policy requires the USG to consider returning to First Principles.

The Guiding Principles for the federal acquisition system are clear and concise:

“48 Code of Federal Regulations Part 1:

1.102 Statement of guiding principles for the Federal Acquisition System.

(a) The vision for the Federal Acquisition System is to deliver on a timely basis the best value product or service to the customer, while maintaining the public's trust and fulfilling public policy objectives. Participants in the acquisition process should work together as a team and should be empowered to make decisions within their area of responsibility.

(b) The Federal Acquisition System will-

⁵ As the space economy grows and the government-as-customer revenues shrink as a percentage of overall revenues, it is possible that legacy government contractors who used the FAR/DFAR as a moat for protecting their government contracts against new market entrants may find it difficult to transition their teams and business cultures to a more open market structure that is not as highly regulated or protected.

- (1) Satisfy the customer in terms of cost, quality, and timeliness of the delivered product or service by, for example-
 - (i) Maximizing the use of commercial products and services;
 - (ii) Using contractors who have a track record of successful past performance or who demonstrate a current superior ability to perform; and
 - (iii) Promoting competition;
- (2) Minimize administrative operating costs;
- (3) Conduct business with integrity, fairness, and openness; and
- (4) Fulfill public policy objectives.

(c) The Acquisition Team consists of all participants in Government acquisition including not only representatives of the technical, supply, and procurement communities but also the customers they serve, and the contractors who provide the products and services.

(d) The role of each member of the Acquisition Team is to exercise personal initiative and sound business judgment in providing the best value product or service to meet the customer's needs. In exercising initiative, Government members of the Acquisition Team may assume if a specific strategy, practice, policy or procedure is in the best interests of the Government and is not addressed in the FAR, nor prohibited by law (statute or case law), Executive order or other regulation, that the strategy, practice, policy or procedure is a permissible exercise of authority." (74)

The FAR's Guiding Principles fit and evolved to buy from terrestrial markets and industries that grew over decades to serve terrestrial customers and use cases.

For industrial space companies, financing, investors and markets to grow and thrive, the FAR's Guiding Principles would need take a refreshed long horizon perspective, wherein global competitiveness serves national security as a prime space asset. Federal Acquisition Regulations adapted for space (**S-FAR**) would adapt the FAR's Guiding Principles as follows:

- "Timely and best value" would take into account the different business models beyond Cost Plus that, given the infancy of burgeoning sectors of the industrial space sector in 2021, will establish companies and business models that reduce the cost and assure continually upgraded versions of best value in future years while opening access to the US Government market for a broader set of new entrant companies.
- "Value" requires looking across the lifecycle costs and the market structure that will emerge – not just in the spot market of current procurement needs – and will determine and potentially add to the government program's value. (75) (76)
- "Maximizing the use of commercial products and services" by primarily "using contractors who have a track record of successful past performance or who demonstrate a current superior ability to perform" would unduly rely on past prime contractors to be the sole source of innovation or the capacity to conceive and deliver innovation.

- “Promoting competition” would mean making sure that the U.S. industrial base exists to meet national security needs in space, and that the U.S. industrial space sector is grown through healthy competition for sales of space hardware, software and services to non-adversary nations and their companies.
- “Minimizing administrative operating costs” would have to include minimizing the total development, financing and other costs traditionally funded by the government for bespoke space capabilities, including the rescue and bailout packages and Congressional earmarks inserted to favor prime contractors.
- “Conducting business with integrity, fairness, and openness” would require re-writing the rules so that new companies - especially companies whose founders are minorities, women, disabled, veterans, or otherwise traditionally under- represented – and who by definition lack the financial and institutional influence resources of prime contractors, should not be required to serve as subcontractors wherein they risk losing their intellectual property, their profit spread, their talented workforce, or all of the above.
- Indeed, an inclusively defined “Acquisition Team” “exercising personal initiative and sound business judgment in providing the best value product or service to meet the customer’s needs” and finding that “a specific strategy, practice, policy or procedure is (x) in the best interests of the Government, (y) not addressed in the FAR, and (z) not prohibited by law (statute or case law), Executive order or other regulation,” may and even must adopt “the strategy, practice, policy or procedure [as] a permissible exercise of authority.”⁶
- Given the immaturity of markets in 2021 that define, trade in, and finance space capabilities as “space commodities,” the government should look forward to understand innovations and adaptations of terrestrial markets and principles through which future federal space acquisitions can be assured as high quality and best price/value. (4) (1) (2) (3)

All industries and companies – old and new, large and small – navigate the arcane and complex of the FAR and DFAR as they seek to sell space capabilities to the U.S. government. (77) The existing regulations protect oligopoly markets led by established companies with traditional business models. For new entrants and innovators, the regulations prevent entry and fair competition. The compliance paperwork, reports, and other activities add little value to the final product delivered to the federal customer, but increase cost, delay, and risk. As part of their professionalism and responsible stewardship, federal contracting officers want to find ways to help the innovators and the federal program managers seeking to sponsor innovation. But too often, the contracting officers can be overly cautious and unaccustomed to approving the inherent risks of innovation with innovators for space capabilities. Or worse, the flexibility embedded in federal acquisition practice emboldens “insiders,” growing procurement dependency on the same cohort of traditional companies, rather than being used to grow smaller and more agile innovators. (78 p. 12)

⁶ 48 CFR §§1.102-2 through 1.102.4 give and expect the Acquisition Team members to take personal initiative in adapting the rules to fit the mission. (73)

There is no publicly available OMB, Office of Federal Procurement Policy (OFPP) or other review of FAR, DFAR, or other regulations that the executive branch or legislative branch have conducted to determine whether the regulatory landscape for the government to buy space assets, products, and services, is efficient, effective, or creates a level playing field for healthy competition among established and up-and-coming companies.

How much does the FAR / DFAR add to the cost of government contracts?

The FAR and DFAR protect U.S. government interests against the risks of a contractor's default, malfeasance, or other harm. FAR and DFAR compliance rules result in the government paying more for the products and services it buys from the private sector and from other government entities than would be commercially payable, with the added cost as recompense to the government contractor for delays, doubts, and debates over whether the contractor provided what the government contracted for versus what the government program truly functionally needed.

To economize on buying industrial space products and services, the federal government needs to review for itself and for traditional large companies and newer venture-backed companies:

- the costs and benefits of FAR and DFAR regulatory compliance;
- the human resources (FTEs and PTEs) hired to manage and analyze such compliance;
- the delays in authorizing payment for work completed, due to "paperwork" associated with compliance; and
- the interest on working capital and other loans, or the venture capital or other equity investment raised to buffer delays in government paying for completed work, where the delay relates to "paperwork" associated with compliance.

Until Congress or the Office of the President otherwise assign such tasks, OMB OFPP may be an appropriate office of principal responsibility (**OPR**) to organize such review on regular basis.

Is the cost of FAR / DFAR for space worth it?

Stated another way: *What evidence exists that the added cost of FAR / DFAR improves the functionality and allows for innovation of space assets, products, and services bought by the USG?*

The government has historically incurred unintended risks or received inferior products or services. The FAR and DFAR serve as first lines of defense in reducing risk and assuring best value. Government buys from the private sector all the goods and services that, if produced commercially, would grow the national economy and its industries through sales to other customers beyond federal departments and agencies.

However, no publicly available analysis routinely asks whether the government's legitimate concerns for the former risks, balanced in favor of the latter benefits, are being well served by the FAR and DFAR rules. (79) Annual assessments benchmark whether programs comply with FAR and DFAR requirements, (80) but fail to ask whether the costs, delays and uncertain outcomes of compliance are worthwhile or produce innovative, (81) scalable outcomes that can be readily used by government. (82)

Other areas of government functions, beyond procurement, are building informational tools for answering similar effectiveness, efficiency, performance, and unintended consequences questions, through new technology fields such as "legaltech," "regtech" and "legal informatics." (83)

Artificial Intelligence (**AI**) and its task automation through machine learning (**ML**) are becoming high priority capabilities across the U.S. government. The U.S. Department of Justice is exploring how to use AI to improve the efficiency, effectiveness, and fairness of its processes and priorities. (84) Often AI/ML companies and researchers worry that their algorithmic engines will displace or unfairly tilt official decisions, (85) or whether procurement officers understand how to buy AI's value while minimizing its risks. (81) Procurement professionals outside of the United States are asking how they can use AI to reduce corruption, fraud, and similar downside risks. (86) (87)

The flipside question has yet to be truly asked and answered: **How might AI/ML discover and mitigate the cost, waste and risks that the FAR / DFAR engineer into the U.S. methods and practices of procurement, or delay government access to innovations in rapidly changing technologies, such as industrial space?**

The DoD's AI Strategy makes no mention of using AI to analyze the FAR / DFAR as a cost or obstacle, or for ways to ease its barriers to innovation. (88) The 2017 National Defense Strategy notes a backlog of procurement and reform efforts, but it does not mention using legal informatics or AI to simplify FAR / DFAR requirements as possible means for saving money or process simplification. (89) (90) The NDAA: National Defense Authorization Act – specifically Title VIII - Acquisition Policy, Acquisition Management, And Related Matters – requires the Secretary of Defense and others in leadership to make comparative acquisition analyses, judgments, and reports. (78) Section 833 of the NDAA codified as 10 USC §2361a requires university research on federal defense acquisition practices. (91 p. 1494) Such complex tasks are impossible to achieve consistently without applying the same brute force computing power of AI informatics used in intelligence and warfighting to look outward and into cyberspace, to sift through the truths revealed in the "big data" cascading off decades of FAR / DFAR transactions.

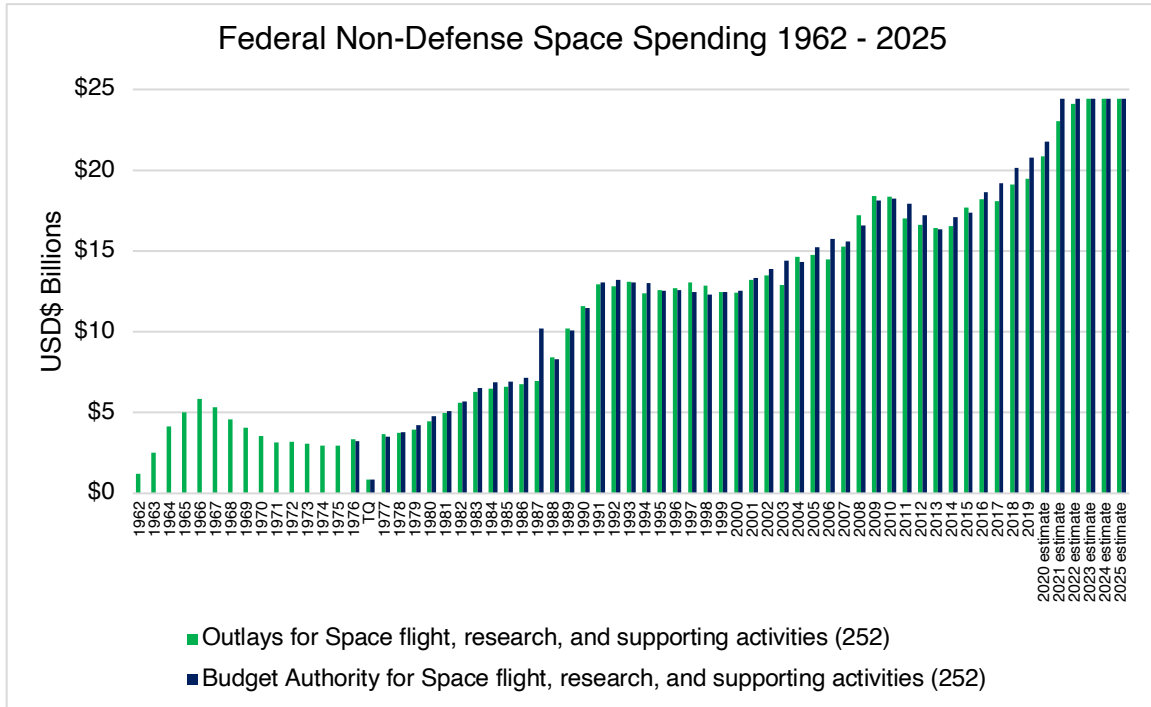
Take a hypothetical: Assume that OMB / OIRA sought to understand how the added costs and delays of FAR / DFAR procurements impact and contain risks in the quality, quantity, and functionality of the goods and services required by the federal government to carry out its missions. As input for training the AI/ML engine to replicate and improve on the manual procurement decisions, GSA, DoD and other agencies could supply data on thousands of contracts across the FY budget, or within a narrow domain of, say, defense, intelligence, and space, having an aggregate value exceeding \$1 million.

Such a legal informatics analysis might reveal:

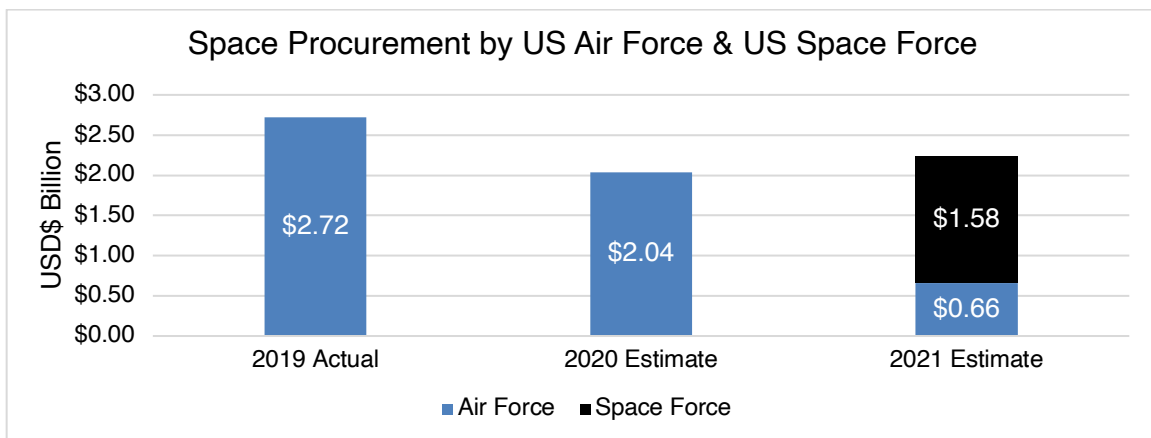
- 1) in what percentage (number of contracts / average size of problem child contract) if /how FAR / DFAR -
 - a) surfaced a major compliance issue threatening the USG getting the functionality of what it was buying, vs.
 - b) reduced competitive bidding to only those companies who could navigate the FAR / DFAR compliance but may have provided inferior functionality?
- 2) How many and which sections of the FAR / DFAR -
 - a) have ever been the source of administrative actions, citing the contractor's default or need for corrective action
 - b) in the cited defaults, how much (USD\$ amount per default and as a percentage of total contract award) was in dispute?
- 3) What statutes and Executive Orders/Actions account for FAR / DFAR provisions?
- 4) Does the terrestrial context in which such statutes were passed and EOs/EAs were promulgated fit:
 - a) The USG's needs for agility in space procurement?
 - b) The industrial space sector's needs for efficient procurement that keeps pace with the rapid innovations for space dominance that peer governments are pursuing? In other words, if a new cubesat design emerges every 2 years but it takes an average of 4 years for a USG program to buy it, then in 10 years the peer government has 5 new versions while the USG program has only bought 2.5 new versions...!
- 5) How frequently were multiple Department / Agency needs for similar functionality in space or that provide independent functionality to make the newest systemically valuable and integratable
 - a) considered prior to the contract award, or
 - b) accounted for contract amendments, or
 - c) grew the timeline or specifications for the contract out of proportion?

The U.S. government's growing reliance and spending on space

The government is spending billions annually to acquire, build and use space-based capabilities in civilian, national security, and scientific programs. The chart below shows federal civilian space expenditures. (92)



Aggregate historical space expenditures are not available from unclassified sources for DoD and the intelligence community. They likely would add significantly to the civilian amounts shown in the chart above. For comparison purposes, FY 2021 space procurements for the US Air Force and US Space Force are shown in the following chart. (93 pp. 272-273)

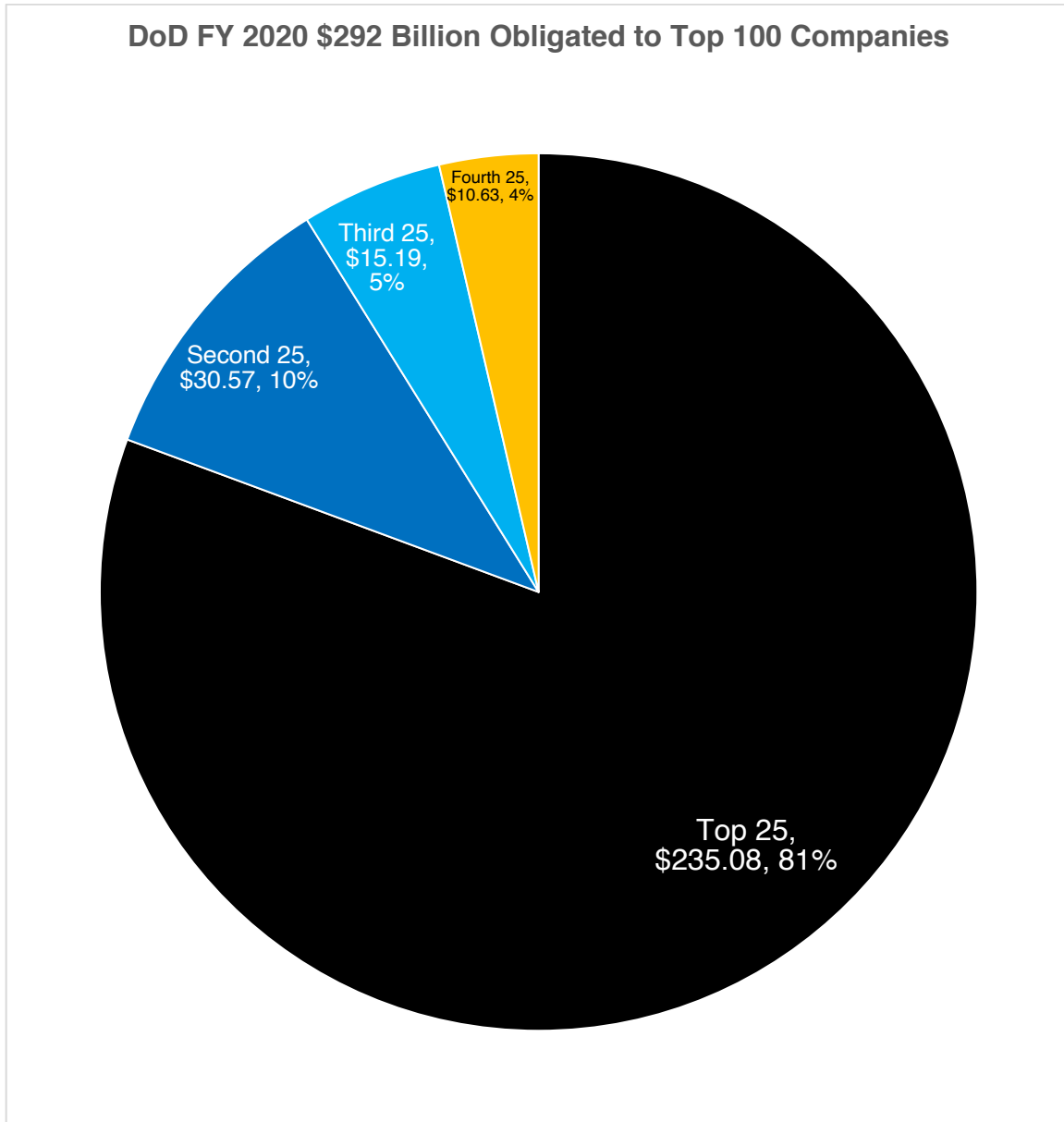


Annually, the government's expenses for space support agencies' growing dependence on space as a common capability to perform traditional and new services. The budgets of programs that depend on or use, or will depend on or use, space capabilities provided by the industrial space sector is unknown today.

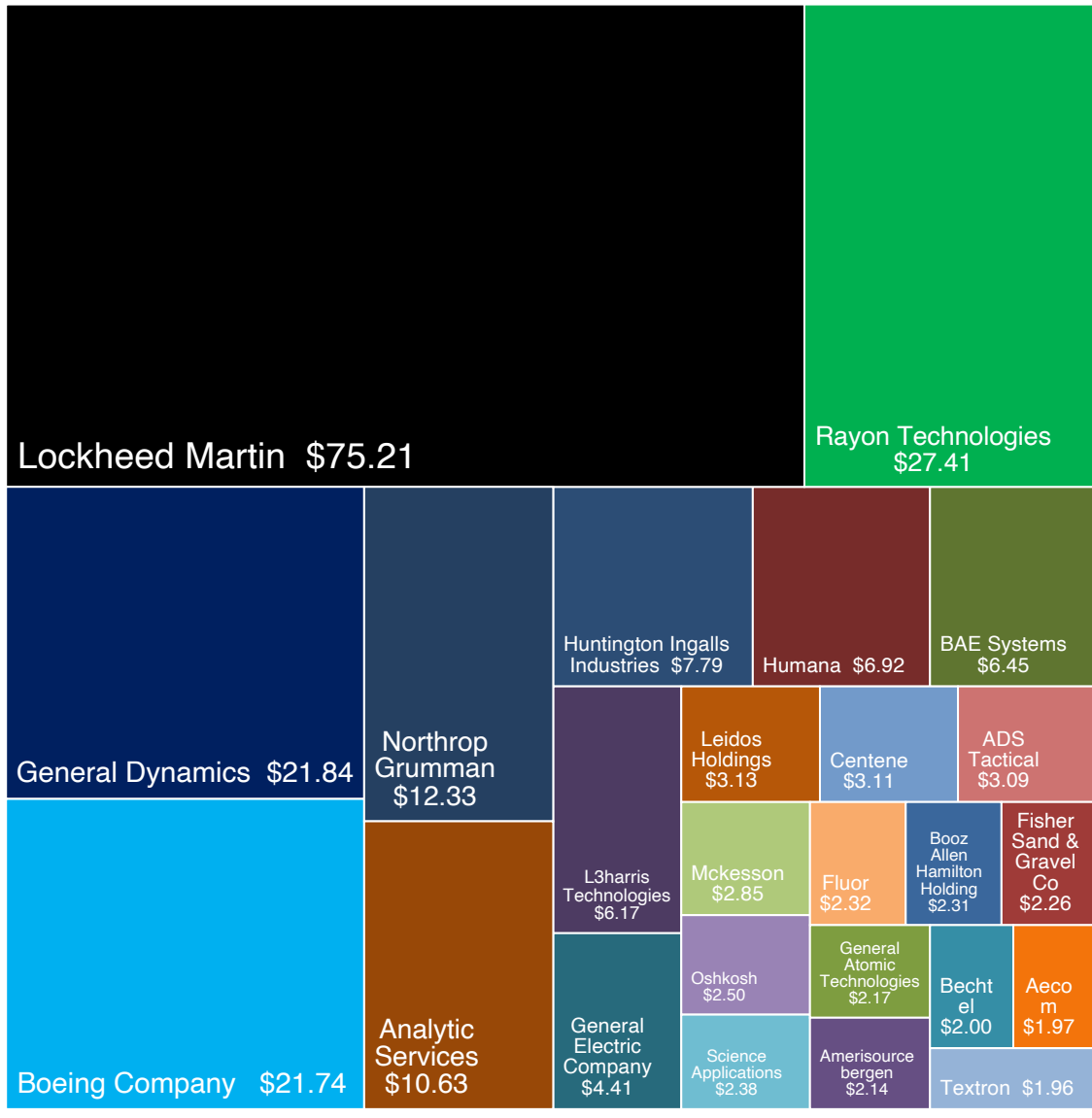
Like information technologies, computerized data and telecommunications, space systems are fast becoming a “shared service” (94) used daily and in response to natural catastrophe, extreme weather and other events requiring situational awareness or timelines to track, mitigate and improve economic, environmental, legal, social, or other potential areas of concern within government purview.

Reviewing Top 100 Contractors' Dominance in Space Contracts

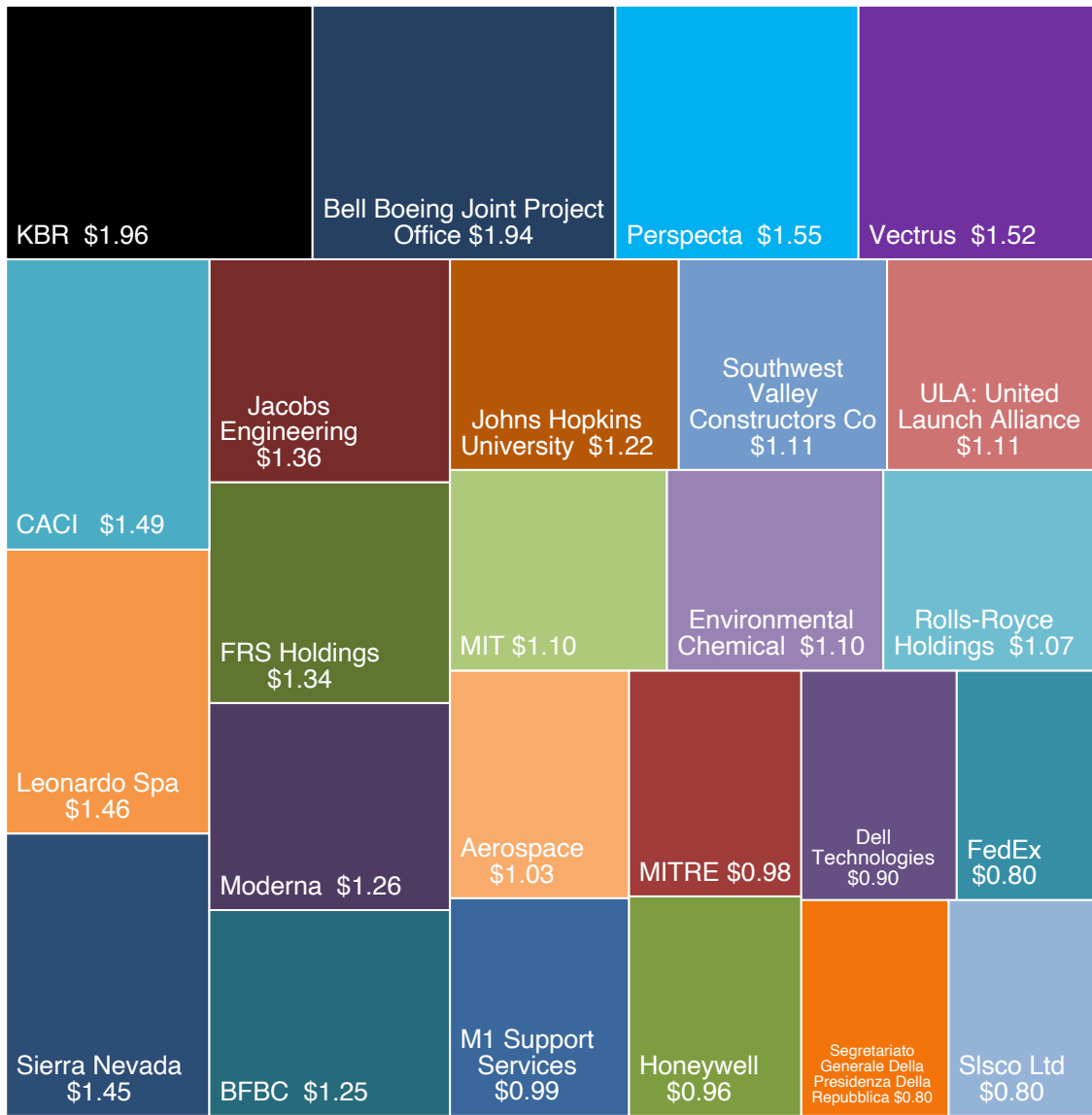
The FAR and DFAR generate annual data on who the U.S. government buys what from. One source for such data is the Statis Reports link on beta.SAM.gov portal (**SAM Procurement Data Portal**) provided by the U.S. General Services Administration (**GSA**). (95) The Portal lists the Top 100 largest federal contractors by federal agency or department for each FY between FY 2006 and FY 2020. (96) For FY 2020, the quartiles can be visualized by the charts below.



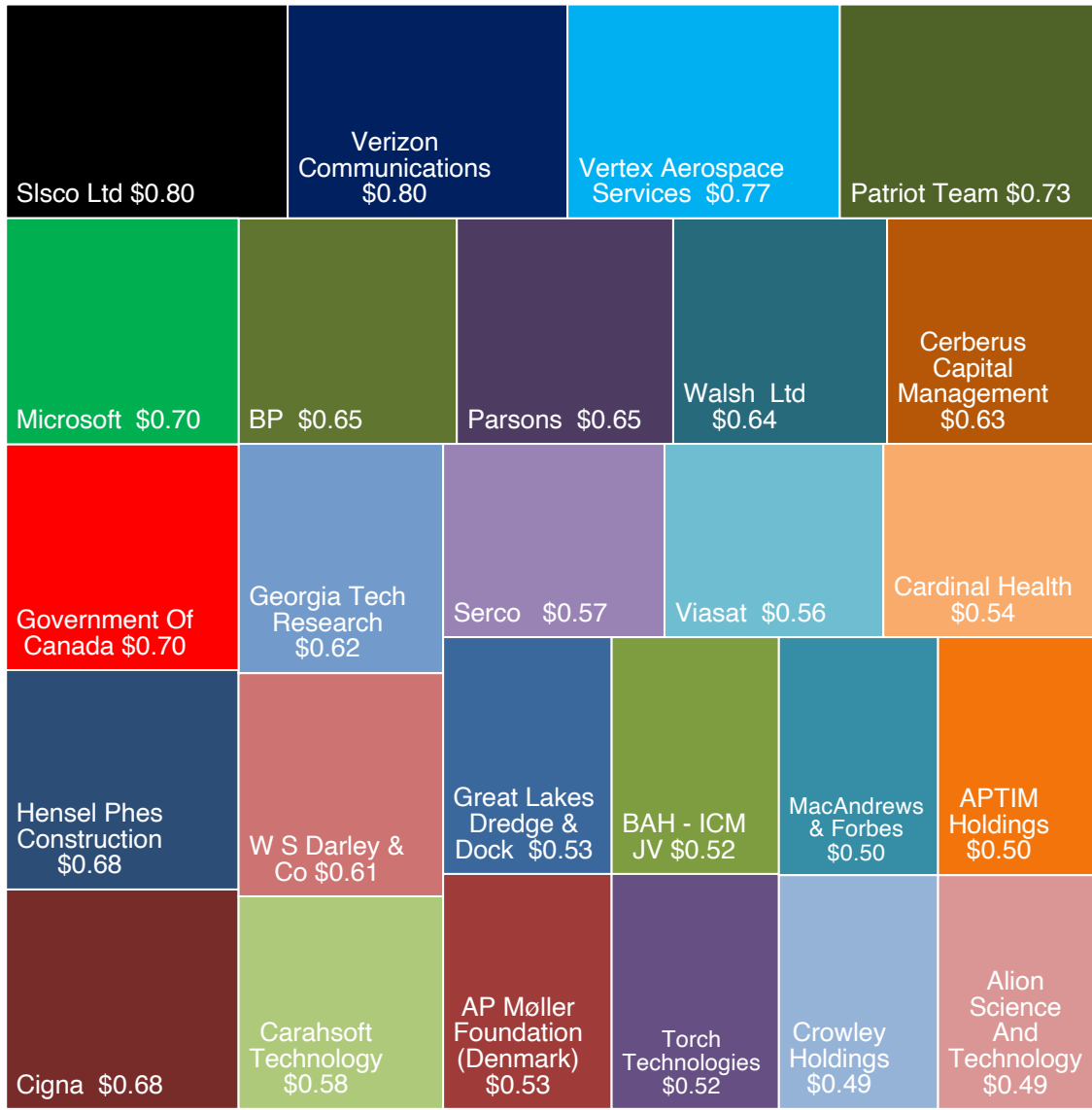
DoD FY 2020 \$235 Billion Obligated to Top 25 Companies



DoD FY 2020 \$30 Billions Obligated to Second 25 Companies



DoD FY 2020 \$15 Billion Obligated to Third 25 Companies



DoD FY 2020 \$10 Billions Obligated to Fourth 25 Companies

AT&T \$0.49	Valiant Integrated Services \$0.48	Carlyle \$0.48	Defense Systems And Solutions \$0.48	IAP Global Services \$0.48
IBM \$0.48	Battelle Memorial Institute \$0.44	Highmark \$0.43	Walsh Federal \$0.42	Weeks Marine \$0.42
Whiting-Turner Contracting Company \$0.47	Airbus SE \$0.41	Consortium Management \$0.40	Lumen Technologies \$0.40	World Wide Technology Holding Co \$0.39
Charles Stark Draper Laboratory \$0.46	Accenture Public Limited Company \$0.41	DCS \$0.38	Martin's Point Health Care \$0.38	Cisco Systems \$0.37
Johns Hopkins Health System \$0.45	Nana Regional \$0.41	Manson Construction Holding Company \$0.38	Anham Fzco \$0.36	Columbia Helicopters \$0.36

The SAM Procurement Data Portal also shows the frequency of contract terminations due to contractor default or other causes. (97) A cursory analysis suggests that smaller contractors (those not in the Top 100 Contractors for the same FY) are terminated due to default regularly, as would be indicative of a well-functioning acquisitions management system. But it appears that Top 100 Contractors only rarely face having their contracts terminated for default, whether because the USG contracting agency issued multiple extensions and modifications of the underlying contract, the Top 100 Contractor or the place for performance of the contract is in or aligned with a key Congressional District, or for other reasons that large company size or large contract size accrues.

Further analysis could test whether

1. Top 100 Contractors routinely perform better – default-free – as compared to their smaller competitors;

2. Top 100 Contractors are embedded and invested in defining federal contract requirements in order to reuse their existing workforce, intellectual property, manufacturing facilities and supply chains, which reduces business model and other risks; (98)
3. Top 100 Contractors are institutionally or politically protected or given further leeway, time, and funding to cure contract defaults, as compared to their smaller competitors;
4. Small company set asides are being misused or used wrongfully by Top 100 Contractors; (99)
5. Smaller competitors are taking larger risks in proposing and pursuing more innovative projects than their Top 100 Competitors; and
6. How the prominence of the Top 100 Contractors inhibits, frustrates or facilitates interoperability or causes operational fragility across a wider range of products and services, used in clusters, for government space operations, and supplied by a wider variety of companies, large and small.

Subsidizing Innovation at Traditional vs New Companies

A corollary of the government's reliance on traditional contractors is its subsidy of their use of Independent Research and Development (**IRAD**) and other funding channels to pursue corporate research.

A recent Government Accountability Office (**GAO**) report found that:

“DoD does not know how contractors' independent R&D projects fit into the department's technology goals. As a result, DoD risks making decisions about its multi-billion dollar science and tech investments that could duplicate work or miss opportunities to filling gaps that the contributions of private industry do not cover. DoD has a database of independent R&D projects, but it is not very useful or informing investment decisions because DoD does not obtain information in these and other areas:

- *Priority.* Contractors do not identify whether a project aligns with any of 10 modernization priorities. The department uses those priorities to make decisions about R&D investments.
- *Cost.* The database does not capture a project's complete cost, which could help DoD understand cost implications of future related work.
- *Innovation.* The database does not include whether a project is a lower-risk, incremental development or a more innovative “disruptive” technology. Disruptive projects carry higher risk of failure but offer possible significant rewards in the long term.

While DoD is not required to review independent R&D projects to understand how they support DoD's priorities, GAO analysis showed 38 percent of industry projects aligned with DoD's priorities.” (100)

IRAD is an institutional and systemic example of the federal government tilting the “level playing field” that the nation relies on for innovation in favor of larger established corporations versus their smaller competitors, which thus injects unfairness into any call for proposals to fulfill government requirements in areas previously supported by IRAD or similar subsidy.

Small to medium-sized enterprises (**SMEs**), nongovernmental organizations (**NGOs**), universities, and similar enterprises that are not part of the traditional contractor base are eligible for other grants and contracting opportunities. However, they face the risk that no funding will be provided, or that only a narrow scope of project deliverable will be funded for early phase research, or that funding will not be renewed in subsequent years or phases. Innovation accelerator programs⁷ provide seed funding on a scale too minor and too unsustainable to level the playing field. In many cases, these accelerator programs force the SME “winners” to become subcontractors under established prime contractors, thus exposing the SME's innovation designs, methods, suppliers and human capital to

⁷ Such innovation accelerators include Small Business Innovation Research (**SBIR**) (110), Defense Rapid Innovation Fund (126), Rapid Reaction Technology Office. (111 p. 12) NavalX (112), Defense Innovation Unit (**DIU**) (113), Defense Advanced Research Projects Agency (**DARPA**) (63), Defense Innovation Marketplace (114), Doolittle Institute (115), ERDCWERX (116), and public-private sector efforts like AFWERX (117), DEFENSEWERX (118), SOFWERX (119), SpaceWERX (120), National Security Innovation Network (**NSIN**) (121), and Hyperspace Challenge (122).

being cherry-picked by or recruited as the prime contractor's, while simultaneously growing the prime contractor's IRAD and other institutional powers. (101)

IRAD funds anything or everything the recipient contractor chooses to research. The patents resulting from IRAD-funded research are not freely available to the public to use, but rather are proprietary to the patentee.

To raise similar research funding on a multi-year unrestricted basis, a startup company would have to issue stock, take out a loan, or find other capital, at a cost beyond the "free money" that IRAD subsidies provide prime contractors and other entrenched competitors.

Market Structure for Space Acquisitions and Investments

For over 75 years, the U.S. government has bought assets for space functionality in civilian and military contexts. During that time, the market structure for the space industry, its supply chains, ancillary industry suppliers, customers base, investors and financiers has globalized and commercialized.

There are 2003 pages in the FAR for FY 2000 and 1992 pages in the FAR for FY 2022. (102) (103) If FAR / DFAR rules largely remained the same between FY 2000 and FY 2022, but government's dependency on space functionality significantly grew, are the FAR / DFAR rules enhancing or stifling competition, speeding growth of industrial space capabilities and investments or constraining such growth? Will space capabilities become as essential a transformation in government functions as has been government's shift from analog to digital processes? Unless the domestic and global market structure for space capabilities is well understood, the United States – the innovator for dynamic market structures and their evolutions – would fail to rapidly innovate its procurement processes, and thus risk falling behind in the ongoing competition for strategic parts of the emerging space economy.

Market concentration (104) of traditional contractors provides the government legacy technologies and defers innovation. While market concentration may not increase how much the government pays for what it needs, (105) the extinctions of numerous once vital

U.S. corporations show that dominant market power can and does limit the insight, capacity or will to disrupt established product offerings, customers' patterns for using traditional products, (106) and thus limits innovation in fast-changing industries (107) like industrial space. (108) (109)

Industrial space has become a truly global industry serving and relying on international suppliers, investors and finance. Allies and adversaries are competing for dominance in space via such trends. (3) (4) Through greater analysis and transparency, the USG and the industrial space companies' investors and financiers can join with our allies in growing our and their companies and strategic economic and national security interests. On the flipside, the same analysis and transparency, organized and led through public-private ethical and legal curiosity are necessary at this early stage to assure that adversaries do not get the better of us, nor use our market-based system as a petard on which to hoist themselves above us in space or on earth.

A few questions arise:

- 1) **Monopoly Control of Markets** - Over the past 20 FY budgets,
 - a) How much was spent on space functionality (imagery, launch, etc.) and through which federal programs?
 - b) What percentage of those budgets were spent through contracts with prime contractors (defined as contractors receiving more than 1% of total government space functionality spending for the FY in question)?
 - c) How many new subcontractors were brought into teaming agreements each fiscal year who received portions of this budget, and how much?
 - d) How many new contractors received Facility Clearances (FCL) indicating a capacity to perform on contracts with even the lowest level of classified requirements?

- e) How many patents were filed each FY by the prime contractors? To ease comparison, across all such companies calculate the rate innovation as the number of patents filed per \$1M of government contract
 - f) What was the credit rating (S&P Moody's Fitch) of the prime contractors most recent to the year of the FY?
 - g) What is the imputed cost of capital to the prime contractors?
 - h) What significant events occurred during each FY affecting the prime contractors, such as
 - i) Bankruptcy or insolvency threat or filing
 - ii) Adverse change in credit rating
 - iii) 12-month percentage reduction in market capitalization of more than the change in the Dow Jones Industrial Average
 - iv) 12-month adverse change in Credit Default Swap pricing, volatility or other market indicator of material adverse change in financial capacity
 - v) USG contract cancellation or threat of cancellation
 - vi) Reduction in workforce
 - vii) Sale of division
 - viii) Patent challenge or threat against prime contractor
 - ix) Patent litigation or challenge brought against another company's intellectual property claim
 - x) Merger or Acquisition
 - xi) Industry consolidation
 - xii) Delisting of stock on major exchange
 - xiii) Restatement of prior year's financial statements or SEC disclosures
 - xiv) Taken private through private equity, SPAC or other transaction
 - i) For each FY, what is the combined campaign finance contributions at federal and state election cycles reported by the prime contractor and its employees on OpenSecrets.org in the aggregate, and as a percentage of federal contracts held in that FY?
- 2) **Innovation Culture of the Markets** - Over the past 20 FY budgets,
- a) Of the space functionality budget for each FY, how much was spent with companies that did not exist (and were not the result of merger) in the FY five years earlier?
 - b) What types of products or services were provided by those companies?
 - c) How many patents were filed each FY by those companies? To ease comparison, across all such companies calculate the rate innovation as the number of patents filed per \$1M of government contract
 - d) How much capital did such companies attract (debt or equity) in every FY since winning a government contract?
 - e) What is the imputed cost of capital for such companies?
- 3) **Foreign Investment in the U.S. Companies** – Over the past 20 FY budgets,
- a) Has the government tracked the amount and strategic emphasis of foreign investment in space functionality provided by U.S. companies?
 - b) If so,
 - i) what companies providing which space functionality have taken foreign investment,
 - ii) what percentage of their capital is from foreign sources and

- iii) are trends in space functionality funded by foreign sources evident?
 - c) What is the rate of revenue growth for foreign investor backed companies vs companies with primarily U.S. domestic shareholders?
 - d) What issues have arisen for U.S. companies in taking foreign investment, by
 - i) Fiscal Year (FY)
 - ii) National origin of the foreign investor
 - iii) Percentage of revenues derived by national origin of the customer
 - e) How many companies have been approved by DCSA as FOCI-mitigated? How is this trend changing over time?
 - f) What corporate ownership structures disguise or mask indirect foreign control of U.S. companies or USG contractors? (110)
- 4) **Emergence of New Market Structures** – Over the past 20 FY budgets,
 - a) What market structures have pre-determined the cost and quantity of the space functionality available for purchase and use by the government?
 - b) What innovations in market structures for acquiring space functionality has the USG led or used?
- 5) **Resistance to Buying from Innovators or through New Market Structures** –Over the past 20 FY budgets,
 - a) How much of the lack of contracting with new companies (#2 above) or the resistance to new market structures (#4 above) is attributable to
 - i) FAR / DFAR rules making change difficult?
 - ii) Contracting Officers being conservative and not wanting to take responsibility for change?
 - iii) Objective criteria for technical or other “readiness levels” being unavailable or unproven for the new innovation or innovator?
 - iv) Capital or workforce of the new companies being of concern, notwithstanding entrenched companies’ credit rating and capital access being a function of entrenched procurement patterns?

Transitioning Space Procurement to the Industrial Space Age

In 2021, industrial space companies (also called “new space companies” and “commercial space companies”) design, prototype, and sell reliable and multi-purpose assets and services for use in LEO and elsewhere in space. The nation’s economic future and national security would suffer if the FAR / DFAR insulates U.S. government programs, procurement officers, and others from transitioning to a blended acquisition approach: part commercial, part custom-made, part domestic, part sourced with and from allied nations and their companies.

Industrial space companies form from expert engineering and business management teams, attract private capital, and sell to government and private sector customers. They defray the risks and delays of bespoke procurement activity beholden to, and proved of singular value and usefulness to, a specialized government program or use scenario.

Interoperability in space is existential. The bespoke satellite using customized designs cannot readily be refueled, repaired, upgraded, cyber-hardened or protected from space debris by industrial space operators whose capabilities are designed to serve the broad satellite or other market customer base. Until OMB calls for government procurements of space assets and capabilities to conform to a public-private, industry-driven consensus of interoperability, the government will be buying, and annually spending to maintain and cobble together, renewed versions of obsolescence.

America’s strategic competitors do not use the FAR / DFAR or anything remotely as restrictive. Sometimes the activities of global competitors – whether allies or adversaries - undermine the norms, values, and laws that underpin America’s open economy. The United States may be the only nation that has empowered procurement officers as the official interpreters of procurement’s rarified, epistemological code. Our global competitors’ procurement mechanisms and relationships with industrial space companies display urgency, agility, continuity, and drive toward long-term infrastructure visions for operating in, to, and from space.

China is notable in its One Belt One Road long-term commitment to (1) a NorthStar Vision, (4 p. 82) and (2) bringing many developing nations into that vision, although this commitment comes with its lack of business ethics and transparency, disrespect for human and intellectual property rights, and hostility toward fair trade policies, among many other important concerns. To retain America’s competitive edge, the United States government must finally develop innovative ways of thinking and new ways of acting while remaining true to America’s national ethos and role as a strategic competitor.

During the Industrial Age, the United States set the NorthStar Visions, and used those visions to lead other nations, as allies, to embrace through their own governing traditions, our standards for business ethics, market transparency and government as leading but not primary customer for innovative technologies and economic progress.

Staying a Global Leader in Space

America must evolve 20th century Industrial Age acquisition policies to the current digital Information Age to better make strategic investments that correlate to Americans' 21st century way of life, economic well-being, and democratic norms and values. The United States must reexamine legacy ways of operating to shape a future with American strategic leadership, or accept follower status. Future scenarios show that follower status may mean subservience to authoritarian-led economic systems.

China is the United States' strongest economic, military, and political rival, on Earth and increasingly in space. The space economy is vast and expanding. America's big aerospace prime contractors, together with SpaceX, Blue Origin, and newer space firms can all have a sizeable share of this global market. However, American economic success in space and its national security benefits will not be easily achieved if there is intra-industry fratricide and infighting among American companies. (101) In addition, the U.S. government's way of supposedly leveling the playing field inhibits market growth, innovation, and competitive pricing because taxpayer money is spent rewarding a few well-established firms.

Russia and China have reorganized their space forces to unify long-term agility and government-wide use of space capabilities. On December 17, 2019, Congress passed the National Defense Authorization Act for fiscal year 2020 establishing the U.S. Space Force (**USSF**), as a new service within the U.S. Air Force (**USAF**).⁸ The USSF is first new independent military service added since the Army Air Force in 1947 that evolved into the USAF.

Keeping up with rival governments' space organizational structures is not a recipe for innovations that will assure U.S. leadership. We need to fundamentally reexamine and rethink how U.S. industrial space companies are organized, how national security space programs overly rely on a handful of powerful traditional large companies, and how the financial, insurance and commodity markets provide long-term capital. Then U.S. leadership in space will be assured and globally worth following by allied nations and their companies and investors.

⁸ The United States is now the third nation in the world to reorganize its space forces.

Concluding Thoughts and Recommendations

This Report raises clusters of questions that are within and across many missions of the USG in growing and relying on the burgeoning industrial space sector.

OMB, OFPP, Treasury, the CFOs of federal departments and agencies, Congress and its various House and Senate committees, the Congressional Research Service, and numerous other offices can address, find data to answer and develop policies, individually or government-wide to make sense of such questions and the interdependent lines of inquiry and economics they map.

The FAR, DFAR, procurement officers and others involved in investing taxpayer dollars in space-based assets and services are doing so under procurement rules and conventions of beliefs and practices grown from, and growing moss since, the industrial age.

To do things differently, and to retain U.S. global leadership, we must move from 20th century to 21st century capabilities and the processes they require.

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