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# ASSESSING COMMERCIAL SOLUTIONS FOR GOVERNMENT SPACE MISSIONS

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# **Summary**

Government organizations are increasingly leveraging commercial offerings to meet space mission needs. For over two decades, national policies have been directing U.S. government organizations to transition their acquisition approach from a legacy of creating space capabilities to a future of buying, adapting, and adopting commercial capabilities and services. Although there has been significant attention on the value of using commercial capabilities and services, less attention has been given to how government organizations should go about making decisions and managing risk when planning to use specific commercial solutions for specific needs. This paper proposes frameworks and associated recommendations for how government organizations can assess and characterize the readiness of candidate commercial providers and commercial markets to meet national needs. One framework describes a multifactor approach that entails assessing market, capability, production, operational, and financial readiness. A complementary framework provides a structured approach to characterize attributes of acquisition scenarios to inform government acquirers when to *buy*, *adapt*, *adopt*, or *create* a solution in the national interest.

# Introduction

Developments in commercial space have led to new areas of convergence of what is technically feasible, economically viable, and policy acceptable.<sup>1</sup> In an era where technological advances are leading to significant improvements in capability, tremendous opportunity exists for the U.S. government to use and leverage commercial products and services.

Government organizations are increasingly leveraging commercial offerings to meet space mission needs.<sup>2</sup> Since 2012, after the retirement of the space shuttle, NASA has contracted with commercial service providers to deliver cargo and crew to the International Space Station. NASA's Launch Services Program manages commercial launches of government satellites, including interplanetary spacecraft using a standardized contracting mechanism. NOAA has been acquiring Earth observation data from commercial satellites for weather and scientific research. Although these efforts are significant, government organizations could go much further in exploiting the market readiness of the commercial space sector to provide a range of space capabilities. For example, NASA, praised for focusing on commercial solutions for the Artemis program, currently sources approximately 20 percent of the Artemis architecture from commercial providers. Opportunities exist for government organizations to continue to expand their use of commercial solutions over time and to leverage lessons learned from early adopters.<sup>3</sup>

For over two decades, national policies have been directing U.S. government organizations to transition their acquisition approach from a legacy of creating space capabilities to a future of buying, adapting, and adopting commercial offerings to meet national mission needs. The National Space Policy 2020 directs government organizations to "[p]urchase and use United States commercial space capabilities and services, to the maximum practical extent under existing law, when such capabilities and services meet United States Government requirements."<sup>4</sup> The U.S. Space Force (USSF), Space Development Agency (SDA), National Oceanic and Atmospheric Administration (NOAA), and National Aeronautics and Space Administration (NASA) have been implementing "commercial first" policies.<sup>5</sup> A set of recent representative cases are outlined in Appendix A.

#### **Clarification of "Commercial"**

Prior to World War II, the U.S. government primarily relied on government-owned arsenals, laboratories, and shipyards staffed by military and civilian personnel for developing defense assets. Since WWII, the U.S. government has invested in building major systems for national security by hiring private sector contractors.<sup>6</sup> Given the history of hiring contractors, emphasis on the government increasing use of commercial products and services may seem confusing. While the term "commercial" is often associated with the private sector engaged in making profits, in this paper the term "commercial" specifically refers to capabilities and services that exist due to private sector investments, in contrast with bespoke solutions driven by government investments that are developed by contractors.

Leveraging commercial capabilities can add tremendous value, but also presents inherent risks to the government. Government decisionmakers should make informed tradeoffs when deciding what, when, where, and how to leverage commercial capabilities to maximize value, meet mission needs, and appropriately manage and mitigate risks. Although there has been significant attention on the value of using commercial capabilities and services, less attention has been given to how government organizations should go about making decisions and managing risk when planning to use specific commercial solutions for specific needs.<sup>7</sup> This paper frameworks proposes and associated recommendations how for government organizations can assess and characterize the readiness of candidate commercial providers and commercial markets to meet national needs.

# Assessing Readiness of Commercial Solutions

In response to national mission needs, government organizations can benefit from a framework to assess commercial offerings to determine their government readiness for acquisition and integration into Hybrid Space Architectures, which could accommodate both government-created systems and commercial products and services.8 The framework in Figure 1 describes a multifactor approach that entails assessing capability, market, production, operational, and financial readiness.9 Conducting such assessments in a systematic way can inform the government of the viability and sustainability of a specific candidate commercial offering for a given national mission need.



Figure 1: Commercial Readiness Assessment Framework.

Readiness assessments can inform government program managers on the degree to which a commercial provider can supply a solution that delivers desired outcomes to established standards and mission requirements over the period of need. Focusing first on mission needs and outcomes rather than prescriptive requirements opens the acquisition landscape.

Readiness assessments are a systematic method to look at a spectrum of acquisition and integration criteria qualitatively and quantitatively. The Commercial Readiness Assessment Framework shown in Figure 1, adapted from multiple sources, is an objective, tailorable risk management framework for identifying viable commercial solutions across five key areas<sup>10</sup>:

- 1. Capability Readiness Assessment: А disciplined process to assess maturity of a commercial solution using technology readiness levels as a key metric.<sup>11</sup> Analytics are used to model performance beyond assessing the technology readiness of underlying materials, components, subsystems, and systems. This assessment determines if a capability is sufficiently mature and meets the requirements for integration in an operational environment to meet a government mission need based on sound scientific, engineering, mathematical and principles.
- 2. Market Readiness Assessment: A disciplined process to assess the level of market readiness for a commercial solution. This assessment studies the environment and dynamics for a specific market segment, including economic environment, segment size, suppliers, buyers, new entrants, market disruptors, price sensitivity and elasticity, offering differentiation, switching costs, and future roadmaps and projections. From a buyer perspective, this assessment considers a variety of factors, including the extent to which a price might change over time

due to supply and demand and the viability of market players given the viability of the broader market segment.

- 3. Production Readiness Assessment: Structured processes used in DOD acquisitions since 2005.12 These include assessments of documentation, digital models, quality assurance plans, testing plans, and schedule-to-production readiness for a specific solution, including supply chain factors.<sup>13</sup> This assessing assessment addresses degrees to which the solution can be delivered at the scale necessary to meet need and informs confidence or risk of sourcing from trusted producers.
- Readiness 4. **Operational** Assessment: Δ structured process to assess the degree to which a solution meets operational needs from the standpoint of architectural fit, operational requirements, interoperability, reliability, resiliency, security, stability, sustainability, scalability, survivability, and safety. Operational Readiness Assessment processes are aligned with Operational Readiness Reviews (ORR), Flight Readiness Reviews (FFR), and Program Protection Plans (PPP) used by NASA.<sup>14</sup> A capability could be impressively built, sold at a good price, have the capability to be produced at scale from sellers that do not pose threats, but not be deemed compatible within the government's broader architecture.
- 5. Financial Readiness Assessment (FRA): A disciplined assessment of financial readiness of a specific legal entity. Aspects include corporate ownership, governance, management team, compliance framework, business model, and working capital. Additional aspects include long-term capital, liquidity, solvency, operating efficiency, profitability, financial ratios, trends, intellectual property rights, cyber and physical security. A further consideration is assessing

foreign ownership and control considerations. A financial readiness assessment is a risk management process requiring reasonable due diligence in engaging, selecting, and assessing candidate commercial solution providers. A capability could meet all the needs of a government customer, but the provider of the capability may not have sound financials, which could mean the provider is not able to sustainably provide the capability for the duration needed by the government. A company could have sound financials but could also have ownership or investors from countries that would pose national security concerns.

#### **Government Readiness**

The government acquirer of commercial space solutions must have the will and means to assimilate and operationalize acquired offerings into its mission architecture. Assimilating commercial offerings into a hybrid space architecture may impact policy, security, process, resiliency, training, and logistics. Discussion of the policy implications of integration of commercial solutions for government missions is complex and beyond the scope of this paper. That said, government organizations will need to understand the dynamic nature of commercial markets and commercial providers will need to adjust to government regulations acquisition to enable successful mission outcomes.

The sweet spot for leveraging the commercial sector's capabilities for government missions is to identify products and services with viable commercial markets that exist or can be developed, with financially sustainable commercial companies and business models, and sufficient production capacity and trusted supply chains to meet government demand. An objective of applying the Commercial Readiness Assessment Framework is to identify sufficiently mature commercial solutions that can be integrated to meet operational

requirements within cost, risk, and schedule constraints specific to the needs of the government mission. To inform decisions to assimilate specific commercial solutions into government architectures and acquisitions, assessments are conducted before the government determines an appropriate acquisition scenario and initiates the acquisition for a commercial solution. A span of acquisition scenarios is described in the next section. This is in sharp contrast to government acquisitions conducted to create solutions, where assessments and reviews are conducted after proposals are received.

Results from commercial readiness assessments inform government organizations in selecting appropriate acquisition scenarios. For a scenario where government needs a new capability and there is no information on commercial investment or development, or there are defendable justifications for not selecting commercial, government organizations can select an acquisition tailored to "create" a bespoke solution. For a scenario where assessments reveal a commercial product available to acquire directly, government organizations can select an acquisition scenario to "buy" a commercially available solution. These and two intermediate scenarios are described in the next section. These two sections are tightly coupled. There is an interplay between commercial readiness assessments for a specific company and its solution in the context of broader market characterizations that inform government organizations' decisions on the appropriate acquisition scenario to execute.

# Scenarios for Government Acquisition of Commercial Solutions

Government acquisition of a commercially available offering may not be appropriate for each government mission. There are some missions where government organizations may want to retain complete control over the design and operation of their systems. There are also missions where the commercial market may not be mature enough to offer a commercial solution. And there are missions where government organizations may want to acquire and integrate a combination of commercial and/or government solutions to deliver required outcomes. After assessing the readiness of individual commercial solutions and suppliers, government organizations should consider the state of the market for that capability to inform the appropriate acquisition approach. In many cases, it may not be feasible to simply buy an existing commercial capability or service. Government organizations may need to adapt a commercial capability, adopt a commercial solution, or create a government-led capability. Understanding the maturity of markets for commercial solutions can organizations help government determine conditions for buying commercially available products or services.15

Assessing commercial markets focuses on the maturity of available, or soon-to-be-available, commercial capabilities, associated market dynamics, market economics, and the relative power of buyers and sellers. A straightforward acquisition transaction can be used for commodities in markets where the government is one of many buyers with many commercial sellers with similar offerings. Where the government requires adaptations to tailor an available commercial capability, the government buyer leverages private sector investment risk to bring that solution to market and pays for, and accepts the risks for, required adaptations. For immature markets associated with emerging technologies not yet commercially viable, the government can adopt the emerging capability to further assess its potential for government use, which could have the added effect of helping accelerate development through shared investment risk.

A structured approach to characterize attributes of four acquisition scenarios informs government acquirers when to *buy*, *adapt*, *adopt*, or *create* a solution.<sup>16</sup> Figure 2 presents these scenarios as quadrants characterized as:

- **Bespoke Market** (where government *creates* a solution): In this scenario, no viable commercial market is recognized and there are no indicators a market will develop. There are only a few qualified providers, with specialized capabilities, to develop a bespoke solution underwritten by government investment.<sup>17</sup> Quite often "one and done" or "some and done" are the only viable approaches and the government must invest to establish requirements and hire a contractor to create the solution.<sup>18</sup>
- Niche Market (where government *adapts* a commercial solution): In this scenario, there are few suppliers, but there are promising commercial capabilities that could be adapted or tailored to meet specific needs of a government customer.<sup>19</sup> Under this market, government might be an anchor tenant and tailor an available commercial capability, buying products or services that may serve some, but not all, of a government's needs for a particular mission. Ground communication terminals for defense applications are an example of a niche market where the government procures existing capabilities and ruggedizes and tailors them for a specific national mission.
- Emerging Market (where government *adopts* a commercial solution): In this scenario, a commercial market does not yet exist, but is on the horizon for both commercial and government applications, and could be stimulated or accelerated by government action, perhaps through creative use of grants, grand challenges, prizes, public-private partnerships, and/or Other Transactions Authorities (OTA).<sup>20</sup> Cooperative research and development agreements are appropriate for emerging markets, like the National Geospatial Intelligence Agency has

with satellite-based commercial synthetic aperture radar providers. Government spending in this scenario is often more about consideration of future capabilities than acquiring systems that fill an immediate need.

• Established Market (where government *buys* a commercial solution): Attributes of this market scenario include one or more commercial providers with readily available products and services that can be bought and sold, acquired through competitive transactional commercial contracts. In this scenario, the government may be one of many buyers.<sup>21</sup> Commodity products and services can be purchased commercially without any tailoring or customization to meet government needs. Satellite communications are representative of a commercial service in an established market, at least for unprotected satellite communications.

The range of market scenarios recognizes not every acquisition opportunity can be satisfied by the government buying a commercially available solution. Under an established market, it may make sense for a government official to simply purchase the capabilities it needs. Under other market scenarios, a government official may need to tailor commercially available capabilities, use commercial capabilities to meet part of the need and be supplemented with systems acquired under traditional acquisition processes, or entirely rely on systems acquired under such traditional processes.<sup>22</sup> These four market scenarios capture some of the complexity facing government organizations wanting to exploit commercial capabilities. A 2009 Defense Science Board report lists nine different scenarios in which the government could be acquiring a commercial system where each of these would produce different outcomes.<sup>23</sup> These include:

- "Buy it from a manufacturer...and use it as it is."
- "Buy it from a manufacturer and make minor modifications."
- "Buy it from a manufacturer and make significant modifications."
- "Have a manufacturer make significant modifications before buying it."
- "Have a manufacturer gut an existing product and replace most of it."
- "Have a manufacturer modify a commercial prototype product to meet military requirements."
- "Have a manufacturer assemble a collection of commercial and military components independently qualified on different systems."
- "A product that does not yet exist but requires commercial development commercial plants or processes."

Even this list is far from exhaustive. The list does not cover Hybrid Space Architectures where a combination of bespoke and commercial solutions comprises a mission architecture.<sup>24</sup> Solutions for government missions can be categorized in these scenarios as a way to satisfy immediate needs: buying a commodity, partially addressing current needs by tailoring a solution within a niche market, investing in advancing a solution to meet future needs in an emerging market, or creating a bespoke solution unique to government needs where there is no identified market. Figure 2 describes the four market and associated acquisition scenarios. Assessing the readiness of commercial solutions to meet government needs using a commercial readiness framework informs government organizations on which type of acquisition can best serve the national interest. This two-tiered approach of, one, evaluating individual commercial providers and solutions and, two, using information to determine market scenarios can be applied to inform government acquisitions.

Characterizing the readiness of commercial markets is helpful for addressing immediate needs and for planning future capabilities years down the road. If a solution is assessed as fitting in an established market, or on the cusp of becoming an established market, the government may not need or want to initiate long-term programs to create solutions through a traditional requirements process. If something is in a niche market, the government may want to plan for creating opportunities to ensure availability of solutions to meet critical needs for the foreseeable future. For solutions in emerging markets, government organizations may see value in investing to advance commercial solutions enabling confidence to address a broader market demand. And for government needs where commercial readiness assessments do not present viable solutions or markets, the government can justify acquiring bespoke solutions using traditional



Figure 2: Government Acquisition Market Scenario Matrix (MSM).

acquisitions based on government requirements and investments. The degree to which a commercial capability meets requirements should be factored into the decision calculus. A commercial solution that meets 60 percent of the need at 10 percent of the cost of a bespoke solution is worthy of serious consideration. A commercial capability that does not meet operational needs is not worth the effort regardless of how cheap or attractive it appears to be.

## **Other Considerations**

This paper proposes approaches for how the government can assess commercial solutions to increase the successful adoption of commercial capabilities. It does not address all issues pertinent to acquiring commercial space capabilities for government missions. For example, this paper does not evaluate the level of risk associated with different types of missions.<sup>25</sup> It also does not propose assessments of government readiness to leverage commercial solutions. Even if a commercial capability is mature, affordable, and meets most needs, the government organization also needs to be ready to adopt or assimilate the solution. For example, in pursuing a commercial, mobile, lightweight communications device, one can purchase as many state-of-the-art cellular phones as they like. However, without the necessary communications infrastructure for those phones, there is no useful communications capability.

# Conclusion

When making the decision to acquire a commercial capability, government agencies should determine the level and scope of assessments needed to match their risk tolerance. This paper contains an approach for conducting multifactor readiness assessments of capability, market, production, operational, and financial attributes of a solution and the company providing the solution for government missions as described in Figure 1. With the results of the readiness assessment, a second framework is

described in Figure 2 to align government acquisitions with scenarios suited to buy, adapt, adopt, or create solutions for national missions. The two-tiered approach assesses available commercial offerings and aligns acquisitions with four distinct scenarios described as *commodity*, *niche*, *emerging*, and *bespoke*. Applying a disciplined and structured approach can inform government acquisitions and integration of commercial solutions.

There are plenty of arguments for the value of the government acquiring commercial capabilities and services-that doing so saves money and time, supports the U.S. industrial base, and boosts U.S. competitiveness. Less attention gets paid to how government organizations should go about making these decisions. Acquiring a complement of commercial offerings to populate hybrid architectures for government space missions requires an understanding and evaluation of commercial market dynamics, players, and business models in addition to understanding technology and capability readiness. emerging Assessing commercial solutions and how investment risk and responsibility should be balanced between commercial interests and government interests needs to be aligned with attributes of market scenarios for specific missions. The frameworks in this paper outline steps that can inform government acquisition strategy to leverage commercial solutions for national space missions.

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# **Appendix A: The National Context**

• NASA's fiscal year 2022 budget request includes increased funding for utilizing commercial solutions<sup>26</sup>: \$1.1 billion for Human Landing System for commercial partnerships to develop and deploy the integrated landing systems to transport the first woman and first person of color to the moon; \$491 million for technology maturation to advance revolutionary disruptive exploration technologies from proofof-concept to demonstration, including initial delivery of Lunar Surface Innovative Initiative payloads to the lunar surface by Commercial Lunar Payload Services (CLPS) and initiation of industry and commerce innovation opportunities; \$497 million for the Lunar Discovery and Exploration program, which partners with industry to deliver to the moon instruments and other payloads, including the VIPER mission, a lunar rover to investigate volatiles on the South Pole of the moon; \$42 million for Communications Services Program to begin demonstration of commercial services to support future NASA missions; and \$101.1 million for design maturation of multiple commercially owned and operated LEO destinations (from which NASA, along with other customers, can purchase services) to stimulate the growth of commercial activities in LEO. NASA's Plan for Commercial LEO Development<sup>27</sup> lays out steps for the near-term, mid-term, and long-term. As part of NASA's five-part Plan for Commercial LEO Development, the agency released quantification of the demand forecast for the type and amount of services NASA intends to purchase in the future when those services become commercially available<sup>28</sup>, giving the commercial sector time to plan and position for future government demand. NASA's Commercial Crew and Cargo Program is a critical enabler for further American economic space development-an equivalent of developing

roads, railroads, canals, and other national investments to expand frontiers. NASA envisions a future with seamless, smartphonelike experience to all communications users in near-Earth space.<sup>29</sup> Their stated vision is "[b]y 2030, practically all NASA missions in near-Earth orbit will utilize only industry-provided services to meet their space communications needs. No longer will we rely on governmentowned space-based relay assets and a mixture of government and commercial ground network locations. Instead, ours will be a completely commercial paradigm."

NASA's Commercialization, Innovation, and Synergies (CIS) Office, a new office situated the Exploration and within Space Communications Projects Division at Goddard Space Flight Center, is currently utilizing these frameworks to assess the readiness of commercial capabilities to support the Near Space Network (NSN) enterprise and Space Navigation Communications and goals.30 (SCaN)commercialization The development of a commercial market for downlink services in the near space region is a substantial opportunity, but public/private partnerships present some unique challenges. A CIS role is to actively engage private industry to identify current and future commercial service providers and users. By connecting experts from industry, academia, and other U.S. government and international agencies to create a community of innovators dedicated to providing dependable communications. navigation. and data acquisition services, CIS and NSN will provide a one-stop reputable and proactive team that will help scientific missions achieve their goals.

A critical aspect of the role CIS plays in the development of the NSN is establishing a community of providers and users through a dynamic cycle of engagement activities that has a global reach and a unified goal. This will help NASA fill the gaps revealed through market analysis providing companies an avenue to discuss mission requirements, timelines, and potential mutually beneficial opportunities. The CIS Capability Studies program is designed to identify future technology needs for the NSN, assess the maturity of commercial capabilities proposed for or used in a system, using technology readiness levels as a key metric, and invest in early-stage capabilities for further development. The National Oceanographic and Atmospheric Administration (NOAA) periodically conducts assessments to determine the viability of commercial solutions to address NOAA observing system objectives prior to considering the purchase of commercial data for operational use. NOAA conducted the Commercial Weather Data Pilot (CWDP) Round 1 from 2016-2018, as well as an expanded CWDP Round 2 from 2018-2020, both focused on demonstrating radio occultation data.<sup>31</sup> NOAA used Round 2 of the CWDP to confirm the readiness of the commercial sector to provide Global Navigation Satellite System Radio Occultation (GNSS-RO) data. NOAA last issued a request for information in 2020 to inform Round 3 of the CWDP. In NOAA's FY22 Congressional Budget Justification CWDP, \$13 million was allocated to the CWDP program to fund "testing of commercially available capabilities to assess the accuracy, value, and impact of the commercial data or service." To the extent possible, such capabilities will be evaluated by comparison to established and validated NOAA operational products and deliverables; to ensure the necessary ground systems, services, IT security interfaces, and data processing are in place for ingesting the commercial data selected; and, to Deliver assessment report(s) on the viability of the pilot data set(s) and the capabilities of the commercial systems to meet NOAA observation requirements for operational services. NOAA

plans to share outcomes from CWDP to foster interagency coordination on acquisitions of space-based weather data for operational use within the Federal Weather Enterprise. NOAA awarded initial contracts in November 2020 to purchase commercially available space-based radio occultation (RO) data for use in NOAA's operational weather forecasts in. A further \$5 million was allocated for FY22 for NOAA's Commercial Data Program (CDP), "if NOAA determines that data or services licensed and evaluated through the CWDP are cost effective, operationally viable, and appropriate for meeting a NOAA observation requirement, NOAA will pursue purchase of the commercial data or service via the Commercial Data Purchase, within the Commercial Data Program." Based on a successful Round 2 pilot, NOAA initiated operational data purchases via Indefinite Delivery Indefinite Quantity (IDIQ) contract.

- On July 1, 2021, **The Space Development Agency** released the Tranche 1 Optical Communications Terminal Standard, providing an initial framework and protocol definitions, guided by recommendations from the Consultive Committee for Space Data Systems (CCSDS) for optical communication systems deployed by SDA and its partners. NASA, DARPA, AFRL, and the greater national security space community are working to align efforts to reflect the critical nature of developing interoperability between resilient commercial systems.<sup>32</sup>
- The National Geospatial Intelligence Agency (NGA) leverages commercial remote sensing to meet critical intelligence, surveillance, and reconnaissance (ISR) mission needs. The number and diversity of commercial ISR vendors has exploded in recent years offering unprecedented opportunities for the U.S. government across both Title 10 and Title 50 to meet an expanded portion of national overhead ISR needs with commercial capacity. The

government has been informed by independent and objectives assessments of commercial solutions, tracking the ever-changing landscape of this competitive market and arming decisionmakers with business intelligence insight. These assessments build confidence for government acquisitions and integration of capabilities through screening vendor claims to separate the substantiated capabilities which can contribute to requirements from the marketing chaff. All in context of leveraging commercial solutions for government missions to advance U.S. space capabilities in the national interest.

• U.S. leadership is establishing a national cislunar strategy to coordinate government and

commercial investments and space systems to develop a sustainable cislunar neighborhood. Multiple government agencies-including NASA, SDA, U.S. Space Force (USSF), **Defense Advanced Research Projects Agency** (DARPA), and Air Force Research Laboratory (AFRL)-are investing in layers of space infrastructure. Essential layers provide transportation, communications, navigation, surveillance, and protection. In parallel, multiple companies and private sector investors are investing and building layers of space infrastructure. There is a need and a value for independent and objective assessments of government and commercial investments to coordinate for an integrated enterprise.

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