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LESSONS FROM THE CLOUD: OUTSOURCING AND INTEGRATING COMMERCIAL SPACE SERVICES

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Summary

The U.S. defense sector has spent the last two decades outsourcing and integrating commercial cloud capabilities into its vast information technology architecture to realize the benefits of resilience, rapid innovation, and agile implementation. Over this time, the Department of Defense (DOD) has learned that realizing these benefits comes with enablers and tradeoffs and that, sometimes, a gradual evolution is the most practical way to achieve longer-term end goals. Using lessons from commercial cloud integration, this paper proposes an integration maturity model to facilitate bringing commercial space services into DOD space architectures. This framework builds on the success of a phased approach at various levels of outsourcing, with an understanding of the investments required and the risks inherent in each.

Introduction

Commercial companies are rapidly integrating new technologies into the space sector and are outpacing DOD acquisition cycles for some space-based capabilities, such as large communications constellations.[1] The expanding space economy along with the proliferation of space technologies and services has yielded new opportunities and directions for DOD space activities in areas as diverse as launch, communications, and remote sensing activities. Interest in even more commercial integration has been inspired by experiences like the Ukrainians' use of Starlink in the Russian-Ukraine war.

While these events have played out on the world stage, the Office of the Secretary of Defense (OSD), and the United States Space Force (USSF) have been drafting strategies to codify and guide commercial space integration. The DOD aims to take advantage of commercial innovation, volume, and pricing to complement existing government capabilities.[2] The mantra embraced by the Department of the Air Force and U.S. Space Force organizations, "exploit what we have, buy what we can, build what we must," reflects a notable shift toward commercial acquisition.[3]

The past 20 years of cloud services integration efforts offer a practical phased approach for growing the "as-a-service" (aaS) model, which government space stakeholders are coming to expect. Commercial cloud implementations have inspired aaS models in the space sector, such as ground station as a service (GSaaS), and on-demand satellite communication or connectivity services. These turnkey services can deliver a mission capability with a substantial reduction in the capital investment of hardware, software, and government staff support. Traditionally, the acquisition strategy for space capabilities has not focused on services

but, instead, on the acquisition of platforms and products. This is changing. During 2024, the Office of the Secretary of Defense published a strategy focused on integrating commercial solutions into national security space architecture, and the Department of the Air Force also released a strategy defining its path to commercial space implementation. [4, 5]

The DOD Commercial Space Integration Strategy and the U.S. Space Force Commercial Space Strategy are clarion calls to the DOD and industry on *what* space capabilities should (or could) be outsourced or procured aaS. Yet, there is still a gap in guidance for exactly *how* a service-based acquisition approach could be pursued to include commercial services as part of a hybrid space architecture. In other words, the direction to the DOD to lean more on commercial space services, such as satellite-based communications, connectivity, remote sensing, and positioning, is widely recognized. However, strategic and implementation guidance for how to integrate these services into a DOD hybrid architecture is relatively new and less certain. There is opportunity for the U.S. Space Force to adapt and learn how to do this effectively to meet the urgent requirements of an increasingly contested space environment.

Government Adaptation: Streamlining and Partnering

To make commercial acquisition a reality, mechanisms exist for government use of commercial capabilities. In 1994, the Federal Acquisition Streamlining Act (FASA) reformed acquisition to gain access to the latest commercial technologies and to benefit from competitively priced commercial goods and services. The act (Secs. 8104 and 8201) established a *preference for acquisition of commercial items* for both armed services acquisitions and civil agency acquisitions and directed "to the maximum extent practicable" that government emphasize *functional* specifications rather than *design* specifications. The emphasis on functional specifications opened the door to full and open competition and the commercial sector's ability to offer innovative solutions to the government's needs.[6] More recently, the National Defense Authorization Act (NDAA) for Fiscal Year 2022, S. 1607, took on the use of commercial space capabilities, specifically requiring that the DOD determine whether individual space program requirements can be met with commercial capabilities.[7]

Thirty years after the initial FASA, and a few years after FY22 NDAA, S. 1607, DOD is now clarifying where commercial space capabilities should and will be leveraged via new space strategies. The DOD Commercial Space Integration Strategy (April 2024) defines where commercial capabilities are relevant and can be used by the DOD. It does this by categorizing 13 separate mission areas as "government primary," "hybrid," or "commercial primary."[8] In furtherance of commercial integration, it also identifies four priorities to maximize the benefits of commercial space solutions:

1. Ensure access to commercial solutions across the spectrum of conflict.
2. Achieve integration prior to conflict.
3. Establish the security conditions to integration commercial space solutions.
4. Support the development of new commercial space solutions for use by the joint force.

Correspondingly, the U.S. Space Force Commercial Space Strategy (April 2024) highlights "USSF mission areas considered suitable for commercial integration,"[9] with an emphasis on operational integration of both data and hardware.

These documents define what missions are candidates for commercial integration and provide considerations for that integration. Yet realizing

these priorities will also require a roadmap or well-defined framework for implementation.

Using the Commercial Cloud as a Model for Commercial Space Services

Fortunately, we can look to other hybrid architectures to gain practical insight into how to integrate commercial capabilities. Commercial cloud service capabilities offer one such example, where customers access software and services in commercially owned and operated data centers via the internet or other network infrastructures. For at least 20 years, the DOD has been working to integrate commercial cloud capabilities into its IT architecture to create a hybrid architecture of on-premises and commercial cloud capabilities. Over that time, both DOD and cloud service providers (CSPs) gained experience and identified best practices for working together. Early on, there were few IT capabilities under government purview that agencies were willing to shift to a commercial provider. Today, however, the DOD is using commercial cloud services for numerous use cases and at all classification levels. In many ways, the cloud is now part of the no-fail fabric of DOD IT—the infrastructure that must be reliable and available to mission needs. Thus, lessons and best practices from commercial cloud integration could accelerate the successful integration of commercial space capabilities into the DOD's space services architecture.

Commercial cloud integration is a useful model for consideration of broader commercial space services integration because of several similarities beyond their goals of hybrid architectures:

- For both cloud and space, commercial companies are leading invention and pushing the envelope for new capabilities.
- Both DOD IT and DOD space architectures must be capable of managing and processing data at multiple classification levels.
- There is private sector demand for many of the same or similar cloud services as those needed by the DOD, such as elastic computing capabilities, resilient storage, and artificial intelligence and machine learning. Similarly, industry demand for space services includes data transport, satellite communications, and multiple forms of imagery—capabilities needed by the DOD as well.
- Both commercial cloud and commercial space services are sold to customers aaS. This means capabilities are paid for based on use, akin to renting. They both use cost models built on operational expenditures (OPEX) versus the customer owning the capability, which would entail capital investment and expenditures (CAPEX).

This is not a perfect analogy. The commercial cloud market is dominated by a handful of "hyperscale" companies. Amazon Web Services (AWS), Microsoft Azure, and Google Cloud together account for 66 percent of the worldwide market, with no other company holding more than 4 percent of the market share.[10] By contrast, commercial space services are provided by a large, growing, and diverse set of service providers, from heavyweights like SpaceX and Maxar to small startups like BlackSky, Capella Space, and Slingshot Aerospace.[11] Further, some issues that matter to DOD cloud customers, like data sovereignty (where a data center is physically located) do not have parallels for satellites that circumnavigate the globe.

Although no analogy is perfect, lessons from integrating commercial cloud capabilities into

hybrid IT architectures can provide a useful framework for the U.S. Space Force and DOD as they work to integrate a broader portfolio of commercial space services into hybrid space architectures.

Common Benefits of Commercial Integration

Experts on commercial cloud integration and commercial space integration describe remarkably similar benefits. These benefits derive from the fact that a profit-motivated industry strives for both efficiency and market relevance as it builds customer-focused products. As a result, the government customer can access both commercial cloud and commercial space services without significant upfront CAPEX to harness resilience, rapid innovation, and agile implementation. In combination, these benefits have the potential to increase DOD capability and capacity.

Resilience

Integrating a range of commercial services and capabilities into DOD architectures provides resilience to natural disasters and human-caused disruption by increasing the volume and diversity of physical systems.

For cloud capabilities, data and workloads are typically replicated across multiple and geographically dispersed data centers. Resilience means that loss of any one data center—due to power outages, technical failure, or nefarious action—will not result in the loss of data or a capability. Similarly, cloud services can provide additional options for networking between and among data centers. CSPs now offer vast networking capabilities across terrestrial, SATCOM, and 5G modalities. These capabilities can be leveraged by DOD, alongside DOD cryptography, to extend DOD's existing network options.[12]

According to the OSD, commercial augmentation in space allows for diversification—one of six methods of achieving space resilience.*, [13] Commercial space systems can contribute to the resilience of U.S. Space Force missions by providing mission support services "using different platforms, different orbits, or [different] systems and capabilities."[14] By providing alternatives for mission support, commercial integration can allow for "buy back," meaning the purchase of a commercial capability to replace a degraded defense capability.[15]

The Terms for Resilience Vary, But the Meaning Is the Same

For the cloud, three concepts support resilience:

- High availability – the ability to access data and workloads reliably
- Fault tolerance – design that allows for contingency options when one fails
- Disaster recovery – the ability to ultimately return to the pre-failure state.[16]

Meanwhile, the U.S. Space Force has defined a resilient force as one that can "withstand, fight through, and recover from attacks."[17] Notably, despite the different terms, resilience in both cloud and space applications has three components: a capacity to be hardened against failure, an ability to work despite failure, and an ability to recover from failure.

*The other five means of achieving space system resilience are disaggregation, distribution, protection, proliferation, and deception.

Rapid Innovation

At this point it is a truism, although backed by data, that the private sector is funding research and development at a rate that exceeds the government.[18] And often industry can pay scientists and technical staff higher salaries, leading many in competitive fields to choose to work for a private sector employer. For example, a 2023 analysis by researchers of the Massachusetts Institute of Technology (MIT) concluded that 70 percent of those who hold doctorates in artificial intelligence work in the private sector; that number was just 20 percent in the early 2000s.[19] Government leaders see an opportunity to flex to the growing commercial market dynamics to tap into rapid industry innovation.

For cloud capabilities, service providers compete for global market share, which drives them toward competitive pricing and product differentiation by introducing new products and services. Gartner, Inc. has named Amazon Web Services (AWS), Google, Microsoft, and Oracle as "leaders" in Strategic Cloud Platform services, in part due to the breadth and pace of service and feature introduction. For instance, Gartner's 2023 "Magic Quadrant for Strategic Cloud Platform Services" report[20] states that AWS has "breadth and depth of [Infrastructure-as-a-Service and Platform-as-a-Service] services" and innovations in hardware design, Google is a "leading developer of its own [AI/ML] models" and supports third-party integration, Microsoft has "deep investments in generative AI innovator OpenAI," and Oracle has "impressive year-over-year pace of feature introductions." †

As DOD Chief Software Officer Rob Vietmeyer stated "Advanced cloud computing capabilities are available globally, empowering both positive progress and, unfortunately, malicious actors. While risks exist, shunning this technology is no longer an option. It's the cornerstone of modernization, demanding we actively manage its challenges to unlock its vast potential."[21]

For the space sector, startups are driving a surge in new capabilities and services in areas such as communications, sensing, launch, and in-space logistics.[22] In a 2023 *National Defense Magazine* article, Col Eric Felt explains that industry "can respond much faster than the government can to help fulfill our future needs and make sure we maintain the technology edge against China."[23]

Agile Implementation

Using commercial capabilities aaS allows the DOD to quickly spin up a capability without the lengthy procurement timelines and substantial capital investment for facilities construction. The aaS model specifically allows a customer to access capabilities or products already in place. This model may not be limited to capacity constraints if the same product can be used by multiple customers or if demand varies over time and geography. It also allows the DOD to shift with agility from one capability to another as the situation demands.

For cloud capabilities, the DOD can tap into data centers that already exist, spinning up virtual machines in minutes, instead of the months or years associated with buying on-premises servers or building new data centers. The DOD can also take advantage of short-term "agile capacity contracts" for an evolving set of skills to support commercial cloud implementation, as the needs for specific applications, artificial intelligence capabilities, or

†Gartner, Inc.'s *Magic Quadrant* is a graphical illustration of four types of technology providers, including: challengers, niche players, visionaries, and leaders with 15 weighted criteria to plot vendors.

coding languages change.[‡, 24] Similarly, the DOD can take advantage of existing commercial space services, including imagery, satellite communications relays, data transfer, processing, and analysis.[25]

Enablers and Tradeoffs to Realize Cloud Benefits

During the 2023 testimony before the Senate Armed Services Committee's cybersecurity subcommittee, the DOD's Chief Information Officer emphasized that "[a]t last, the department has access to enterprise cloud capabilities from four world-class U.S. vendors at all three security classification levels from the continental United States to the tactical edge."[26] But advancing down the commercial cloud computing learning curve did not happen overnight. In fact, the DOD has been working to identify processes and policies to integrate commercial data centers since the early 2000s.[27] Over the ensuing two decades, DOD customers and CSPs have made progress through five key enablers (which sometimes come with tradeoffs) to realize the benefits of commercial integration. See Figure 1.

Adapt Security Standards to the Context

Integrating commercial cloud and DOD IT architectures required DOD to develop an entirely new way of certifying cloud security—the Federal Risk and Authorization Management Program (FedRAMP®).[§, 28] The work to develop these certifications proceeded over years, with close collaboration between vendors and the government and a willingness to adapt on-premises cybersecurity standards to a cloud-specific implementation context.[29] Vendors must

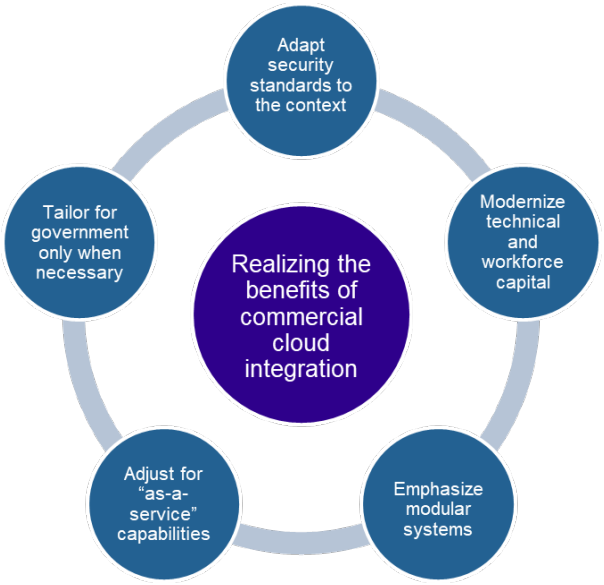

Figure 1: Realizing the benefits of commercial cloud integration through five key enablers.

then be willing to make the investments required to achieve compliance certifications.

Modernize Technical and Workforce Capital

The DOD must be technically current to benefit from more advanced commercial cloud applications and may require capital investment across the IT stack. For instance, a CSP employee called out that one DOD base still had a 64 kbps analog network, which was a substantial impediment to accessing cloud applications requiring high-speed connectivity.[30] Another identified applications that are "40 and 50 years old" and still being used by the DOD.[31] The failure to upgrade IT systems at rates commensurate with technical advancement and to the detriment of system performance is commonly termed "technical debt." This was perhaps most

[‡]Agile capacity contracts support evolving projects with skilled labor and services in short increments. Defense Acquisition University acknowledges that capacity-based contracts are still rather new. They are structured for maximum flexibility and modifications occur without expensive contract modifications.
[§]FedRAMP® is a government-wide program that offers a standardized approach to security assessment, authorization, and continuous monitoring for cloud computing products.

famously the cause of a "meltdown" of Southwest Airlines' outdated flight management systems at the end of 2022, which led to thousands of canceled flights and stranded passengers.[32]

In addition to capital investment, workforce training is critical to ensure that integration of commercial capabilities can be accomplished with flexibility and speed, and that workers understand the underlying commercial systems, their capabilities, and limitations. As described in the DOD's *Requirements for the Acquisition of Digital Capabilities Guidebook,* effective contracting for cloud services requires "great familiarity with cloud services along with the scope and intended uses of the acquisition."[33] Google's Jason Brown agrees, emphasizing that government customers ask smart technical questions and think differently when they have technical literacy.[34] Similarly, managing agile capacity contracts requires technical proficiency because the functional specifications for delivery are not defined in the contract.[35] Unfortunately, agencies and the private sector are "all competing for the same resources,"[36] and "federal agencies are at a disadvantage"[37] when it comes to hiring technical staff. This further complicates the DOD's ability to get the necessary workforce support.

Emphasize Modular Systems to Enable Accessibility, Interoperability, Flexibility, and Speed

The fiscal year 2017 National Defense Authorization Act requires that major defense acquisition programs use a modular open systems approach (MOSA) to "enable incremental development and enhance competition, innovation, and interoperability."[38] Beyond major acquisitions, the DOD recommends MOSA solutions and contract specifications for digital capabilities as well.[39] Further, data should be findable, accessible, interoperable, and reusable to be most useful for artificial intelligence and machine learning applications.[40] Achieving these characteristics requires the development of interoperability standards and application programming interfaces (APIs) to allow software applications to exchange data and functionality. Here, too, collaboration with industry is critical because the DOD does not set standards for commercial products. Rather, it encourages "adoption and use of voluntary industry consensus standards" to which government can contribute. For instance, DOD Directive 5144.02 "DoD Chief Information Officer" emphasizes the "interoperability, collaboration, and interface between DoD and non-DoD systems."[41] Additionally, the Office of Management and Budget's revised Circular A-119, "Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities," calls for federal agencies to "use voluntary consensus standards, when they exist, in lieu of Government-unique standards, except where inconsistent with law or otherwise impractical."[42] These consensus-based standards, supported by industry, pave the way for increasing modularity and the ability to "plug and play" to enable seamless failover from one system to the next.

Adjust Contracting and Budgeting for aaS Capabilities

A service-oriented architecture, also known as SOA, is a type of modular approach to product design that eliminates centrally hosted and owned software. SOA applies a software distribution model that can reuse components, allowing a cloud provider to host applications and make them available to end users over the internet. The shift to aaS capabilities implies a shift away from upfront capital-intensive projects and toward increased IT operating expenses, requiring that DOD manage contracts differently. For instance, government leaders have seen early cloud usage that exceeded the budgets for subscriptions. Addressing overages and learning from them for future contracts requires that the government be a savvy and assertive customer.[43]

Further, sometimes the "best-of-breed" capabilities and applications that DOD seeks do not all reside in the same commercial cloud. In this case, the government finds itself in the role of systems integrator to build a hybrid cloud environment to access certain applications it seeks, or it contracts out for implementation in different clouds.

Tailor for Government Only When Necessary

The most value comes from utilizing true commercial capabilities, rather than a government-bespoke version of them. As Alphabet's Milo Medin stated in a 2018 Air Warfare Symposium speech, "In those areas where the commercial sector dominates, the best the DoD can hope for is parity for access to that technology."[45] CSPs not only offer purely commercial capabilities but also government versions designed with government specifications (still developed and operated by CSPs). These include FedRAMP-certified clouds and classified clouds. CSPs offer far more data centers, availability zones, and regions for commercial customers than they do for those supporting government-specific uses. These commercial capabilities thus offer greater resilience.

Clouds specifically designed for government use are rarely at parity with the commercial cloud for specific services and features. Because government-bespoke clouds have additional certification requirements, services and features must often be rearchitected in order to operate on those bespoke clouds. Thus, the purely commercial cloud offers greater access to new and enhanced capabilities than those created by CSPs for government use.

Commercial cloud solution providers, like cloud-native software companies and professional services companies, outnumber government cloud solutions, offering a more diverse range of capabilities to provide "the right tool at the right time."[46]

These five enablers have been key to realizing the benefits of commercial cloud integration. To accelerate speed of success, the U.S. Space Force can consider the need for these enablers in how it phases commercial services into its hybrid space architecture.

On Risk

Security and trust with using truly commercial systems has been and continues to be a challenge in DOD's use of the commercial cloud. Yet some see an opportunity cost—a risk—in *not* making more use of commercial capabilities. As expressed by Milo Medin, "It's extremely risky to allow obsolete, insecure systems to decay in place. It's risky to have critical programs that deliver new capabilities stretch out while other nations advance. It's risky to train around defects in products rather than fixing them…. There is a price to be paid for lagging behind in innovation."[44]

A Phased Approach for Commercial Space Integration

Following the successes from commercial cloud integration, the DOD can accrue similar benefits from a hybrid space architecture that leverages commercial space services. The DOD and, in particular, the U.S. Space Force have been pushing toward commercial space service integration. To fully realize the resilience, innovation, and agile implementation benefits of commercial integration, however, the U.S. Space Force may need to make changes to and investments in its technology infrastructure, workforce, and culture.

Fortunately, commercial integration can be undertaken in phases. As described in this paper, maturing the DOD's relationship with commercial CSPs has taken decades. Yet the U.S. Space Force can choose with deliberate urgency a phased approach on a much steeper learning curve by addressing the enablers underpinning integration. In fact, major CSPs also promote a modulated

approach to cloud maturity.** While the terms and number of phases differ, all approaches begin with small, individual implementations. They conclude with integration that is fully optimized and takes best advantage of the cloud's capabilities.[47] Such an approach does not necessitate a specific destination; different phases of maturity will satisfy different needs. Consequently, the U.S. Space Force may choose different maturity end states for different mission areas, depending on the guidance provided in strategy.

A phased maturity model allows the U.S. Space Force to realize benefits today while setting the conditions for greater maturity as a consumer of space capabilities in the years ahead. Table 1 presents a maturity model for the U.S. Space Force and the DOD to integrate commercial space services into a hybrid space architecture, which accounts for the sometimes-significant investments in enablers and the tradeoffs inherent in adopting them.

Table 1. Commercial Space Services Integration Maturity Model

	Limited	Moderate	Full
Integration approach	Commercial space capabilities are used individually and in parallel	Commercial space offers commercial and DOD-specified capabilities	Commercial space provides DOD space services on behalf of the government
Focus of change	Some technical workforce proficiency	Significant investment in enablers	Cultural shift in government vs. commercial capabilities
Resilience	Backup options	Seamless failover	Contractor service-level agreements and resilience standards
Innovation	Buy innovative services in silos to supplement DOD capabilities	Integrating data and products across commercial providers	Commercial-driven innovations on DOD-specific systems
Agile implementation	Procure services "as-is"	Commercial space offerings have DOD-specific implementations as well	DOD uses M&O contracts for commercial implementation of space services

**For instance, Oracle has defined six levels of maturity (None, Ad Hoc, Opportunistic, Systemic, Managed, and Optimized); Google defines three maturity scale phases (Tactical, Strategic, and Transformational).

Limited

The Limited integration phase of commercial space services is in reach and, in some places, in use today. SATCOM subscription services procured by the military is an example of where the Limited integration phase is already evident. The Limited integration phase minimizes the need to heavily invest in commercial integration enablers:

- The DOD and U.S. Space Force contract for and use commercial space capabilities individually and with already available commercial services. Commercial services are procured "as-is," similar to commercial off-the-shelf (COTS) products or a contractor-owned and -operated facilities model.
- Familiarization or reskilling of personnel may help the DOD become more informed and effective consumers of commercial space services. However, no new technology or contracting mechanisms are needed.
- Commercial capabilities provide backup options, though these options will not yield seamless failover and may have different capabilities than those operated by the DOD. New commercial space capabilities are introduced incrementally, with limits to how well emerging technologies can be used synergistically with each other and existing systems and data.

Limited integration phases minimizes investment and change

- ☐ Adapt security standards to the context
- ☑ Adjust for "as a service" capabilities
- ☐ Emphasize modular systems
- ☐ Modernize technical capital
- ☐ Modernize workforce capital
- ☑ Tailor for government only when necessary

Moderate

The Moderate integration phase brings commercial services more fully into a hybrid architecture but requires substantial enabler investment by DOD and commercial providers. DOD's *Enterprise SATCOM Management and Control (ESC-MC) Implementation Plan*, published in October 2022, defines a "hybrid, heterogeneous [SATCOM] architecture" that could serve as an exemplar of Moderate integration.[48] This phase requires investment in commercial integration enablers:

- The DOD must modernize applications, data management, and networking to effectively integrate commercial space data and innovative technologies into its common operating pictures and computing. Although buying down technical debt by modernizing systems is expensive, the effort can result in more robust benefits than limited integration. Technically integrating commercial space capabilities can allow a more seamless failover from primary to alternate systems. Moreover, integrating commercial data feeds can allow DOD to make use of modern AI/ML and high-performance computing for sensing and decisionmaking at the speed of relevance.
- The Moderate integration phase may also be the most resource-intensive for the government. Diversity of vendors and capabilities tends to correlate with integration complexity. In this middle-ground phase, the government integrates commercial and government capabilities, which require technical talent and possibly intensive management oversight.
- Such integration also requires the ability to "plug and play" with modularity to the maximum extent practicable. Modular standards and architectures also open doors for innovation and

allow our national security space architecture to "avoid competitive obsolescence by future proofing through regular introduction of new technologies."[49] To do this, the DOD may need to work closely with commercial space vendors to establish acceptable implementation of security standards—a collaborative and potentially resource-intensive endeavor.

Moderate integration is the most investment-intensive, for true hybrid architectures

- ☑ Adapt security standards to the context
- ☑ Adjust for "as a service" capabilities
- ☑ Emphasize modular systems
- ☑ Modernize technical capital
- ☑ Modernize workforce capital
- ☑ Tailor for government only when necessary

Full

The Full integration phase requires cultural change inside the DOD and across the U.S. Space Force. It embraces the enabler "tailor for government only when necessary" and avoids investing in commercial integration enablers where possible by using commercial capabilities exclusively. In essence, this phase requires a reexamination of who can and should provide space-based services to the joint force. As described by the Air Force Research Laboratory (AFRL) CIO Alexis Bonnell (in the context of commercial IT), "not trying to do their special sauce means we can do more of our special sauce."[50] A hypothetical SATCOM example of full integration is one in which commercial providers are responsible for all wideband and narrowband communication. They own and operate the SATCOM infrastructure and support classified communications by adopting DOD-specific cryptology and waveforms on behalf of the DOD.

In this phase, resilience is achieved through contractual agreements with commercial providers. These space-based service providers would commit to service-level agreements (SLAs) and be held to specific resilience standards. DOD-specific instantiations of a service (akin to FedRAMP-certified and classified commercial clouds) would be provided only when necessary, using a management and operating (M&O) contract, where the government owns the systems and the contractor operates them. (See sidebar). M&O contracts would specify fast-follower[††] capabilities on DOD systems after they are introduced in commercial versions.

The Full integration phase requires that DOD acquisition professionals are comfortable with the definitions of what are "inherently governmental" capabilities (which are less limiting than believed by some in the government) and may require established agreements about security and defense of systems. Moreover, full implementation may require information security agreements between commercial providers and the DOD, which may result in adapted security standards.[51]

Full integration pushes space services to commercially provided or operated to minimize enabler investment

- ☑ Adapt security standards to the context
- ☑ Adjust for "as a service" capabilities
- ☐ Emphasize modular systems
- ☐ Modernize technical capital
- ☐ Modernize workforce capital
- ☑ Tailor for government only when necessary

[††] Unlike a "first mover," a "fast follower" waits for a competitor to successfully innovate before imitating it with a similar product. These terms were introduced by a Stanford Business School professor, David Montgomery, and co-author, Marvin Lieberman, "First-mover Advantages," *Strategic Management Journal*, Vol. 9, 41-58, 1988.

Management and Operating (M&O) Contracts

M&O contracts were originally developed during World War II for execution of the Manhattan Project.[52] The Federal Acquisition Regulation (FAR) Subpart 17.6 defines an M&O contract as "an agreement under which the Government contracts for the operation, maintenance, or support, on its behalf, of a Government-owned or -controlled research, development, special production, or testing establishment wholly or principally devoted to one or more major programs of the contracting Federal agency."[53] These contracts require approval of the head of the agency, must be reviewed at least once every five years, and have criteria for use including (1) being in the interest of national defense, (2) requiring a special, close relationship with the contractor, and (3) being substantially separate from a contractor's other business. Like the government-owned, contractor-operated (GOCO) model, M&O contracts previously had limited application to specific types of production. However, they have been proposed as a useful model for cloud contracting.[54]

Conclusion

If history is any lesson, these are early days for commercial space services outsourcing and integration. Two decades in, the DOD has embraced and is accelerating the use of the commercial cloud in hybrid IT architectures. The Joint Warfighting Cloud Capability, awarded in December 2022, was a seminal contract to spur increasing adoption of the commercial cloud across the DOD.[55] Further, the DOD's recently published FY25 Strategic Management Plan targets increasing cloud use, with a goal of 60 percent of systems in the cloud by FY26.[56] Toward that goal, the DOD Commercial Space Integration Strategy and U.S. Space Force Commercial Space Strategy are likely to be the beginning of a significant shift to commercial capabilities in DOD space architecture.

Just as the commercial space sector itself is maturing, so too must the DOD's ability to tap into it. Realizing the full range of benefits from commercial space services integration will require that the U.S. Space Force invest in technology and workforce enablers, consider tradeoffs, and embrace and optimize commercial capabilities. Doing so can yield greater resilience, improved access to innovation, and more agile implementation for DOD space capabilities. It can also free up the U.S. Space Force to focus more of its limited resources on space warfighting and competitive endurance in the space domain. Yet the balance between commercial and DOD capabilities will need to look different for different missions, as there are tradeoffs to using commercial systems. A commercial space services integration maturity model like the one presented here can serve as a roadmap for how space integration is done once the appropriate mission areas and vendors are identified.

The commercial space sector has demonstrated remarkable innovation. SpaceX showed us that launch vehicles can be reused and launch costs significantly reduced. Startups are creating new spacecraft form factors and developing impressive imagery and analytics. As the U.S. Space Force looks to a space domain that is contested and increasingly dynamic, their ability to comprehensively tap into the capabilities of the commercial space sector may be just what we need to stay ahead of our adversaries.

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