

Integrating Commercial Space Services into the DoD Architecture

Understanding Operational and Policy Implications

he U.S. Department of Defense (DoD) relies on a wide variety of space capabilities, such as satellite communications (SATCOM) and remote sensing, to carry out its missions. Although DoD has traditionally developed and operated its own satellite systems, its use of commercial space services has increased as the industry has expanded, and it is expected that DoD use of these services will continue to grow. Despite the benefits of these commercial services, DoD must consider the potential vulnerabilities from the use of these services.

The space environment is becoming increasingly contested, congested, and competitive with adversaries aiming to deny, degrade, or destroy critical space capabilities on which DoD relies. In recognition that commercial space systems have an increasingly important role in supporting military missions, there are growing concerns about commercial space systems being targeted by U.S. adversaries.

Congressional interest in this topic led to a requirement, specified in the National Defense Authorization Act for Fiscal Year 2022 (specifically in Public Law 117-81, Section 1607, as passed in 2021), for a study that assesses "(1) the extent of commercial support of, and integration into, the space operations of the armed forces; and (2) measures to ensure that such operations, particularly operations that are mission critical, continue to be carried out in the most effective manner possible during a time of conflict."

This independent study—conducted for the Department of the Air Force by RAND Project AIR FORCE to fulfill the congressional requirement covered ten topics detailed in the U.S. Senate legislative proposal, which can be broadly divided into operational and policy concerns (see Table 1).

In conducting this assessment, the research team explored six commercial space markets— SATCOM; space domain awareness (SDA); remote sensing; environmental monitoring; positioning, navigation, and timing (PNT); and space logistics synthesizing information collected from a variety of sources, including relevant policy, literature, and other open-source information on the commercial space industry and discussions with more than 70 government and industry subject-matter experts. This research summary contains highlights from this assessment.

Operational Implications

Current DoD use of commercial space services to support armed forces operations varies widely depending on the mission. Commercial SATCOM has been used to augment military SATCOM capac-

TABLE 1 Assessment Topics Raised by Congress

Operational Topic	Current usage	The extent to which DoD uses commercial satellites to support armed forces operations
	Anticipated usage	The anticipated increase in such use during the subsequent 10-year period
	Operational impact	In the event that the armed forces lose access to commercially operated space systems and data provided by such systems, the impact on armed forces operations
	Mitigation measures	Steps the department might take to mitigate the risk of loss of such access
	Resiliency	As the department develops plans to increase the resiliency of its space architectures, the anticipated role of commercial systems in such plans
	Interference activities	The frequency with which third parties have interfered with commercially operated satellites that support armed forces operations during the past decade
Policy Topic	Governance	The international agreements and organizations that govern the manner in which commercial entities operate systems in outer space
	Commercial as a military target	Whether, under current international law, a commercial satellite used to support military operations is considered a legitimate military target
	Awareness	The extent to which owners of commercial satellites are aware that such satellites may be targeted by a foreign power
	Insurance	The current insurance coverage scheme for commercial satellites that support armed forces operations

SOURCE: Features information from U.S. Senate, National Defense Authorization Act for Fiscal Year 2022, Bill 2792, Section 1513, Study on Commercial Systems Integration into, and Support of, Armed Forces Space Operations, September 22, 2021.

ity for decades and is a critical enabler to several highvalue missions. Commercial SATCOM services largely support DoD's wideband and narrowband SATCOM applications when additional capacity is needed, for DoD users who do not have the priority to gain access to military SATCOM for their missions or who find the commercial systems easier to use than existing DoD systems.

Commercial SATCOM supports such missions as command and control; airborne intelligence, surveillance, and reconnaissance (ISR); logistics; special operations; morale, welfare, and recreation; and training. How much DoD depends on commercial SATCOM varies by mission. In some cases, commercial SATCOM augments DoD systems. However, in other cases, it may be the only viable communications path.

Future DoD use of commercial SATCOM is likely to grow substantially with increasing demand for SATCOM capacity to support a diverse array of DoD missions and users worldwide. Commercial SATCOM services will also be a key element of a hybrid (military-commercial) architecture to improve resiliency, and the global SATCOM market is well postured to meet this increasing demand, as it is expected to grow steadily over the next ten years, offering a diversified portfolio of capabilities, such as proliferated low earth orbit SATCOM.

DoD uses other commercial services, such as SDA and remote sensing, for niche applications. SDA is an essential capability needed to support the safety and sustainability of space operations and is critical to the protect and defend mission conducted by the U.S. Space Force. As the number, capability, and use of satellites increase, military SDA capabilities will be increasingly stressed. Although some commercial SDA companies have been operating for more than a decade, DoD currently relies mostly on its own SDA capabilities to support its missions and uses commercial capabilities as an augmentation to its own, primarily in support of the protect and defend mission.

DoD has been taking a slow approach to incorporating commercial SDA within its SDA architecture, but the use of commercial SDA services is likely to increase as commercial providers continue to advance and DoD is better able to leverage these services. Commercial SDA services provide a wide variety of space surveillance and reconnaissance capabilities that can be of beneficial value to DoD in augmenting its own capabilities as demands for SDA services increase and improving resiliency of the SDA architecture. Leveraging commercial SDA in an effective and efficient manner, and potentially in a quicker way, will also involve addressing technical, operational, security, and acquisition-related challenges that are possible to resolve with proper planning.

Remote sensing services are purchased by the National Reconnaissance Office to support the intelligence community and DoD users. The majority of the purchased imagery (95 percent) supports foundational geospatial intelligence missions—mapping, charting, and geodesy. The increased commercial capacity to satisfy a larger number of imagery collection requirements allows national space-based ISR systems to focus on the most challenging and sensitive missions. With the increased capacity and access to commercial imagery, combatant commands are using the imagery to support their missions.

DoD use of commercial remote sensing is likely to continue growing as commercial capabilities, such as higher revisit rates from proliferated constellations and multi-phenomenology sensors, become more valuable to DoD. How much, how fast, and in what sectors will be determined by DoD's demand for space-based sensing, market conditions, intelligence community investment strategy, and policy decisions on the future responsibilities and force structure for tactical ISR.

DoD use of commercial services is limited for the remaining missions examined—environmental monitoring, PNT, and space logistics. The space-based commercial environmental monitoring market is small and has received limited funding so far. The market offers radio occultation data for space weather characterization and terrestrial weather prediction, primarily for study and evaluation purposes. DoD use of commercial PNT services is limited to experiments and technology demonstration and can be challenging because of user equipment requirements. Space logistics is a relatively new mission, and DoD has not made any significant use of commercial capabilities in that area beyond technology demonstration.

These emerging markets are still evolving and still proving whether they can provide consistent value to DoD customers. There is a combination of uncertainty and potential for each of these markets. The degree to which DoD will use these services in the future will, in part, depend on how much DoD signals its future needs today and indicates its intention to use commercial services in the coming years. Companies will use DoD demand signals to decide on future investments that will potentially expand capabilities of interest to DoD, thus There is a combination of uncertainty and potential for each of these commercial space markets.

increasing the use of these services. Such demand signals could be particularly important in emerging markets, increasing the viability of companies and services.

Loss of Access in Conflict

Even as the use of commercial services is expected to increase, loss of access to some commercial satellite services is expected in armed conflicts with peer adversaries. Historically, the frequency of third-party intentional interference with commercial services supporting DoD has been limited. However, it is important to realize that this perspective derives from a historical period in which the United States has not experienced direct armed conflicts with near-peer adversaries and, thus, may not be a viable picture of the future. The Russian invasion of Ukraine has already changed the tenor of the conversation about interference with commercial satellite systems. Commercial SATCOM operators have observed an increase in sophistication in purposeful electromagnetic interference techniques and cyberattacks by a third party in recent years and have invested significantly in increasing their cyber defenses and adopting best practices for hardening their systems.

It is unlikely that DoD will lose access to all commercially operated space systems during a conflict because of the inherent resilience of individual company services and DoD's access to multiple, independent providers—for both commercial SATCOM and SDA services. Nevertheless, losing access to these services would likely have an adverse effect on the operational effectiveness of the supported missions—even mission failure could occur depending on the criticality of commercial services to the supported mission and the mitigation options available. Thus, it is important to understand the potential consequences so that DoD can continue to build resiliency into the system, especially for the most critical missions.

Operational impact will differ depending on the mission. For example, at one end of the spectrum are missions that use commercial services primarily for augmentation-such as the Navy's use of commercial SATCOM for the maritime command and control and SDA's protect and defend mission that relies primarily on government systems. For Navy maritime command and control, commercial SATCOM is primarily used to augment bandwidth and is not a single-source communications path-reflecting the Navy's recognition that commercial SATCOM may not be available in contested operations during conflict. The Navy carrier strike group uses a system, called the Automated Digital Network System, that automatically adjusts the transport of data between military and commercial SATCOM, enabling near-seamless transition between the two depending on availability while afloat.

Additionally, tactics, techniques, and procedures, such as prioritizing data and personnel for accessing limited bandwidth, have been developed to enable the continuity of critical operations should access to commercial SATCOM be lost.

DoD's niche use of commercial SDA services helps reduce negative operational impact, but so does the means by which these services are leveraged. The approach entails using as many commercial SDA providers as possible and ensuring that some redundancy exists for all services being provided by these companies. The combination of a large number of providers and a robust command and control construct makes these services resilient to opponents' attack.

The Army's Blue force tracking system is fully dependent on commercial SATCOM for friendly unit location data. Loss of commercial SATCOM would result in loss of easily representable and timely position and location information, which would reduce commanders' situational awareness and adversely affect their ability to command their forces. The reduced situational awareness that would be incurred by loss of access could be mitigated by use of tactical radios.

The Army is also heavily dependent on commercial SATCOM for the reporting of logistics information that is critical to Army operations. There are no reliable alternatives to Army use of commercial SATCOM for the automated tracking and reporting of logistics information, other than (possibly) attempts to manually communicate equivalent information over the Army's already saturated and scarce military SATCOM channels. Loss of access for this mission could inflict critical disruption on Army logistics operations depending on the nature of disruption in commercial SATCOM services, resulting in inefficiencies and delays in maintenance and resupply that would degrade the combat effectiveness of the force.

Policy Implications

Leveraging commercial space to support DoD operations requires an operational architecture that can effectively leverage the commercial services through appropriate integration, command and control, contractual agreements, and supportive policy at the national and international levels.

The Outer Space Treaty regime represents the strongest set of *hard laws*—that is, instruments with a binding effect—that govern the behavior of commercial and government operators in space. Under this treaty, participating host nations are responsible for the behavior of their commercial space owners and operators. But international enforcement mechanisms are weak or nonexistent, and the treaty regime is dated. Consequently, more-recent governing efforts are evolving toward developing and propagating norms of behavior that are voluntary.

The International Telecommunications Union, a branch of the United Nations, is an example of successful intergovernmental coordination for the man-

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agement of millions of frequencies for the global radio network and orbital slots for geosynchronous satellites. Its success depends on its narrow focus and the mutual interests it serves. Absent clear international norms and guidance, some commercial operators are working together to establish their own operational guidelines for the safety and sustainability of the space domain. However, existing international space forums or commercial forums are likely to have little impact on restraining aggressor behavior during conflict.

Efforts to establish rules and norms for space are challenged by the fluid space environment. One of the more-pressing concerns in the existing environment is the debate over whether a commercial satellite used for military objectives is considered a legitimate military target. The international legal context today supports a consensus that commercial assets supporting military operations are legitimate military targets—and DoD and the U.S. government need to plan for this eventuality.

The principal adversaries of the United States (Russia and China) generally do not recognize a distinction between commercial and military satellites. Statements made by Russia and China indicate that they consider commercial satellites as legitimate military targets largely because they do not recognize a distinction between commercial and military satellites. During the early phase of the Russia-Ukraine war, Russia actively targeted ViaSat and Starlink SATCOM services used by Ukrainian forces with the intent of disrupting communications.

The Law of Armed Conflict, passed in 1949 as part of the Geneva Conventions, frames the contemporary debate along several measures: whether it is possible to distinguish between military and civilian use, how to define *military use* and *support to military operations* in the context of neutrality, and what constitutes a proportional response. But much of this debate is unsettled in the international community.

DoD policies are clear in their intention to use commercial integration on a wide-ranging and adjustable scale for space support to military activities, which risks making the entire U.S. commercial space infrastructure a legitimate military target. What is lacking is a common understanding and rules of engagement about what constitutes a legitimate adversary military attack and a legitimate military response, as well as how to protect commercial space operators providing vital services to the military.

Commercial satellite operators are well aware that they face threats from U.S. adversaries and that they might be targeted. However, the level of their awareness varies depending on the level of access they have to a wide variety of information sources. These operators have access to a variety of threat warning information that ranges from general awareness to near-real-time awareness. Although some of this information is in the public domain and available through U.S. government sources, classification of other information and restricted access channels limit the type of information that is shared and who can access it. As the environment in which these commercial providers must operate becomes increasingly contested, new channels will likely be needed to make information available to a wider set of commercial satellite operators and to improve the timeliness and specificity of such information.

Satellite operators obtain a variety of insurance to cover activities throughout the satellite life cycle, but most insurance policies exclude losses occurring from acts of war and cyberattacks, and the latter is viewed as a growing threat by the industry. Satellite operators make choices about what type of insurance or coverage they seek based on their risk profile, which could vary depending on their satellite technologies, architecture, business model, and other factors.

The market for insurance has shifted in recent years as these risk profiles shift. For instance, many operators of proliferated low earth orbit constellations are choosing to self-insure because their low-cost satellites are replaced more frequently than traditional satellites in geosynchronous earth orbit that are high cost and long-lived. Only 1 percent of all satellites in low earth orbit are insured, compared with about 40 percent of satellites in higher orbits.

Central to the insurance discourse is how to protect satellites that support military operations. The commercial industry continues to support the U.S. armed forces using the existing insurance regime, and there are no glaring insurance obstacles that would drastically change that support in times of conflict, barring a catastrophic event. That said, commercial satellite operators, DoD, and the space insurance industry are exploring various protection options to adapt to this dynamic space environment, including the potential role that the government might play in providing financial and nonfinancial protection.

The Way Ahead for DoD

Commercial space services offer DoD an opportunity to meet its evolving mission needs by improving capacity, capability, and responsiveness and enhancing the overall resiliency of space missions. The department is moving forward in providing strategic guidance on how to take advantage of these important capabilities. For example, the 2024 DoD Commercial Space Integration Strategy presents strategic guidance on integrating commercial space capabilities into DoD's space architecture—identifying mission areas in which moreexpansive opportunities exist and those in which use of commercial space is likely to be minimal. It also articulates plans to evaluate financial protection options for commercial space entities that support U.S. military operations.

In turn, the U.S. Space Force released its own commercial space strategy that details its intent to integrate commercial space capabilities, including during crisis or conflict through the Commercial Augmentation Space Reserve framework, and key considerations for balancing cost, benefits, and risks when integrating commercial solutions.

Yet much work remains for DoD to operationalize the integration of commercial space into DoD's space architectures, even in SATCOM—a space mission area in which DoD has the most experience working with the commercial sector. The reality that commercial satellites may be targeted by U.S. adversaries is further complicating the matter. DoD should consider a variety of measures to mitigate the risk of losing commercial space services that support critical DoD operations, especially in times of conflict. The feasibility and effectiveness of employing these measures must be investigated within specific contexts, as both factors will vary depending on the space mission, technical characteristics of commercial space services or systems, tasks or missions being supported, commanders' risk tolerance, and a host of other contextual factors.

The principal mitigation measure is to increase the resiliency of DoD's space architecture, which involves integrating a diverse set of commercial space capabilities from multiple providers. Operationalizing such a hybrid architecture could be a long journey. To ensure successful implementation, DoD should determine the roles of commercial space services early in the capability and architecture development process and follow through by allocating a corresponding budget based on the expected commercial contribution.

DoD will also need to continue the advancement of its commercial space integration strategies and policies to ensure that they remain aligned with the pace of commercial development and the growing threats to attaining national security objectives and sustaining U.S. leadership in commercial space.

Implementing these measures will require synchronization of activities across the U.S. government and DoD components—including the possibility of legislative and regulatory actions. It will also require a concerted effort by DoD to further strengthen its partnership with the commercial space industry by communicating its evolving needs, investing in emerging technologies, and expanding information exchange.

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