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July 2018

MILITARY SPACE SYSTEMS

DOD's Use of Commercial Satellites to Host Defense Payloads Would Benefit from Centralizing Data

Accessible Version

GAO-18-493

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GAO Highlights

Highlights of GAO-18-493, a report to the Committee on Armed Services, House of Representatives

Why GAO Did This Study

Each year, DOD spends billions of dollars to develop, produce, and field large, complex satellites. For such satellite systems, a single adversary attack or on-orbit failure can result in the loss of billions of dollars of investment and significant loss of vital capabilities. As DOD plans new space systems and addresses an increasingly contested space environment, it has the opportunity to consider different acquisition approaches. One such approach is to integrate a government sensor or payload onto a commercial host satellite.

House Armed Services Committee report 115-200, accompanying a bill for the Fiscal Year 2018 National Defense Authorization Act, included a provision for GAO to review DOD's use of commercially hosted payloads. This report (1) determines the extent to which DOD uses commercially hosted payloads and (2) describes and assesses factors that affect their use.

GAO reviewed DOD policies, documentation, and planning documents, and interviewed a wide range of DOD and civil government officials, and commercial stakeholders.

What GAO Recommends

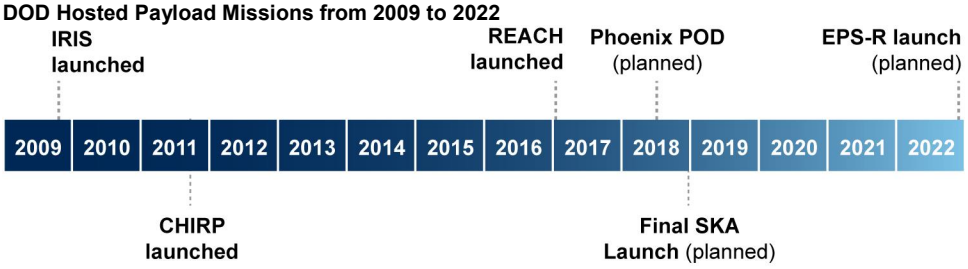
GAO recommends that DOD require programs using commercially hosted payloads to contribute resulting data to a central location. In implementing this recommendation, DOD should assess whether the Air Force's Hosted Payload Office is the appropriate location to collect and analyze the data. DOD concurred with the recommendation.

View GAO-18-493. For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

GAO and others have found that using commercial satellites to host government sensors or communications packages—called payloads—may be one way DOD can achieve on-orbit capability faster and more affordably. Using hosted payloads may also help facilitate a proliferation of payloads on orbit, making it more difficult for an adversary to defeat a capability. Since 2009, DOD has used three commercially hosted payloads, with three more missions planned or underway through 2022 (see figure below).

DOD Hosted Payload Missions from 2009 to 2022



CHIRP Commercially Hosted Infrared Payload
EPS-R Enhanced Polar System Recapitalization
IRIS Internet Protocol Routing in Space
Phoenix POD Phoenix Program: Payload Orbital Delivery System
REACH Responsive Environmental Assessment Commercially Hosted
SKA Spacebased Kill Assessment

Source: GAO analysis of Department of Defense information. | GAO-18-493

DOD estimates that it has achieved cost savings of several hundred million dollars from using commercially hosted payloads to date, and expects to realize additional savings and deliver faster capabilities on orbit from planned missions. Cost savings can result from sharing development, launch, and ground system costs with the commercial host company.

Among the factors that affect DOD's use of hosted payloads are

- a perception among some DOD officials that matching government payloads to commercial satellites is too difficult; and
- limited, fragmented knowledge on how to mitigate various challenges

GAO found that further opportunities to use hosted payloads may emerge as DOD plans new and follow-on space systems in the coming years. However, DOD's knowledge on using hosted payloads is fragmented, in part because programs are not required to share information. In 2011, the Air Force created a Hosted Payload Office to provide expertise and other tools to facilitate matching government payloads with commercial hosts. However, GAO found that DOD programs using hosted payloads are not required and generally do not provide cost and technical data, or lessons learned, to the Hosted Payload Office, or another central office for analysis. Requiring programs that use hosted payloads agency-wide to provide this information to a central location would better position DOD to make informed decisions when considering acquisition approaches for upcoming space system designs.

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July 30, 2018

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

Each year, the Department of Defense (DOD) spends billions of dollars to develop, produce, and field its space systems. These systems provide the government with critical intelligence information, communication and navigation methods, weather data, and other capabilities vital to military and civilian agencies and commercial industry. As satellites have become more complex, they have required larger investments of money and time to develop, produce, and launch. Some satellites, which have taken more than a decade to develop due in part to their size and complexity, contain technologies that are obsolete by the time they are launched. Additionally, in recent years, threats to DOD space systems have emerged, including anti-satellite weapons, communications jamming, and increased environmental hazards in space, such as orbital debris. A single adversary attack, on-orbit problem, or launch failure of a DOD satellite can result in the loss of billions of dollars of investment and a significant loss of capability.

DOD is currently planning new and follow-on space systems for some of its major space programs that are in production or have been fielded. As such, program officials have the opportunity to consider fresh approaches for acquiring space-based capabilities that may be more cost-effective, place technologies on orbit more quickly, and potentially offer added resilience and augmented capabilities to allay emerging threats. Both the 2010 National Space Policy and the 2013 National Space Transportation Policy call on federal agencies to explore the use of inventive, nontraditional arrangements for acquiring commercial space services.[1] One such arrangement is to place a government payload—such as a sensor or a communications package—on a commercial host satellite. In

[1]Executive Office of the President of the United States, *National Space Policy of the United States of America* (June 28, 2010), and *National Space Transportation Policy* (November 21, 2013).

addition to launching with the host satellite, the hosted payload uses available resources from the host satellite, such as power and communication systems. The hosted payload approach allows both the government and commercial entity to capitalize on shared development and launch costs, potentially reducing overall costs for both. The House Armed Services Committee report 115-200 accompanying a bill for the National Defense Authorization Act for Fiscal Year 2018 contained a provision for GAO to review DOD's use of hosted payloads. This report (1) determines the extent to which DOD uses commercially hosted payloads and (2) describes factors that affect DOD's use of hosted payloads and assesses how DOD is addressing them.

To determine the extent to which DOD uses commercially hosted payloads, we reviewed DOD documentation of prior, current, and future plans to use hosted payloads, including budget documentation and informational briefings. We analyzed program office planning documents, including management directives, hosted payload user guides, lessons learned, and analyses of alternatives study guidance. We also studied tools used to identify hosted payload opportunities and program contract documents, including the 2014 Hosted Payload Solutions multiple award indefinite delivery indefinite quantity vehicle. Because our review focused on commercially hosted payloads, we did not assess DOD's efforts to host its payloads on other government agency satellites. We interviewed DOD officials from the offices of the Under Secretaries of Defense for Acquisition and Sustainment, and Policy; the Office of the Secretary of Defense Cost Assessment and Program Evaluation; DOD's Chief Information Officer; Missile Defense Agency; the Navy's Program Executive Office for Space Systems and Space and Naval Warfare Systems Command; and research and development organizations, including the Defense Advanced Research Projects Agency and Naval Research Laboratory. Additionally, we conducted interviews with Air Force personnel from Air Force Space Command, the Space and Missile Systems Center's Hosted Payload Office (HPO), and the Space Test Program.

To describe and assess the factors that affect DOD's use of commercially hosted payloads, we examined applicable policies, strategy documents and briefings, including the 2010 National Space Policy, 2013 National Space Transportation Policy, and the Air Force's Space Warfighting Construct. To understand logistical, technical, and other considerations for using commercially hosted payloads, we reviewed program documents on commercially hosted payload arrangements from DOD and interviewed the organizations listed above. We also interviewed officials

in the Departments of Commerce and Transportation, as well as the National Aeronautics and Space Administration (NASA). Finally, we interviewed a broad range of industry stakeholders, including commercial satellite manufacturers and owner/operators, and industry associations—such as the Satellite Industry Association and the Hosted Payload Alliance—to understand perspectives on the factors that affect the use of commercially hosted payloads.[2] We compared DOD efforts to address factors affecting their use of commercially hosted payloads to criteria established in our work on strategic sourcing best practices as well as our work on duplication, overlap, and fragmentation.[3]

We conducted this performance audit from July 2017 to July 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Commercially Hosted Payloads

DOD defines a hosted payload as an instrument or package of equipment—a sensor or communications package, for example—integrated onto a host satellite, which operates on orbit making use of the host satellite's available resources, including size, weight, power, or

[2]The Satellite Industry Association (SIA) was formed in 1995 by several major US satellite companies as a forum to discuss issues and develop industry-wide positions on shared business, regulatory, and policy interests. In 2011, a group of satellite operators and manufacturers formed a satellite industry alliance called the Hosted Payload Alliance to increase awareness of the benefits of hosted government payloads on commercial satellites, as well as to facilitate communication between satellite companies and potential users.

[3] GAO, *Strategic Sourcing: Leading Commercial Practices Can Help Federal Agencies Increase Savings When Acquiring Services*, GAO-13-417 (Washington, D.C.: Apr. 15, 2013) and *2013 Annual Report: Actions Needed to Reduce Fragmentation, Overlap, and Duplication and Achieve Other Financial Benefits*, GAO-13-279SP (Washington, D.C.; Apr. 9, 2013).

communications.[4] A *commercially hosted* DOD payload is a DOD payload on a commercial satellite.[5] In general, hosted payloads may be either experimental or operational. Experimental payloads demonstrate new or existing technologies on orbit for potential use on future operational space systems. Operational payloads deliver required capabilities to end users. Hosted payload arrangements may be unsuitable for some missions. For example, some payloads may be too large or need too much power for a host satellite to feasibly accommodate, or may require unique satellite maneuvers that, if exercised, would negatively affect a host satellite's primary mission. Civil government agencies, like NASA and the National Oceanic and Atmospheric Administration (NOAA), have used or have plans to use commercially hosted payloads. For more information on the commercially hosted payloads that civil agencies have used or plan to use, see appendix I.

Potential Benefits of Using Commercially Hosted Payloads

We and others have identified potential benefits of using commercially hosted payloads to gain space-based capability, such as:

- **Cost savings—**Commercially hosted payloads may increase affordability because the government payload owner pays for only a portion of the satellite development and shared launch and ground systems costs, rather than for the entire system. Also, smaller, lighter, and less complex systems may shorten procurement timelines, reduce research and development investment, and reduce risk in technology development. Some government agencies have reported saving hundreds of millions of dollars to date from using innovative arrangements such as hosted payloads.[6]
- **Faster on-orbit capability—**Because commercial satellites tend to take less time from concept development to launch than DOD

[4] Department of the Air Force, Headquarters Space and Missile Systems Center, Program Management Directive (PMD) for Space and Missile Systems Center Hosted Payload Office (HPO) (Los Angeles, CA: July 2011).

[5]A commercial satellite is a satellite owned or operated by a company to provide services, such as broadcast television or satellite telephone, to customers.

[6]See also GAO-13-279SP. In April 2013, we found that government agencies could achieve considerable cost savings on some missions by leveraging commercial satellites through innovative mechanisms such as hosted payload arrangements.

systems do and have relatively frequent launches, hosting government payloads on commercial satellites may achieve on-orbit capability more quickly.

- **Increased deterrence and resilience—**Distributing capabilities across more satellites increases the number and diversity of potential targets for an adversary and may make it more difficult for an adversary to decide which assets to attack, serving as a deterrent. Additionally, more frequent launches could increase DOD's ability to reconstitute its satellite groups—or constellations—more quickly in case of unexpected losses of on-orbit capabilities. Recent strategic and policy guidance government-wide and at DOD have stressed the need for U.S. space systems to be survivable, or resilient, against intentional and unintentional threats—both types of which have increased over the past 20 years. Intentional threats can include purposeful signal jamming, laser dazzling and blinding of satellite sensors, missiles intended to destroy satellites, and ground system attacks. Some unintentional threats to satellites are created by the harsh space environment itself, like extreme temperature fluctuations and radiation, and the growing number of satellites, used rocket parts, and other space debris on orbit, which could collide with orbiting satellites.
- **Continual technology upgrades and industrial base stability—** New technologies may be continually incorporated into space systems using hosted payloads, which may be uniquely suited for higher rates of production and launches than traditional DOD satellites. Using commercial satellites for government payloads could help maintain the U.S. commercial space industry's ongoing technology developments by maintaining stable business and incentivizing new companies to enter the marketplace. Further, increased production may be distributed over multiple contractors—including traditionally lower-tier contractors—to foster more competition.

As we reported in October 2014, hosted payloads are among several avenues DOD is considering to increase the resilience of its satellites in the face of growing threats.[7] DOD has been looking at ways to break up larger satellites into multiple smaller satellites or payloads after decades of building large, complex satellites to meet its space-based requirements. The broader concept of breaking up larger satellites into smaller ones is known as disaggregation. In 2014, we reported that DOD

[7]GAO, *DOD Space Systems: Additional Knowledge Would Better Support Decisions about Disaggregating Large Satellites,* GAO-15-7 (Washington, D.C.: Oct. 30, 2014).

lacked critical knowledge about the concept of disaggregation, including how to quantify a broad range of potential effects.[8] At the time, for example, DOD did not have common measures for resilience, which we found is a key consideration in making a choice as to whether to continue with a current system architecture or to change it. Recently, senior DOD officials have also made public statements that indicate a willingness to consider innovative acquisition approaches so that acquisition timelines can be reduced. For example, in a 2016 strategic intent document, the Commander of Air Force Space Command stated that the Air Force should seek innovative acquisition approaches that leverage DOD's buying power across the industry.[9] Additionally, the Secretary of the Air Force stated that the Air Force is exploring more affordable and innovative ways to acquire its satellite communication services through investments in commercial industry and international partnerships.

Matching Payloads with Commercial Host Satellites

Opportunities to match a DOD payload with a commercial host can arise in various ways. DOD may first develop a payload and seek to match it with a commercial host, DOD may work in tandem with a commercial company to develop a payload to be hosted, or commercial companies—likely the satellite owner, operator, or system integrator—can first identify upcoming satellite hosting opportunities to DOD. In each scenario, the DOD program (or payload owner) and the commercial host generally consider the basic properties of both the payload and host satellite in attempting to find a match. These properties—including the size, weight, area, power, and required orbital characteristics of the payload and host satellite—should be complementary to create an arrangement that is mutually compatible for each party, according to Aerospace Corporation

[8]GAO-15-7.

[9]*Air Force Space Commander's Strategic Intent*, Headquarters Air Force Space Command, Petersen Air Force Base, Colorado Springs, CO (2016).

recommendations and officials we spoke with.[10] Specifically, these properties include:

- The size of the payload when it is stowed and when it is deployed on orbit, including the available area on the host satellite;
- The available weight and mass distribution the host satellite can accommodate;
- The available power on the host satellite;
- The thermal requirements of the payload and corresponding capability of the host satellite;
- The requirements to limit electromagnetic interference—disturbances that affect electrical circuits on the payload and host satellite;
- The available command, telemetry, and mission data rate requirements of the payload and corresponding capability of the host satellite;[11]
- The compatibility of interfaces between the payload and host satellite;
- The pointing accuracy and stability of the host satellite; and
- The necessary orbits, including altitude and inclination.[12]

Other considerations when matching a DOD payload with a host satellite are the compatibility of radio frequency spectrum (spectrum) needs between the payload and host, and the satellite's intended orbital location.[13] Spectrum is a natural resource used to provide essential

[10]Aerospace Corporation, *Guidelines for Hosted Payload Integration*, Aerospace Report Number TOR-2014-02199, June 6, 2014. Aerospace Corporation operates a federally funded research and development organization. Federally funded research and development centers are sponsored and funded by the government to meet specific long-term research and development needs that cannot be met as effectively by existing in-house or contractor resources. They are operated, managed, or administered by universities, not-for-profit or nonprofit organizations, or industrial firms.

[11]As used here, data rate is the speed at which data are communicated between the payload or host satellite and a ground terminal.

[12]Satellites travel around the Earth at various altitudes and angles (or inclinations) relative to the equator. For example, low Earth orbit is the region of space up to an altitude of approximately 1,500 miles. Satellites in this orbit typically have low (along the equator) to high (over the Earth's polar regions) inclinations. Geosynchronous Earth orbit (GEO) is a circular orbit at an altitude of 22,300 miles with a low inclination.

[13]Radio frequency spectrum is a scarce natural resource of electromagnetic radiation lying between the frequencies of 3 kilohertz and 300 gigahertz. The radio waves carry information in ranges of frequencies called "bands".

government functions and missions ranging from national defense, weather services, and aviation communication, to commercial services such as television broadcasting and mobile voice and data communications. The frequencies, or frequency bands, of spectrum have different characteristics that make them more or less suitable for specific purposes, such as the ability to carry data long distances or penetrate physical obstacles. Each frequency band has a limited capacity to carry information. This means that multiple users operating at approximately the same frequency, location, and time have the potential to interfere with one another. Harmful interference occurs when two communication signals are either at the same frequencies or close to the same frequencies in the same vicinity, a situation that can lead to degradation of a device's operation or service. As such, a payload or satellite's specific placement in any given orbit could potentially interfere with a neighboring payload or satellite in the same orbit.

In the United States, the National Telecommunications and Information Administration (NTIA) of the Department of Commerce is responsible for establishing policy on regulating federal government spectrum use and assigning spectrum bands to government agencies. The Federal Communications Commission (FCC) allocates spectrum and assigns licenses for various consumer and commercial purposes. Additionally, all government and commercial satellite programs must apply for approval to operate at a given orbital location using a given band of spectrum internationally through the International Telecommunication Union (ITU). The ITU is an agency of the United Nations and coordinates spectrum standards and regulations.

The Air Force's Hosted Payload Office

In 2011, the Air Force created the Space and Missile Systems Center's (SMC) Hosted Payload Office (HPO) to provide acquisition architectures that achieve on-orbit capability more quickly and affordably. The HPO uses various resources and capabilities to meet its objectives:

- **Hosted Payload Solutions Contract:** In 2014, SMC established the Hosted Payload Solutions (HOPS) multiple award indefinite delivery indefinite quantity (IDIQ) vehicle.[14] According to HPO documents,

[14]An Indefinite Delivery Indefinite Quantity (IDIQ) contract provides for an indefinite quantity, within stated limits, of supplies or services during a fixed period. The government places orders for individual requirements. FAR § 16.504(a).

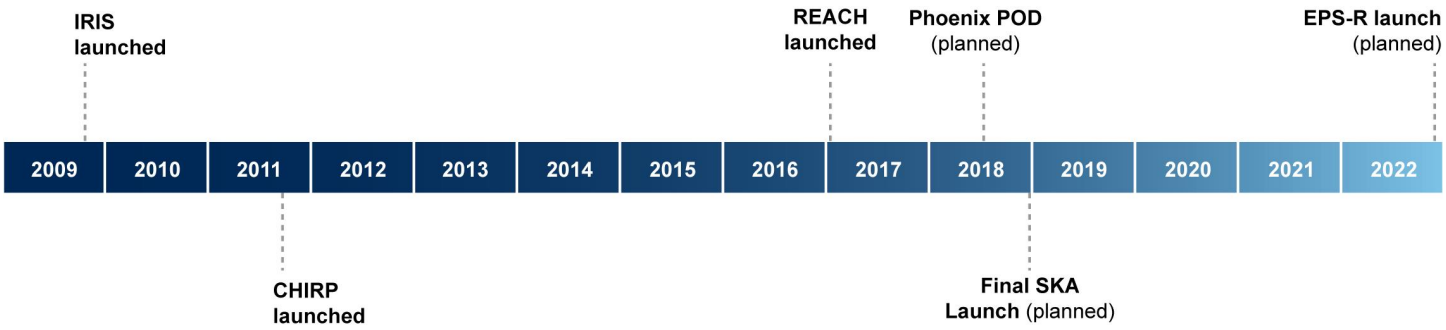
SMC established the contract—available to all DOD and civil agencies—to streamline commercially hosted payload arrangements by selecting a pool of commercial vendors that government payload owners can use to access space on commercial host satellites. Programs do not have to use HOPS, however, and may contract with commercial companies directly. The HOPS vehicle includes 14 vendors across the commercial satellite industry. SMC awarded task orders for studies to each of the vendors with a contract to gather information on potential host opportunities, orbits and launch schedules, cost estimates for hosting fees, and existing host satellite interfaces.

- **Feasibility Studies:** Using the information it gathered from the 14 vendor studies, the HPO stated that it built a database to provide information on potential satellite hosts and the suitability of certain payloads for host opportunities, including cost estimates. The HPO stated that it can use this information to assess the feasibility of a hosted payload opportunity for interested SMC space programs. The HPO also conducts feasibility studies for interested programs based on publicly available information and from industry requests for information.
- **Hosted Payload Interface Design guidelines:** The HPO published hosted payload interface design guidelines to provide technical recommendations for hosted payload developers. According to HPO officials, the intent of these guidelines is to reduce integration costs and improve the host-ability of all hosted payloads.
- **Hosted Payload Data Interface Unit:** The HPO is developing a secure hosted payload data interface unit to protect payload data from unauthorized access by the host. Following its release of draft documentation to industry stakeholders in March 2018, the HPO is currently integrating National Security Agency requirements into its request for data interface unit prototype proposals. According to HPO officials, the office plans to issue a request for prototype proposals in May 2018, integrate a data interface unit and payload in 2020, and launch the integrated system in 2022.
- **Hosted Payload Expertise:** The HPO provides general advice and expertise to programs in the form of hosted payload architectural studies, input on acquisition planning and strategy documents, and other research efforts, according to the office.

DOD Has Used Commercially Hosted Payloads Three Times and Three More Missions Are Planned or Underway

Since 2009, DOD has launched three experimental payloads on commercial host satellites and plans to conduct three more missions through 2022, as shown in figure 1.[15] DOD estimates that it has achieved cost savings of several hundred million dollars from these experimental payloads. According to DOD officials, DOD expects to realize additional cost savings and be able to place capabilities on orbit more quickly from several hosted payload efforts that are planned or underway. Opportunities for additional hosted payload efforts may arise in the near term amid DOD planning for upcoming and follow-on space systems.

Figure 1: DOD Fielded and Planned Commercially Hosted Payloads from 2009 to 2022



CHIRP Commercially Hosted Infrared Payload
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REACH Responsive Environmental Assessment Commercially Hosted
SKA Spacebased Kill Assessment

Source: GAO analysis of Department of Defense information. | GAO-18-493

DOD Has Used Commercial Satellites to Host Three Experimental Payloads

Since 2009, DOD has placed experimental payloads—intended to test or demonstrate an on-orbit capability—for three programs on commercial

[15]In 2009, for the first time, DOD used a commercial satellite to host its Internet Protocol Routing in Space (IRIS). See table 1 for more information on this effort.

host satellites. Several officials within DOD told us that experimental payloads tend to be smaller, less expensive, and their missions more risk-tolerant than traditional operational DOD payloads. In these ways, they said experimental payloads are better-suited to hosting arrangements than operational DOD payloads. The Air Force has not yet used the HOPS multiple award IDIQ vehicle—which was awarded to facilitate commercially hosted payload arrangements—to match a government payload with a commercial host. The HPO told us that, in 2019, NASA and NOAA will be the first agencies to use the HOPS vehicle to find a host satellite for two of their payloads. Table 1 describes the three experimental payloads hosted on commercial satellites to date. For more information on civilian agencies that use or plan to use commercially hosted payloads, see appendix I.[16]

Table 1: Department of Defense (DOD) Payloads on Commercial Host Satellites 2009-2017

Year	Name	Description
2009	Internet Protocol Routing in Space (IRIS) Joint Capability Technology Demonstration	This payload demonstrated integrated communication between land- and space-based internet nodes for the U.S. Strategic Command and Allied Forces.
2011	Commercially Hosted Infrared Payload (CHIRP)	This program tested new infrared sensor technology and demonstrated a successful hosted payload arrangement between government and commercial stakeholders.
2017	Responsive Environmental Assessment Commercially Hosted (REACH)	Air Force documents state that REACH payloads provide extensive test data on space radiation, rapidly detect, warn, and characterize disturbances in the space environment, and address commercial and government methods for collection and distributing this data. REACH payloads will also test resilient space architectures by launching on multiple spacecraft to multiple locations for global coverage.

Source: GAO analysis of Department of Defense information. | GAO-18-493

Air Force officials told us that using commercial host satellites for their experimental payloads has saved several hundred million dollars across these programs and shortened timelines for launching payloads into space. For example, the HPO estimated that the Air Force saved nearly $300 million by using a commercial host satellite for its Commercially Hosted Infrared Payload (CHIRP), as compared to acquiring the same capability using a dedicated, free-flying satellite.[17] In addition, Air Force

[16]We identified that, in addition to DOD and civil agencies, the National Reconnaissance Office (NRO) has used commercial satellites to host experimental payloads for research purposes. According to the NRO, the primary lesson learned is that the NRO experiment should be non-obtrusive with the commercial mission.

[17]A free-flying satellite is a standalone satellite for which an agency pays all costs associated with development, integration, launch, and operations.

officials estimated that using commercial host satellites for its Responsive Environmental Assessment Commercially Hosted (REACH) effort saved the Air Force approximately $230 million. The REACH effort consists of over 30 payloads hosted on multiple satellites. Further, because of the commercial host's launch schedule, the Air Force achieved its on-orbit capability sooner than if it had acquired free-flying satellites.[18] In April 2013, we found that the Internet Protocol Routing in Space (IRIS) payload, launched in 2009, was a commercially hosted payload pilot mission that would provide internet routing onboard the satellite, eliminating the need for costs associated with certain ground infrastructure.[19]

DOD Has Three Commercially Hosted Payload Efforts Planned or Underway

DOD and Air Force officials told us they are planning to pursue commercially hosted payloads for three programs in the coming decade to achieve cost savings and on-orbit capability more quickly. In each case, officials said they have identified cost and schedule benefits for their respective programs. For example, the Missile Defense Agency (MDA) stated that it expects to save approximately $700 million compared to the cost of traditional, free-flying satellites by acquiring its Spacebased Kill Assessment capability as payloads on commercial host satellites, and expects to achieve on-orbit capability years earlier than if it had acquired dedicated satellites for these payloads. Additionally, a program official from the Defense Advanced Research Projects Agency (DARPA) told us DARPA plans to use a commercially hosted payload for the Phoenix Payload Orbital Delivery effort to test more affordable ways to access space. Moreover, Air Force officials told us they expect to save $900 million over free-flying satellites by using two Space Norway satellites to fly an Enhanced Polar System Recapitalization payload. Space Norway plans to launch its satellites in 2022, which the Air Force expects will allow it to meet its need for DOD's required capability. See table 2 for additional details on DOD's planned hosted payloads.

[18]As mentioned above, we did not review DOD's use of hosted payloads on other government satellites; therefore, we use free-flying satellites as the baseline for cost comparison.

[19]GAO-13-279SP.

Table 2: Department of Defense (DOD) Plans for Future Use of Commercial Host Satellites

Year	Name	Description
2018	Spacebased Kill Assessment (SKA)	We found in 2017 that the Missile Defense Agency (MDA) planned to use SKA as an experimental system to determine whether an incoming, lethal enemy ballistic missile was successfully intercepted.[a] MDA may also use SKA to provide a limited operational capability. MDA launched the first of its network of sensor payloads hosted onboard commercial satellites in 2017 and plans to finish launching the payloads in 2018. In addition to ensuring the program is more affordable, agency officials stated that MDA is also using the program as a pathfinder to identify cost-saving measures for future space-based capabilities the agency may pursue to make fielding assets in space more affordable.
2018	Phoenix Program: Payload Orbital Delivery (POD) system	According to documentation from the Defense Advanced Research Projects Agency (DARPA), it plans to reduce the cost of space-based systems by developing and demonstrating new satellite assembly architectures and delivery systems through its Phoenix program. Its POD system is a standardized mechanism intended to safely carry a wide variety of payloads to geosynchronous Earth orbit aboard commercial communications satellites. PODs are designed to help take advantage of the frequency of commercial satellite launches and associated hosted payload opportunities, to enable faster and lower-cost delivery.
2022	Enhanced Polar System Recapitalization (EPS-R)	According to documentation and Air Force officials, the Air Force's EPS-R program plans to provide continuous, protected communications to tactical and strategic warfighters in the North Polar Region in both benign and contested environments. The program plans to develop and acquire two payloads to be launched on Space Norway satellites (Space Norway is a governmentally owned company). This mission may be particularly important as it marks the first DOD payload intended for operational use on a commercial host.

Source: GAO analysis of Department of Defense information. | GAO-18-493

[a]GAO, *Missile Defense: Some Progress Delivering Capabilities, but Challenges with Testing Transparency and Requirements Development Need to Be Addressed*, GAO-17-381 (Washington, D.C.: May 30, 2017).

Additional opportunities for commercially hosted payloads may be forthcoming as DOD develops requirements and designs for new and follow-on space programs. DOD has been analyzing various alternatives to explore possible future space system designs and acquisition strategies for several of its upcoming follow-on programs. In these cases, the analysis of alternatives (AOA) study guidance, set forth by DOD's Office of Cost Assessment and Program Evaluation, included direction for the studies to consider new approaches for acquiring space capabilities.[20]

[20]An analysis of alternatives (AOA) is a review in the DOD acquisition process that compares the operational effectiveness, suitability, and lifecycle cost of solutions to satisfy documented capability needs. Factors to be considered in the AOA include effectiveness, cost, schedule, concepts of operations, and overall risk of each alternative. The AOA is normally conducted during the Materiel Solution Analysis phase of the Defense Acquisition System to support a Milestone A decision to begin technology development for a preferred solution.

For example, AOA guidance directed study teams to include hosted payloads or other disaggregated designs, and commercial innovations in technology and acquisition to meet some space mission requirements. Table 3 provides further details of recently completed and ongoing AOAs to study new designs—or architectures—for upcoming follow-on satellite systems.

Table 3: Department of Defense (DOD) Analyses of Alternatives for Upcoming Space System Architectures

Space system	Study lead	Stated purpose of study and applicability to commercially hosted payloads
Protected Satellite Communications Services (follow-on to Advanced Extremely High Frequency)	Office of the Under Secretary of Defense for Acquisition and Sustainment[a]	Conduct analysis required to ensure DOD pursues the most suitable alternative for providing space-based protected satellite communications services following the current program. The study group was directed to assess a disaggregated scenario, including the use of government or commercially hosted payloads.
Space-Based Environmental Monitoring (SBEM)	Air Force Space Command	Conduct analysis of alternative solutions that can provide environmental monitoring capabilities following the current Defense Meteorological Satellite Program and other meteorological satellite programs. The study group was directed to assess a disaggregated scenario, to include the use of government or commercially hosted payloads.
Space Based Infrared System (SBIRS) Follow-On	Air Force Space Command and National Reconnaissance Office	Provide analytical basis for determining an approach for providing launch detection and missile tracking capabilities following the current program. The study group was directed to assess a disaggregated alternative.
Wideband Communications Services	Office of the Under Secretary of Defense for Acquisition and Sustainment[a]	Evaluate alternatives spanning air, space, cyberspace, and ground systems, their control segments, and their associated compatible user segment to address the required wideband communications capabilities in both benign and contested environments. The study group is directed to assess commercial innovations in technology, operations concepts and acquisition approach, and, where appropriate, include those concepts in the analyzed alternatives.

Source: GAO summary of information from DOD documents and interviews with officials. | GAO-18-493

[a]In response to a provision in the National Defense Authorization Act for Fiscal Year 2017, DOD reorganized the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (OUSD(AT&L)) into the Under Secretary of Defense (Research and Engineering) and Under Secretary of Defense (Acquisition and Sustainment). The National Defense Authorization Act for Fiscal Year 2018 required termination ofd the Principal Department of Defense Space Advisor (PDSA), which was a co-leading organization for the Wideband Communication Services analysis of alternatives.

Logistical and Data Challenges Contribute to Limited Use of Hosted Payloads

Two factors have contributed to DOD's limited use of commercially hosted payloads. First, DOD officials identified logistical challenges to matching government payloads with any given commercial host satellite. For example, most of the offices we spoke with cited size, weight, and power constraints, among others, as barriers to using hosted payloads. Second, while individual DOD offices have realized cost and schedule benefits, DOD as a whole has limited information on costs and benefits of hosted payloads. Further, the knowledge it has gathered is fragmented across the agency—with multiple offices collecting piecemeal information on the use of hosted payloads. The limited knowledge and data on hosted payloads that is fragmented across the agency has contributed to resistance among space acquisition officials to adopting this approach.

DOD Officials Cite Logistical Challenges to Matching Payloads to Hosts

DOD acquisition officials within the Office of the Secretary of Defense told us matching requirements between government payloads and commercial satellites is typically too difficult for programs to overcome. Specifically, they said the cumulative complexity of

- matching size, weight, power, and spectrum needs;
- aligning government and commercial timelines; and,
- addressing concerns over payload control and cybersecurity amounts to too great a challenge.

DOD's Hosted Payload Office is developing tools designed to help address these challenges and DOD offices that have used hosted payloads have also found ways to overcome them.

Matching Size, Weight, and Power

Officials from DOD acquisition and policy offices, as well as Air Force and industry officials we spoke with, cited matching size, weight, and power between DOD payloads and commercial host satellites as a challenge. We similarly found in April 2013 that ensuring compatibility between payloads and host satellites can pose challenges because not all commercial satellites are big enough or have enough power to support

hosting a payload. Whether a host satellite can accommodate a payload can depend on the size of the payload. Additionally, according to industry representatives, the space taken up by the hosted payload affects the amount of revenue-generating payloads the host may place on its satellite, such as additional transponders—devices that emit and receive signals—for the communications services it provides to customers. The complexity of integrating a government payload onto a commercial host can also drive the overall cost of the arrangement.

However, officials said these challenges can be mitigated through the use of various expertise and lessons learned. HPO officials and industry representatives have proposed several approaches to help match properties like size, weight, and power between a DOD payload and a commercial host satellite. The HPO is developing a hosted payload interface unit that could potentially provide a standard for payload developers and system integrators to develop and test their systems. One commercial company proposed an interface unit that would accommodate a "universal" DOD payload. Additionally, industry experts stated that with sufficient planning and time for system integration, nearly any payload can be accommodated on a host satellite.

The HPO issued guidelines in 2017 to assist DOD payload developers in working toward typical payload requirements and standards for host satellites in low Earth orbit and geostationary Earth orbit. These guidelines inform the payload's electrical power and mechanical designs. The principal guideline—echoed by the successful CHIRP demonstration in 2011—is that the hosted payload must "do no harm" to the mission performance of its host. Also, satellite interfaces can vary from company to company.[21] Some commercial companies had experience with the task—and business opportunity—of integrating multiple customers' payloads onto satellites since at least the 1990s.

Matching Spectrum Needs

Air Force, HPO, and industry officials told us that, ideally, the payload should use the same spectrum allocation as the commercial host. They said that this is due in part to the lengthy satellite registration process that takes place in the United States and through the ITU that must be undertaken prior to placing a satellite on orbit. Some DOD officials added

[21]GAO-13-279SP.

that the process for all new satellites from initial filing to ITU approval takes around 7 years. If a satellite owner registers for one frequency band of spectrum and later requires a different band, the owner has to begin the registration process from the beginning—restarting the 7-year timeline. This can be problematic for DOD payload owners seeking to match their military communications payload with an already-registered host satellite—particularly if the host satellite's spectrum allocation is incompatible with the DOD payload.[22] HPO and other DOD officials said that very different spectrum needs between payload and host would therefore preclude the match.

Moreover, a need for military—as opposed to commercial—spectrum for communications payloads can introduce additional complications.[23] Although a process exists for a commercial satellite owner to license military spectrum for use by a hosted payload, representatives from DOD's Chief Information Officer's (CIO) office could cite only one instance where this has happened. One possible explanation stems from a 2012 memorandum from DOD's CIO that outlines various preferred processes for a commercial host satellite to host military communications payloads.[24] Several industry officials we spoke to said that the various processes outlined in the 2012 memorandum would add to the already-lengthy process of spectrum registration. Further, the memorandum instructs that contractual terms between the payload and host satellite owners should restrict all military spectrum use exclusively to the U.S. military. However, one industry official told us that international entities do not necessarily recognize U.S. military spectrum, and commercial companies that obtain licenses through other countries are permitted to use those frequencies. For example, a senior official of one commercial company we met with stated

[22]According to an industry representative, even if a payload begins operation in an approved spectrum allocation, any change in the parameters of the license requires bilateral coordination with neighboring satellites. If the addition of a payload adds new capability to a previously-approved license, the ITU process must be started over from the beginning.

[23]The DOD Chief Information Officer defines military satellite communications frequencies as Ultra High Frequencies of 240-270 megahertz (MHz), 290-320 MHz; X-band frequencies of 7250-7750 MHz; Ka-band frequencies of 20.2-21.2 gigahertz (GHz), 30-31 GHz; and Extremely High Frequencies of 43.5-45.5 GHz.

[24]DOD Chief Information Officer, *Guidance for Obtaining Military SATCOM Services from a Commercial Provider via Hosted Payloads Using Military Spectrum* (Washington, D.C.: Sept. 26, 2012).

that the company licensed U.S. military spectrum through another North Atlantic Treaty Organization government after failing to successfully coordinate an FCC request with DOD and NTIA. DOD and industry representatives told us that from a business perspective, it makes little sense for a commercial company to seek hosting opportunities for DOD payloads that require U.S. military spectrum.

Matching Government and Commercial Development and Acquisition Timelines

Government and industry officials we spoke with said that aligning the development and acquisition timelines of a government payload and commercial host satellite is a challenge. The timeline associated with developing government sensors is generally much longer than that of commercial satellites, potentially creating difficulties in scheduling and funding commercially hosted payload arrangements. For example, DOD satellite systems take, on average, over 7 years to develop and launch a first vehicle, while commercial satellite programs typically take between 2 and 3 years.[25] DOD payload owners may find it challenging to accelerate development and acquisition schedules to match those of the commercial satellite host. Additionally, DOD officials we spoke with said that their budget and planning processes require funding commitments up to 2 years in advance of actually receiving those funds. This can further complicate alignment with commercial timelines because the development of a government sensor would need to be underway well in advance of a decision to fund a commercially hosted payload approach.[26] Furthermore, federal law generally prohibits agencies from paying in advance for a future service or from obligating future appropriations.[27]

However, several DOD and other government agency officials we spoke with said that it is possible to align government and commercial timelines. For example, MDA adopted the commercial host's schedule to ensure its Spacebased Kill Assessment payload was ready for integration and launch without delaying the host satellite or worse—missing its own ride to space. DARPA officials told us they were also able to align DARPA

[25]Aerospace Corporation, *How Long Does It Take to Develop and Launch Government Satellite Systems?*, Aerospace Report Number ATR-2015-00535 (March 12, 2015).

[26]We reported similar findings in April 2013 (see GAO-13-279SP).

[27]With respect to prohibiting agencies from paying in advance of future service, see 31 U.S.C. § 3324, and from obligating future appropriations, see 31 U.S.C. § 1341 (a).

acquisition and development schedules with the commercial host. The Air Force's Enhanced Polar System (EPS) Recapitalization program officials were able to leverage existing documents such as requirements documents and acquisition strategies from the predecessor program to speed up the acquisition process. According to Air Force officials, the EPS Recapitalization program had a unique opportunity to take advantage of the availability of a commercial host and had the support of a high ranking Air Force official that enabled the program to move forward using a commercially hosted payload approach.

Maintaining Payload Control and Cybersecurity

Some officials cited concerns with combining government and commercial space missions. For example, officials across DOD told us they were wary of losing control over a hosted payload should a commercial company's needs change. They said that theoretically, a commercial provider could decide to turn off power to the government's payload if the host satellite needed extra power to perform a certain function. Additionally, DOD space program officials expressed concern that commercial practices for ensuring the mission success of the payload may not be up to government standards—that commercial testing and integration standards may be less robust than those used by traditional government programs to ensure success, adding risk to the government payload. Furthermore, officials in one DOD program office expressed a distrust of commercial host motives in offering to support a government payload on their satellite, suggesting that a company could be intending to steal government technologies. However, industry officials we spoke with said that DOD can generally issue a solicitation that includes necessary stipulations. For example, including a condition to preserve the payload's priority of mission and other terms to protect the government's investment may provide some assurance to those officials that perceive security risks.

Additionally, some officials we spoke to cited cybersecurity concerns. They cited loss of control over data security as a challenge to using hosted payloads. Officials told us the data could be vulnerable to eavesdropping or manipulation as it travels between government ground systems and the commercially hosted government payload. However, according to HPO officials, the Air Force overcame this challenge on the CHIRP mission by procuring a secure interface that provided a data link between the payload and dedicated transponder and ground terminal. As mentioned previously, the Hosted Payload Office is developing a hosted

payload data interface unit to mitigate this challenge by securing payload data communications from the host satellite.

Department-wide Information on Commercially Hosted Payloads Is Limited and Fragmented Across Offices

DOD, at the department-wide level, has limited information on commercially hosted payloads—mostly due to a lack of experience in using hosted payloads and complexities associated with them. For example, acquisition officials in the Office of the Secretary of Defense told us that DOD needs more data and analysis of the potential costs and benefits. However, realistic cost modeling for commercially hosted DOD payloads is unavailable because costs can vary across potential hosts and DOD has minimal experience using commercial hosts. Similarly, the HPO performs market research and cost estimates based on data from commercial companies, but according to one official in the HPO, the costs tend to vary based on the supply and demand in the commercial satellite industry. Additionally, HPO officials said their cost savings analyses are based on only two real-world commercially hosted DOD payloads—CHIRP and REACH.[28] HPO officials told us that with additional government data they could compare the costs of system architectures that include free-flier satellites with those that use commercially hosted payloads. Additionally, some potential benefits of using commercially hosted payloads, such as resilience, may be difficult to measure. In our 2014 report on disaggregation, we recommended that DOD define key measures related to disaggregation, including developing metrics to measure resilience.[29] DOD is in the process of developing standard metrics for resilience.

DOD's knowledge of commercially hosted payloads is also fragmented across the agency. Several DOD offices are independently conducting activities related to commercially hosted payloads, such as pursuing commercially hosted payload arrangements, developing lessons learned, and determining demand for commercial hosts. For example, MDA officials told us they have developed cost and technical data and lessons learned based on MDA's Spacebased Kill Assessment payload—

[28]The Hosted Payload Office does not have information on the IRIS effort because it was developed and launched in 2009, several years before the Air Force created the Hosted Payload Office in 2011.

[29]GAO-15-7.

launched earlier this year—but have not shared it across the agency. On the other hand, the Space Test Program, also housed within the Air Force's SMC develops lessons learned on its payloads, which are government payloads on government host satellites and officials there told us they provide lessons learned to the HPO.[30] In October 2017, SMC's Launch Office sent a request for data on hosted payloads to DOD agencies, research laboratories, and universities, but the HPO was not an active participant in this request. Independent efforts within DOD to collect and analyze cost, schedule, and performance results from hosted payloads can create fragmentation in DOD's knowledge base and can increase the risk of duplicative efforts within DOD.[31]

DOD does not collect or consolidate agency-wide knowledge on commercially hosted payloads and has no plans to do so. Agency officials stated that DOD does not require programs outside of SMC to consult the HPO when seeking commercially hosted payload arrangements. The Air Force established the HPO to facilitate commercially hosted payloads, however, the 2011 Program Management Directive that established the HPO states that the HPO will coordinate with SMC directorates for detailed implementation of hosted payloads but does not address coordination with agencies or directorates outside of SMC. According to an HPO official, programs are not required to use HPO expertise or tools

[30]The Air Force's Space Test Program, located at Kirtland Air Force Base in New Mexico, provides mission design and coordinates space launch for DOD science and technology efforts.

[31]Fragmentation is an ongoing issue within DOD space organizations, as we found in July 2016. DOD is currently studying ways to address broader fragmentation in response to congressional directives. The National Defense Authorization Act for Fiscal Year 2017, Pub. L. No. 114-328, § 1616 directed the Secretary of Defense and the Director of the Office of Management and Budget to separately submit recommendations to certain congressional committees on how to strengthen the leadership, management, and organization of the Department of Defense with respect to the national security space activities of the Department and address findings in our report, GAO-16-592R. In our report, we found that DOD space leadership responsibilities are fragmented among several organizations, including 60 stakeholder organizations across DOD, the Executive Office of the President, the Intelligence Community, and civilian agencies. Additionally, the National Defense Authorization Act for Fiscal Year 2018, Pub. L. No.115-91, § 1601 directed the Deputy Secretary of Defense to conduct a review and identify a recommended organizational and management structure for the national security space components of the Department of Defense. In January 2018, the DOD issued guidance aimed at responding to directives from Congress. For example, the guidance assigned responsibilities to streamline operations and better support the warfighter. The guidance also directed a comprehensive review of the Air Force space acquisition organization and authorities.

as they pursue using hosted payloads. Further, this official stated that programs are not required to provide any data or lessons learned to the HPO, or any other central point within DOD, following the pursuit or completion of a hosted payload arrangement. The 2011 Program Management Directive directs the HPO to provide lessons learned to SMC directorates but does not direct SMC offices to share information—such as costs, technical data and lessons learned on completed commercially hosted payload efforts—with the HPO.[32] An HPO official indicated that the HPO obtains data through informal communication with those programs using hosted payloads that are willing to share data.

We found that limitations and fragmentation of data and knowledge are contributing to resistance within DOD to using hosted payloads. Several DOD acquisition and program officials we spoke with who did not have experience with hosted payloads generally stated that the potential risks to using hosted payloads outweighed the benefits, and that there was little evidence-based analysis to prove otherwise. They were not aware of existing tools that could assist them in making decisions even though the HPO has been developing these tools and has made efforts to share them within SMC. DOD acquisition and program officials consistently cited a preference for maintaining the acquisition status quo over introducing any perceived added risk to their programs. At the same time, however, officials who have used hosted payloads were able to overcome logistical and technical challenges and realize cost savings. However, according to an HPO official, there is currently no requirement in place to facilitate sharing their approaches to doing so. We have reported in the past that DOD's culture has generally been resistant to changes in space acquisition approaches and that fragmented responsibilities for acquisitions have made it very difficult to coordinate and deliver interdependent systems.[33]

Moreover, our past studies of commercial strategic sourcing best practices have found that that leading companies centralize procurement decisions by aligning, prioritizing, and integrating procurement functions

[32] Department of the Air Force, Headquarters Space and Missile Systems Center, Program Management Directive (PMD) for Space and Missile Systems Center Hosted Payload Office (HPO) (Los Angeles, CA: July 2011).

[33] GAO, *Defense Space Acquisitions: Too Early to Determine If Recent Changes Will Resolve Persistent Fragmentation in Management and Oversight,* GAO-16-592R (Washington, D.C.: July 27, 2016).

within the organization.[34] Establishing the Hosted Payload Office is one step in this direction, but the office is organized under the Advanced Systems and Development Directorate—a research and development organization—under SMC. Moreover, the 2011 directive that established the HPO does not address coordination or responsibilities for agencies or directorates beyond SMC. Consolidating knowledge is important because it allows organizations to share information and data upon which to develop consistent procurement tactics, such as ways to overcome challenges in matching a government payload with a commercial host. As we found in our work on commercial strategic sourcing best practices, organizations that struggled with fragmented information in the past overcame this challenge in part by consolidating their data on costs and spending. While hosted payload acquisitions are not a typical service acquisition, successful organizations have found that these techniques work for highly specialized technical services for which few suppliers exist.

Conclusions

As DOD considers new architectures and acquisition approaches, commercially hosted payloads have the potential to play a role in delivering needed capabilities on orbit more quickly and at a more affordable cost than traditional DOD space acquisitions. Placing DOD payloads on commercial satellites might also be an effective method by which to increase resiliency. However, DOD's experience and the data collected so far are limited in informing decisions on the use of these payloads. DOD would benefit from leveraging the knowledge and information gained from each hosted payload experience. Centralized collection and assessment of agency-wide data would help enable DOD to mitigate the logistical challenges inherent in matching payloads to hosts, and better position DOD to make reasoned, evidence-based decisions on whether a hosted payload would be a viable solution to meet warfighter needs. Without such knowledge, and a way for interested programs to leverage it, DOD may not be fully informed about using hosted payloads and may risk missing opportunities to rapidly and affordably address emerging threats in space.

[34]GAO, *Strategic Sourcing: Leading Commercial Practices Can Help Federal Agencies Increase Savings When Acquiring Services*, GAO-13-417 (Washington, D.C.: Apr. 15, 2013).

Recommendation for Executive Action

The Secretary of Defense should require programs using hosted payloads to provide cost and technical data, and lessons learned to a central office. In implementing this recommendation, DOD should consider whether the Hosted Payload Office is the most appropriate office to centralize agency-wide knowledge. (Recommendation 1)

Agency Comments

We provided a draft of this report to the Department of Commerce, NASA, and DOD for comment. The Department of Commerce provided technical comments, which we incorporated as appropriate. NASA did not have comments on our draft report. In its written comments, DOD concurred with our recommendation and stated that SMC had initiated a major reorganization since we drafted our report and that under the new organizational construct, the Hosted Payload Office had changed and may not be the appropriate office for centralizing DOD-wide hosted payload knowledge. DOD's comments are reproduced in appendix II. DOD also provided technical comments which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Commerce, the Secretary of Defense, the Administrator of NASA, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-4841 or by email at chaplainc@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

Cristina T. Chaplain
Director
Contracting and National Security Acquisitions

Appendix I: Civil and Other Agency Commercially Hosted Payloads

As shown in table 4, civil and other government agencies use commercially hosted payloads to enhance navigation systems, monitor environmental pollution, conduct scientific missions, and improve search and rescue systems. Officials from all of the agencies we spoke with cited cost savings and the ability to leverage existing commercial schedules and technologies among the reasons they use commercial host satellites.

Table 4: Civil and Other Agency Use of Commercial Host Satellites

Agency	Commercially Hosted Payload Effort
Federal Aviation Administration (FAA)	FAA documentation states that the Wide Area Augmentation System aids in aircraft take-off and landing navigation. This system design requires the use of three geosynchronous Earth orbit (GEO) satellite signals from independent satellites.[a] Two of these sensors are hosted on orbiting commercial satellites, and FAA stated that it plans to procure the third commercial satellite host in 2018. The FAA officials said that using a hosted payload approach was the most economical means of providing these three GEO signals.

Agency	Commercially Hosted Payload Effort
National Aeronautics and Space Administration (NASA)	As stated by NASA officials, five commercially hosted payload efforts across mission areas include monitoring environmental pollution, aerosol and carbon imaging, and measuring densities and temperatures in various Earth atmospheres: • Geostationary Carbon Cycle Observatory (GEOCarb): This mission will measure key greenhouse gases—carbon dioxide, methane, and carbon monoxide—and vegetation health. This mission will fly on an SES Government Solutions commercial satellite in geostationary orbit. • Global-scale Observations of Limb and Disk (GOLD): This mission will collect images of Earth's upper atmosphere to better understand activity in this region, which is responsible for a variety of space weather events. This mission launched on an SES Government Solutions commercial satellite on January 28, 2018. • Deep Space Atomic Clock (DSAC): This mission will demonstrate an ultra-precise, miniature atomic clock to inform future deep-space navigation missions. A Surrey Satellite Technologies commercial satellite will host this mission in low Earth orbit. • Multi-Angle Imager for Aerosols (MAIA): This mission will measure air pollution using a single camera instrument to characterize the size, composition, and quantities of particulate matter. This mission will be hosted on a commercial host in low Earth orbit. NASA expects to select the commercial host in 2018. • Tropospheric Emissions: Monitoring of Pollution (TEMPO): This mission will measure air pollution of North America hourly and at high spatial resolution from geostationary orbit. This payload will be hosted on a commercial satellite, which NASA expects to select in 2019.
National Oceanic and Atmospheric Administration (NOAA)	Cooperative Data and Rescue Services (CDARS): According to NOAA officials, this mission includes the Argos Advanced Data Collection System (A-DCS) instrument. NOAA plans to host this payload on a commercial satellite, which it plans to select in 2019.
United States Coast Guard	Automatic Identification System: According to the U.S. Coast Guard, this mission was designed to improve identifying and tracking ships at sea by collecting data on vessel location, source, and speed. While the original payload failed in 2009, the capability exists on other satellites from the company that hosted the original payload. The government now purchases these data.

Source: GAO summary of information from FAA, NASA, NOAA and U.S. Coast Guard documents and interviews. | GAO-18-493

[a]Geosynchronous Earth orbit (GEO) is a circular orbit at an altitude of 35,852 km with a low inclination (i.e., near or on the equator). A GEO satellite's revolution is synchronized with the Earth's rotation giving it a seemingly stationary position above a fixed point on the equator. Non-geosynchronous Earth orbit satellites are those in orbits other than GEO, such as satellites located in low Earth orbit, medium Earth orbit, or Sun synchronous orbit.

Appendix II: Comments from the Department of Defense

ASSISTANT SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION

JUL 12 2018

Ms. Cristina T. Chaplain
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Ms. Chaplain:

(U) This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report, GAO-18-493, "MILITARY SPACE SYSTEMS: DOD'S Use of Commercial Satellites to Host Defense Payloads Would Benefit from Centralizing Data" dated June 4, 2018 (GAO Code 102187). Detailed comments on the report recommendations and report are enclosed.

Sincerely,

Kevin M Fahey

Kevin Fahey

Enclosure:
As stated

GAO Draft Report Dated June 4, 2018
GAO-18-493 (GAO CODE 102187)

"MILITARY SPACE SYSTEMS: DOD'S USE OF COMMERCIAL SATELLITES TO HOST DEFENSE PAYLOADS WOULD BENEFIT FROM CENTRALIZING DATA"

(U) DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATION

(U) RECOMMENDATION: The Secretary of Defense should require programs using hosted payloads to provide cost and technical data, and lessons learned to a central office. In implementing this recommendation, DoD should consider whether the Hosted Payload Office is the most appropriate office to centralize agency-wide knowledge.

(U) DoD RESPONSE: DoD concurs with comment. The Space and Missile Center (SMC) has initiated a major reorganization since the report was drafted. Under the new organizational construct the Hosted Payload Office has changed and may not be the appropriate office for centralizing DoD-wide hosted payload knowledge.

2

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Cristina T. Chaplain (202) 512-4841 or chaplainc@gao.gov.

Staff Acknowledgments

In addition to the contact named above, Rich Horiuchi (Assistant Director), Erin Cohen (Analyst in Charge), Claire Buck, Jon Felbinger, Stephanie Gustafson, Matthew Metz, Sylvia Schatz, and Roxanna Sun made key contributions to this report.

Appendix IV: Accessible Data

Data Tables

Accessible Data for DOD Hosted Payload Missions from 2009 to 2022

Acronym	Acronym description
CHIRP	Commercially Hosted Infrared Payload
EPS-R	Enhanced Polar System Recapitalization
IRIS	Internet Protocol Routing in Space
Phoenix POD	Phoenix Program: Payload Orbital Delivery System
REACH	Responsive Environmental Assessment Commercially Hosted
SKA	Spacebased Kill Assessment

Accessible Data for Figure 1: DOD Fielded and Planned Commercially Hosted Payloads from 2009 to 2022

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Agency Comment Letter

Accessible Text for Appendix II Comments from the Department of Defense

Page 1

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As stated

Page 2

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