

MILITARY SPACE OPERATIONS, POLICY, AND PROGRAMS

HEARING

BEFORE THE

SUBCOMMITTEE ON
STRATEGIC FORCES

OF THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

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MILITARY SPACE OPERATIONS, POLICY, AND PROGRAMS

WEDNESDAY, MARCH 27, 2019

UNITED STATES SENATE,
SUBCOMMITTEE ON STRATEGIC FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:29 p.m. in room SR 222, Russell Senate Office Building, Senator Deb Fischer (Chairman of the Subcommittee) presiding.

Subcommittee Members present: Senators Fischer, Cotton, Rounds, Cramer, King, Heinrich, Manchin, and Jones.

OPENING STATEMENT OF SENATOR DEB FISCHER

Senator FISCHER. Hearing will come to order.

I'd like to welcome everyone to the Strategic Forces Subcommittee's first open hearing of the 116th Congress.

We meet today to receive testimony on the national security space enterprise. Appearing before the Subcommittee, we have General David Thompson, Vice Commander of Air Force Space Command; General John Thompson, Commander of the Space and Missile Systems Center; Mr. Ken—is it——

Secretary RAPUANO. Rapuano.

Senator FISCHER.—Rapuano, the Assistant Secretary of Defense for Homeland Defense and Global Security; and Ms. Cristina Chaplain, who directs the Government Accountability Office's work on military space programs.

Thank you all for your service and for being here today.

We meet at a time of increased focus on the space domain. In the last few years, we have seen a significant evolution in our approach to space. It's now widely recognized that space is a warfighting domain. It is also a domain in which adversaries are increasingly active and upon which our Nation increasingly depends. Accordingly, we must ensure that our military space operations, policies, and programs are keeping pace with the changing environment, and we look forward to the testimony from our witnesses about the Department's effort in this regard. Their testimony today will help the Subcommittee make informed decisions as we continue to craft the defense authorization bill for fiscal year 2020.

I would also like to note for my colleagues that the full committee will be holding a hearing on April 11th to discuss the Department's proposal to establish a Space Force. With that in mind, it is my intention to use my time today to talk about some of the other key equities in the national security space portfolio.

And, with that, I would turn to my colleague and Ranking Member, Senator Heinrich, for any comments.

STATEMENT OF SENATOR MARTIN HEINRICH

Senator HEINRICH. Well, first, let me thank Chairwoman Fischer for holding today's hearing. This is our first together, and I look forward to future interactions on this Subcommittee.

Let me also thank our witnesses for taking the time to testify today. Between this Subcommittee hearing on the fiscal year 2020 budget proposal and the full committee hearing on the proposed Space Force, there will be much to talk about, relative to space, in the coming weeks.

At today's hearing, I want to concentrate on the threat we face in space, the budget submission to counter these threats, and organizational proposals to train and equip our space personnel.

The idea of a Space Force is not new. The House proposed an almost identical concept in its fiscal year 2018 defense authorization bill. It was dropped in conference. The Pentagon leadership opposed it, as did several of our Senate colleagues. Having said that, it's no secret that the space domain is critical to our military operations, to our economy, and our way of life.

As our adversaries become increasingly active in space, we certainly can't sit idly by. We must, instead, move with a greater sense of urgency and purpose. As an engineer, I continue to prioritize research and development, and cannot stress enough the importance of fostering a culture of innovation and rapid acquisition within the space domain. Whether it's the creation of a Space Development Agency (SDA) or any larger reorganization, we also should not reinvent the wheel nor move pieces around for the sake of saying we did so. We could always strive for our government to be better stewards of taxpayer dollars and for our military to operate more effectively, and I look forward to hearing how we may be able to do so.

Again, thank you all for coming today, and I look forward to hearing all of your testimony.

Senator FISCHER. Thank you, Senator Heinrich.

We will begin with opening statements. I would remind our witnesses today that your full statement will be included in the record.

Mr. Secretary, if we could start with you, please.

STATEMENT OF HONORABLE KENNETH P. RAPUANO, ASSISTANT SECRETARY OF DEFENSE FOR HOMELAND DEFENSE AND GLOBAL SECURITY

Secretary RAPUANO. Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, it is a pleasure to appear before you today, along with Lieutenant General "DT" Thompson, Lieutenant General "JT" Thompson, and Ms. Cristina Chaplain.

Space is a vital national interest. It underpins our economy and way of life, supporting our academia, agricultural, banking, and travel sectors, among others. Moreover, the rapidly growing commercial space sector offers enormous promise for the prosperity of Americans and our global partners. Commercial entities led by the

United States are developing and delivering new space technologies and capabilities at a speed never seen before. Space is also crucial to the defense of the United States and our allies and partners.

As outlined in the National Defense Strategy (NDS), long-term strategic competition is the central challenge to the U.S. prosperity and national security. Space is key to this competition. China and Russia are developing military capabilities, doctrine, and organizations intended to place United States space systems at risk. They are developing a suite of anti-satellite weapons (ASAT), including ground-launch missiles and directed-energy weapons, and continue to launch experimental satellites that conduct sophisticated on-orbit activities to advance their counterspace capabilities. Many of these systems could be employed in the gray zone, that is, activities below the threshold of armed conflict in a manner designed to hold U.S., allied, and partner capabilities at risk and limit our response options.

The emergence of new major state actors in space, and the pace of the technological development, are changing the character of warfare, presenting new challenges and opportunities to military space forces. No longer do space systems simply enable terrestrial forces to fight and win wars. Actions in space also will directly contribute to the outcome of future conflicts. In order to preserve peace and deter aggression, the Department of Defense (DOD) must adapt. Without change, the United States is at risk of losing its comparative advantage in space. A loss of freedom to operate in space would undermine our Nation's prosperity and erode the ability of the Joint Force to deter aggression, protect critical national defense and economic functions, assure our allies and partners, and project power globally. While the United States would prefer that space remain conflict-free, we must recognize rising challenges, and overcome them. The Department must do more to accelerate its response to the changing dynamics of space by adapting our organizations, policies, doctrine, capabilities, and Joint Force employment to more effectively deter aggression, protect our interests, and enhance our lethality.

Earlier this month, the Department provided Congress with a legislative proposal for the establishment of the U.S. Space Force as a new branch of our Armed Forces. If authorized, the Space Force will transform our approach to space by providing singular focus to maintaining and increasing our advantage in countering current and future threats. Establishing a sixth branch of our military with dedicated leadership will unify focus and accelerate the development of space doctrine, capabilities, and expertise to outpace future threats, institutionalize advocacy of space priorities, and further build space warfighting culture. The role of providing Joint Force employment of space capabilities lies with the United States Space Command (SPACECOM), a Unified Combatant Command focused on planning and executing joint space warfighting operations. Establishing U.S. SPACECOM will bring full-time operational focus to securing the space domain and streamline command and control for time-sensitive operations.

Additionally, the Department of Defense has undertaken a series of space acquisition reforms. These reforms, such as Space and Missile Systems Center (SMC) 2.0, will continue to mature with

the establishment of a Joint Space Development Agency dedicated to rapidly developing and fielding next-generation military space capabilities. The SDA will be empowered to go fast, and would be pursuing a development of a transformational new architecture that leverages the investment taking place in the commercial sector.

The Department looks forward to working closely with this committee and all of Congress to ensure that we maintain our freedom of operation in space to support our national security, our economic prosperity, and our way of life.

Thank you.

[The prepared statement of Mr. Rapuano follows:]

PREPARED STATEMENT BY SECRETARY KENNETH RAPUANO

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, it is a pleasure to appear before you along with General Jay Raymond, Commander of Air Force Space Command and U.S. Strategic Command Joint Force Space Component Commander; Lieutenant General John Thompson, Commander, Space and Missile Systems Center; and Ms. Cristina Chaplain, Director, Acquisition and Sourcing Management at the Government Accountability Office. I serve as the Assistant Secretary of Defense for Homeland Defense and Global Security. In this capacity I oversee and guide the development and implementation of the Department of Defense's strategy and policy to achieve its space mission.

Space is integral to the U.S. way of life and the U.S. way of war. Although United States space systems have historically maintained a technological advantage over those of our potential adversaries, those potential adversaries are now advancing their space capabilities and actively developing ways to deny our use of space in a crisis or conflict. Without change, the United States is at risk of losing its comparative advantage in space. A loss of freedom to operate in space would undermine our Nation's prosperity and would erode the ability of the joint force to deter aggression, to defend the Homeland from attack, and to project power abroad.

While the U.S. would prefer that the space domain remain free of conflict, we must recognize rising challenges, and be prepared to meet and overcome them. The Department must accelerate, and is accelerating, its response to the changing dynamics of space. We are adapting our organizations, policies, doctrine, and capabilities to more effectively deter aggression and protect our interests.

Earlier this month the Department provided Congress with a legislative proposal for the establishment of the United States Space Force as a new branch of our armed forces. If authorized, the Space Force would transform our approach to space, increasing our responsiveness in this warfighting domain. The proposal maximizes warfighting capacity and advocacy for space, while minimizing bureaucracy and potential risks. Establishing a sixth branch of our military with dedicated leadership will unify, focus, and accelerate the development of space doctrine, capabilities, and expertise to outpace future threats; institutionalize advocacy of space priorities; and further build space warfighting culture.

The Department looks forward to working closely with this committee and all of Congress on ensuring we maintain our freedom of operation in space in order to support our national security and our economic prosperity.

NATIONAL SECURITY STRATEGY & NATIONAL DEFENSE STRATEGY

The Department's approach to space is aligned and nested within our broader national strategies. Space is a warfighting domain, and just as in air, land, sea, and cyberspace, the Department of Defense must ensure it is prepared to address threats to our national security in the space domain.

The National Security Strategy and the National Defense Strategy recognize space as a priority domain and an operating area from which capabilities are employed and forces are enabled, and recognizes the potential for conflict to extend into space. These strategies direct that we compete as necessary to deter potential adversaries and, when necessary, win any conflict that begins in or extends into space. Our ability to operate and leverage space to advance scientific knowledge, promote prosperity, and secure the freedoms of our citizens and allies and partners must remain unimpeded. We will compete, we will deter, and, if called upon to fight, we will win.

The National Security Strategy, published in December 2017, provides a plan to (1) protect the American people, the Homeland, and the American way of life; (2) promote American prosperity; (3) preserve peace through strength; and (4) advance American influence. Each aspect of this plan is fortified and supported by the advantages our Nation gains from space capabilities.

Our 2018 National Defense Strategy (NDS) charts the course for how DOD will contribute to each of the National Security Strategy's four national interests. Under the NDS, long-term strategic competitions with China and Russia are the principal priorities for the Department, and because of the magnitude of the threats they pose to United States security and prosperity today, and the potential for those threats to increase in the future, require both sustained focus and investment. Space is a key arena in which this competition is occurring. Addressing the challenges posed to our preeminence as a space power is fundamental to our efforts.

To meet the challenge of great power competition, the Department is broadly pursuing three lines of effort—increasing the lethality of our forces, strengthening our alliances and partnerships, and reforming the Department to ensure affordability and delivery of capabilities at the speed of relevance. These approaches are as applicable to the space domain as they are to any other Department endeavor.

STRATEGIC ENVIRONMENT

Space underpins the U.S. way of life and U.S. way of war. Space provides an unparalleled vantage point and medium for rapid, global information collection and dissemination. Space-based capabilities facilitate the flow of people and goods worldwide, while guiding military forces to their positions and weapons to their targets. Satellites enable individuals worldwide to communicate from remote corners of the globe and allow national authorities to command and control forces in multiple theaters simultaneously. Small businesses and multinational corporations alike rely on space-based imagery and other sensing to plan their daily operations, while military commanders understand the security environment through information gathered by intelligence, surveillance, and reconnaissance satellites.

Our nation's interests in space are expanding. New investments and new technology are fueling opportunities for an expanding ecosystem of space systems and services. Advanced technologies are revolutionizing accessibility to space and space-derived capabilities at dramatically reduced costs. Technology continues to progress rapidly in areas such as 3-D printing, artificial intelligence, and machine learning, while advances in electronics are enabling ever-smaller form factors. Space system developers are leveraging all of these trends. Many of yesterday's cutting-edge technologies are mere commodities today, greatly reducing the economic barriers to entry into space. Significant amounts of private financing is pouring into commercial space, fueling a growing space industry. We are witnessing advances in high-throughput communication satellites and the development of commercial plans for mega-constellations offering new capabilities in low-Earth orbit. The commercial sector, enabled by traditional aerospace companies as well as entrepreneurs and venture capitalists, is driving down the cost of access to space through the development of re-usable launch vehicles and other techniques. These developments together are planting the seeds from which future economic and commercial opportunities may grow.

This growth demonstrates that space is no longer the purview of only superpowers or even a handful of nations; participation in space activities is growing more diverse. Space-derived information services such as imagery, weather, communications, and intelligence, traditionally reserved to the governments of just a few space-faring nations, are becoming more attainable to non-State entities, companies, and individuals. This presents new challenges for the Department as new States, non-State actors, and commercial entities, both foreign and domestic, are able to provide services and capabilities once only available to the U.S. Government and a few other space-faring nations. The pace of technological expansion and growing accessibility are forcing our military to think and plan differently, as potential adversaries leverage increased capabilities to observe our force movements, track our activities, and communicate with their own forces at efficiencies, data rates, and levels of security not previously available.

The United States also faces serious and growing challenges to its freedom to operate in space. China and Russia have studied how the United States joint force operates and have embarked on major efforts to develop, test, and field counter-space capabilities in order to destroy or disrupt U.S. and allied space capabilities in a crisis or conflict. These strategic competitors view space as an area where they could weaken our advantages and cause cascading impacts on our sea, air, land, and cyber systems that rely on space-based capabilities. Both have reorganized their militaries

in 2015, emphasizing the importance of space operations, and making denial of space advantages are key components of their strategy. As a result, the United States no longer enjoys the freedom to develop and leverage space systems without deliberate regard to other nations' counterspace capabilities.

These same countries, recognizing the value of space capabilities, are also expanding their use of space to support the lethality and effectiveness of their military forces in other domains. As noted in a recent Defense Intelligence Agency report "Both [China and Russia] have developed robust and capable space services, including space-based intelligence, surveillance, and reconnaissance. Moreover, they are making improvements to existing systems, including space launch vehicles and satellite navigation constellations. These capabilities provide their militaries with the ability to command and control their forces worldwide and also with enhanced situational awareness, enabling them to monitor, track, and target U.S. and allied forces."¹

These emerging threats, in and from space, place our nation's security at ever-increasing risk and drive the U.S. imperative to strengthen its space posture and integration and synchronization of combat power across multiple domains. This includes both the ability to assure and defend our space-based capabilities from attack and the ability to protect our terrestrial forces from space-enabled attacks.

SPACE STRATEGY AND POSTURE

This new environment highlights the role of space in changing the character of warfare and presents new challenges and opportunities to military space forces. No longer do space systems simply support terrestrial forces to fight and win wars; actions in space also will directly contribute to the outcome of future crises or conflicts. In order to preserve peace and deter aggression, the Department of Defense (DOD) must adapt. The DOD must be prepared to assure freedom of operation in space, to deter attacks, and, when necessary, to defeat space and counterspace threats to the national security interests of the United States and its allies and partners.

Policy and Strategy

In addition to the National Security Strategy and the National Defense Strategy, the Department's efforts for Space are guided by the National Strategy for Space, which was signed by the President in March 2018. The National Strategy for Space builds on the other strategies by emphasizing peace through strength, and maintaining U.S. leadership, preeminence, and freedom of operation in the space domain. The space strategy encompasses all aspects of our nation's space interest. It is composed of a strategic framework and implementation plan outlining four key strategic objectives. The first is to strengthen the safety, stability, and sustainability of space activities. The second is to deter and, when necessary, defeat adversary space and counterspace threats used for purposes hostile to the national security interests of the United States and its allies and partners. The third is to maintain U.S. commercial industry as the leading provider of traditional and innovative space technologies, goods, and services on the international space market while limiting potential adversaries' access to critical technologies and capabilities. The fourth is to maintain and extend U.S. human presence and robotic exploration beyond Earth to transform knowledge of ourselves, our planet, our solar system, and our universe. The implementation plan describes four lines of effort: mission assurance; deterrence and warfighting; organizational support; and creating conducive domestic and international environments for U.S. space objectives. The lines of effort represent the key priorities of the strategy and, along with the supporting tasks, describe the ways and means necessary to achieve our strategic objectives.

The first line of effort focuses on mission assurance. We are accelerating the transformation of our space architecture by deliberately moving systems from the research and development phase to the actual fielding of capabilities. As a result, our space systems will be more resilient and more defensible. We are also looking to expand the ability to reconstitute space capabilities to reestablish lost functionality and we are exploring on-orbit satellite servicing capabilities. Fundamental to our strategy is our mission to deter, prepare for, and, if directed, prevail in any conflict, in any environment, against any threat.

The second line of effort focuses on deterrence and warfighting. Our strategy recognizes that—due to actions by our competitors and potential adversaries—the space domain is not a sanctuary. This line of effort seeks to develop options to deter potential adversaries from aggression, including extending conflict into space. It en-

¹Challenges to Security in Space, Defense Intelligence Agency, February 2019

tails a refocus of strategic guidance and doctrine; operational plans, authorities, capabilities, and culture; and rules of engagement to prepare most effectively for space as a warfighting domain.

The third and fourth lines of effort focus on organizational support and fostering a conducive environment. We will pursue improved foundational capabilities, structures, security classification guidance, and processes in order to enable more effective space operations and will foster a conducive environment both at home and abroad. Domestically, this includes streamlining the regulatory environment to leverage and support U.S. industry more effectively, taking into account national security and public safety. Internationally, this includes promoting burden-sharing and marshalling cooperation against threatening adversary actions.

The United States does not fight alone. Cooperation and partnership in the space domain are essential, just as cooperation and partnership benefit our military on land and sea and in the air and in cyberspace. Our defense strategy depends on sustaining and building international alliances and partnerships. The work in this area is critical to advance our common and shared strategic and operational interests of deterrence and lethality. U.S. allies and partners provide an asymmetrical advantage that no competitor can match. We are developing partnerships with the aim to develop and deploy more capable, more assured space architectures and, where appropriate and mutually beneficial, develop a combined operational capacity.

For several years we have had a Combined Space Operations (CSpO) initiative including the United States, United Kingdom, Canada, Australia, and New Zealand. CSpO is identifying operational and programmatic cooperation opportunities, as well as common approaches to understanding and addressing threats in space. Last month we invited France and Germany to join this initiative. In 2018, our annual Schriever Wargame, examining conflict extending to space ten years into the future included robust participation from all the CSpO partners, plus France, Germany and Japan. As a result of wargames such as Schriever, our allies have come to understand the real and significant threats to their space infrastructure and are galvanized along with the U.S. to ensure our collective freedom of action in space.

We will leverage past successes and achieve new ones, such as cost-sharing agreements, hosting U.S. national security payloads on foreign systems, and data-sharing arrangements to bolster shared space situational awareness. The Department of Defense, working with the Department of State, strengthens our leadership and international relationship through participation in international governing bodies and with multilateral and bilateral arrangements.

To achieve these strategic objectives and secure our vital interest of unfettered access to and freedom to operate in space, the Department must fundamentally transform its approach to space from a support function to a warfighting domain—one in which we are prepared for a domain of competition and potential conflict. Space superiority is something to be gained and maintained, and cannot be taken for granted in future crisis or conflict.

Posture and Organization

The President's \$14 billion budget request for space in fiscal year 2020, outlined in Major Force Program-12, puts the Department on a course to build a more lethal force. It advances the lines of effort captured in the *National Strategy for Space* and integrates space into a multi-domain approach designed to deter potential adversaries and defeat hostile activity should deterrence fail. This request, sustains our on-going space operations and support to the joint force while developing and fielding critical capabilities.

The current organization of space within the DOD has enabled the United States to maintain its position as the most lethal force in the world. These structures, however, must evolve with the changing environment. No branch of the Armed Forces has been created since the U.S. Air Force was established in 1947—over 70 years ago. The world has changed significantly in that time. If authorized by Congress, a new Armed Force dedicated to space will develop space forces prepared to meet emerging security challenges.

The trends and threats we face demand a new approach in order to outpace potential adversaries. This requires an approach that that DOD institutionally elevate space consistent with its role in national security; unify, consolidate, and integrate space forces from across the DOD; increase focus in leadership, expertise, personnel, culture, and capabilities for a distinct domain; accelerate our posture to space as a warfighting domain; and deliver dominant warfighting capacity for space while minimizing bureaucracy and cost.

Space Policy Directive 4 was signed by the President in February 2019, and outlines the policy approach to establishment of the U.S. Space Force. Under the proposal, the U.S. Space Force (USSF) and the U.S. Air Force (USAF) would exist with-

in one Military Department while organizing, training, and equipping their forces for two distinct warfighting domains and mission sets. The Secretary of the Air Force would be responsible for organizing, training, and equipping two separate Military Services: the USSF and USAF, each with a uniformed Military Service Chief with equal membership on the Joint Chiefs of Staff (JCS). This model is similar to how the U.S. Navy and U.S. Marine Corps exist within the Department of the Navy. Additionally, a new Under Secretary of the Air Force for Space, to be known as the Under Secretary for Space, will provide dedicated civilian supervision of the USSF, under the authority, direction, and control of the Secretary of the Air Force.

The vast majority of initial Space Force resources—personnel and budget authority—would be transferred from the existing Military Services. The stand-up of the Space Force would be phased over five years—fiscal year 2020 to fiscal year 2024—and would require \$72 million in fiscal year 2020 to establish the headquarters with approximately 200 people.

Over the following years, as missions are transferred to the Space Force, existing personnel and budget authority will transfer into the Space Force from the existing Military Services. By the end of the transition period, more than 95 percent of the Space Force annual budget is estimated to consist of resources that will have been transferred from existing DOD budget accounts, along with an estimated 15,000 transferred personnel. Additional resources will be dedicated to building out the Space Force headquarters and establishing and maintaining new support elements such as education, training, doctrine, and personnel management centers.

Once the Space Force is fully established, these additive costs are estimated to be \$500 million annually, which would represent approximately 0.07 percent of the annual DOD budget. The total additional cost growth over the next five years is estimated to be less than \$2 billion, or approximately 0.05 percent of the DOD budget for the same period. Because of the lean implementation and modest total costs, the Future Years Defense Program topline is sufficient to fully fund the U.S. Space Force.

Complementing a Military Service focused on developing space forces, is a space warfighting command focused on employing the joint force. Consistent with U.S. law, DOD is taking steps to establish a United States Space Command (USSPACECOM) as a unified combatant command focused on planning and executing space warfighting operations to protect U.S. national interests, and those of our allies and partners. Establishing USSPACECOM will bring full-time operational focus to securing the space domain, and will streamline command and control for time-sensitive operations.

Additionally, the DOD has undertaken a series of space acquisition reforms to ensure the joint forces has the capabilities necessary to deter and defeat threats. This includes the Space and Missile Systems Center (SMC), “SMC 2.0” initiatives, which have begun to remove bureaucracy and empower new program executive officers to acquire space capabilities more efficiently and effectively. Rapid acquisition prototyping authorities have been aggressively leveraged with the Space Rapid Capabilities Office, which initiated several new programs in the past year. These acquisition reforms will continue with the establishment of a joint Space Development Agency dedicated to rapidly developing, acquiring, and fielding next-generation military space capabilities. This organization will have a development mindset and will be focused on experimentation, prototyping, and accelerating fielding, as well as leveraging commercial technologies and services. These entities will transition to the Space Force, if authorized by Congress, to strengthen the foundation for space acquisition.

CONCLUSION

Space is a warfighting domain—albeit a nascent and evolving one. It is no longer a question of whether the character of warfare is changing, but rather how the United States should strategically re-orient itself to deter aggression and be prepared to fight and win future wars.

The Department has a plan to maintain U.S. leadership in this key domain of competition and potential warfare. The Department asks for your support, including our legislative proposal, so we can move out in this critical domain.

The Department's partnership with Congress is and will remain absolutely critical to our success. To that end, I remain grateful for this committee's strong support and interest in this vital area, and its advocacy to deter aggression and ensure a lethal and effective force with the unmatched ability to prevail in, from, and through the ultimate high ground.

Senator FISCHER. Thank you, Mr. Secretary.

General "JT" Thompson, welcome.

**STATEMENT OF LIEUTENANT GENERAL JOHN F. THOMPSON,
USAF, COMMANDER, SPACE AND MISSILE SYSTEMS CENTER,
AIR FORCE SPACE COMMAND**

Lieutenant General John THOMPSON. Thank you, ma'am.

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Committee, I am Lieutenant General "JT" Thompson, and I am honored to appear before you today in my capacity as the Commander of Air Force Space and Missile Systems Center and the Air Force Program Executive Officer for Space.

First of all, I'd like to apologize to you on behalf of the United States Air Force. Today, we provided two witnesses for the same hearing, both named Thompson, both lieutenant generals in leadership positions within Air Force Space Command. Since my primary duty location is Los Angeles Air Force Base in Los Angeles, California, and my fellow witness, Lieutenant General "DT" Thompson's duty location is here in the national capital region, feel free to refer to me as "West Coast Thompson" and "DT" as "East Coast Thompson." That's exactly what leadership does in the Pentagon.

At SMC, I am honored to lead the 6,000 dedicated men and women, military, government civilians, and contractors, who collectively have over 100,000 years of national security space acquisition experience. The SMC workforce is dedicated to providing premier national security space assets to support joint and allied forces for our Nation.

While America is absolutely the best in space, our adversaries have recognized the extent to which our space capabilities provide a strategic advantage, and are working to deny the use of our capabilities with asymmetric advantages of their own. The space acquisition enterprise must adapt to deliver capabilities to outpace the threat. In order to meet the objectives of the National Defense Strategy, the Air Force is prioritizing investments in resilience, reconstitution, and operations.

The Air Force space enterprise has greatly benefited from acquisition reforms instituted by the Congress. However, in order to truly address the threat, we must go farther. Recognizing the pace of space acquisitions was too slow, making it difficult to respond to the latest threats, we are changing the way we do business to get capability from the lab to the warfighter faster and smarter.

Specifically, to speed up the pace of acquisitions, we're utilizing alternative congressionally approved acquisition approaches, like other transaction authorities and rapid prototyping, which were granted under section 804 of the Fiscal Year 2016 National Defense Authorization Act (NDAA).

SMC is also benefiting from the delegation of authority for some major defense acquisition programs down to the service acquisition level. With the help of Congress, the Air Force stood up the Space Rapid Capabilities Office, or Space RCO, which will continue to work in close concert with SMC to rapidly develop and acquire critical capabilities. Further, I delegated acquisition authorities for acquisition category-3 programs down to the executive level within SMC simply to speed decisionmaking. And finally, with the support of the Secretary of the Air Force and the Acting Secretary of De-

fense, SMC is undergoing a full transformation on how we operate, known as SMC 2.0.

Although we have a strong history with partnerships with numerous DOD and intelligence community space activities, including the National Reconnaissance Office (NRO), Air Force Research Lab, the National Aeronautics and Space Administration (NASA), and the National Oceanographic and Atmospheric Administration (NOAA), under SMC 2.0, one of our principal tenets is to grow even greater partnerships with our allies, our sister civil and intelligence agencies, and commercial industry to speed up the pace of acquisition and our Nation's legacy as the dominant space power.

I am grateful for the support of this committee and the Congress as we transition our space assets to meet and outpace the threat posed by near-peer adversaries.

Thank you for the opportunity to discuss and defend the vital programs that SMC acquires to enable warfighting capabilities across the globe. I look forward to your questions.

Thank you.

[The prepared statement of General "JT" Thompson follows:]

PREPARED STATEMENT BY LIEUTENANT GENERAL JOHN F. THOMPSON

INTRODUCTION

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Committee, I'm honored to appear before this committee in my capacity as Commander of the Air Force Space and Missile Systems Center (SMC) and the Air Force Program Executive Officer (PEO) for Space. As the SMC Commander and PEO for Space, I have the unique position of providing both organize, train, and equip functions to the Air Force Space Command (AFSFC) Commander and acquisition experience and oversight to the Assistant Secretary of the Air Force (Acquisition, Technology & Logistics), Dr. Will Roper. In order to carry out these unique responsibilities, I am privileged to lead and represent 6,000 dedicated men and women of SMC, who have over 100,000 years of National Security Space Acquisition experience and excellence. The SMC workforce is dedicated to providing premier National Security Space assets to support Joint and Allied forces and our Nation.

To echo Lieutenant General David Thompson's statements, our space forces must operate in an increasingly competitive environment. I have served as a PEO or Deputy PEO in four previous assignments including Intelligence, Surveillance, and Reconnaissance, Strategic Systems, Joint Strike Fighter, and Tanker. In each of those mission areas, I had the luxury of building on America's significant asymmetric advantage over our adversaries. This is not the case in my current role. While America is absolutely the best in space, our adversaries have recognized the extent to which our space capabilities provide a strategic advantage and are working to deny the use of our capabilities with asymmetric advantages of their own; the space acquisition enterprise must adapt to deliver capabilities to outpace the threat. In order to meet the objectives of the National Defense Strategy, the Air Force is prioritizing investments in resilience, reconstitution, and operations. Thanks to the support of Congress, the Air Force space enterprise has experienced an unprecedented year following significant changes proposed by the Air Force in the fiscal year 2019 budget. The Fiscal Year 2020 President's Budget request will expand upon the foundations laid in the previous year with nearly \$14 billion in proposed investment in the space portfolio (including procurement, research and development, personnel, and sustainment funding). This budget request supports our warfighting approach to the space domain and changes to how we prototype and field innovative space technologies in order to stay ahead of our competitors.

A 2016 Government Accountability Office report released titled, *"Defense Space Acquisitions: Too Early to Determine If Recent Changes Will Resolve Persistent Fragmentation and Oversight,"* authored by my fellow witness, Ms. Christina Chaplain, highlighted the following: "fragmentation and overlap in Department of Defense (DOD) space acquisition management and oversight contributed to program delays and cancellations, cost increase, and inefficient operations." Over the past few National Defense Authorization Acts, Congress enabled the De-

partment to leverage new authorities in order to procure weapons systems faster and smarter. The Air Force, and the space enterprise as a whole, has embraced many of these authorities, such as rapid prototyping and delegation of Milestone Decision Authority from the Defense Acquisition Executive to the Service level. The Air Force space enterprise has benefited from those acquisition reforms instituted by Congress; however, in order to truly address the threat, we must go farther. Recognizing the pace of space acquisitions was too slow and often unable to respond to the latest threats, we are changing the way we do business to get capability from the lab to the warfighter faster and smarter.

ACQUIRING THE NATION'S SPACE CAPABILITIES FASTER AND SMARTER

In my capacity as the SMC Commander and the Air Force PEO for Space, I directed several changes within the organization to shorten decision timelines and radically change the often old-fashioned ways in which we acquired space capabilities. One of my first acts upon assuming command of SMC in May 2017, was to delegate acquisition authorities for Acquisition Category (ACAT) III programs down to the execution level. This is similar to the benefits SMC had from the delegation of authority over acquisition programs down to the Service Acquisition Executive for some of our Major Defense Acquisition Programs. Additionally, we are utilizing alternative acquisition approaches like Other Transaction Authorities and those granted under section 804 of the National Defense Authorization Act for Fiscal Year 2016 for rapid prototyping. With the help of Congress, the Air Force stood up the Space Rapid Capabilities Office (SpRCO), which much like the Air Force Rapid Capabilities Office, will acquire critical capabilities by utilizing unique approaches and oversight structures. Finally, with the support of the Secretary of the Air Force and Acting Secretary of Defense, SMC is undergoing a full transformation of how we operate, known as SMC 2.0.

Delegating Acquisition Authorities

SMC executes approximately 36 unclassified ACAT I–III level and 6 rapid prototyping programs, which represents over \$7 billion in Research, Development, Test & Evaluation and Procurement funding each fiscal year. Upon taking command, I delegated authority for 19 ACAT III and Services Category programs under \$100 million, accounting for 37 percent of the total PEO for Space portfolio, to SMC System Program Directors. Those Program Directors are fully qualified acquisition professionals, averaging 20 years of experience each; the programs in their portfolios represent critical capabilities like the Ground Based Optical Sensor System (GBOSS), a vital space situational awareness capability. GBOSS provides global search, tracking of non-cooperative launches, and discrimination between closely spaced objects. With this delegation, System Program Directors and their teams are now responsible for all facets of program execution, from milestone decisions to source selection and beyond. This delegation and other process improvement initiatives resulted in a reduction of acquisition timelines by 65 percent from the first acquisition event to contract award in fiscal year 2016 through fiscal year 2018. By reducing the amount of time it takes a program manager to reach a decision maker, SMC is not only saving time and taxpayer money, but also empowering the next generation of acquisition professionals.

For SMC's larger programs, we have seen similar impacts from delegation of Milestone Decision Authority for Major Defense Acquisition Programs (MDAPs) from the DOD level to the Air Force level, allowing faster access to the decision maker. In 2017, the Under Secretary of Defense for Acquisition and Sustainment delegated authority for seven of nine major national security space programs to the Air Force. The Air Force is projected to accelerate the delivery of warfighting capabilities for these seven programs by an average of 24 months. One example of significant time saved is with the Global Positioning System III Follow-On Production Program (GPS IIIF). With GPS IIIF, the Air Force will introduce increased resiliency in the form of the Regional Military Protection capability to ensure the warfighter has a protected Position, Navigation, and Timing signal when and where they need it most. Additionally, the GPS IIIF program will use planned technology insertions throughout its development and production phases to ensure a long-term, viable constellation, able to bring forth new capabilities faster. The Air Force awarded the GPS IIIF contract in September 2018 after a full and open competition, saving approximately \$1.6 billion over the life of the contract while taking advantage of delegated authority to reduce decision times by six months over a traditional DOD-level acquisition program.

Alternative Acquisition Approaches

Section 804 of the National Defense Authorization Act for Fiscal Year 2016 authorizes Middle Tier Acquisitions to rapidly develop operational prototypes and field production quantities of new or upgraded systems with minimal development required within five years. So far, six programs executed by SMC have been designated as 804 programs to tailor documentation and reviews within the Department, flatten access to decision authorities, and in some cases, deploy novel approaches to program execution, yielding several years in time saved over a traditional DOD acquisition. An example of one of our 804 programs is the Evolved Strategic Satellite Communications system (ESS). ESS is our next-generation protected, strategic satellite communications system, which will provide the President and other national leaders with protected, anti-jam communications capabilities through all levels of conflict, to include the nuclear environment. The program approach for ESS focuses on maturing the payload to meet new requirements and strategic scenarios by creating competition, driving innovation, and increasing affordability. The Air Force plans to deliver this next-generation, resilient, Nuclear Command, Control and Communications (NC3) capability with an estimated time savings of at least two years.

SMC is also executing five other 804 programs in the Overhead Persistent Infrared (OPIR), Protected Satellite Communications, and Position, Navigation, and Timing mission areas with over 16 years in projected time savings for fielding new capability over traditional acquisition methods. As we continue to recapitalize systems across the space enterprise in order to make them more resilient and responsive to the current threat environment, the Air Force will request 804 designations for more programs, when practicable, to deliver capability to the warfighter faster and smarter. It is also important the Air Force maintains transparency and oversight with DOD and congressional stakeholders, which is achieved through tri-annual reports delivered by the Secretary to both entities.

Space Rapid Capabilities Office

In the National Defense Authorization Act for Fiscal Year 2007, Congress created the Operationally Responsive Space Office (ORS), chartered to respond to U.S. Strategic Command-validated urgent needs and develop enabler technology. As Lieutenant General David Thompson stated, the National Defense Authorization Act for Fiscal Year 2018, renamed ORS as the Space Rapid Capabilities Office. Although the SpRCO is not an organization for which I have oversight, it remains an important mission partner and collaboration between SMC and the SpRCO is vital for providing the best possible capabilities to the warfighter as an integrated space architecture. In collaboration with General Raymond and AFSPC, my team supported the stand up and definition of the organization, which is now undoubtedly poised to meet the Committee's expectations.

Other Transaction Authorities

Other Transaction Authority agreements, generally referred to as OTAs, are another non-traditional acquisition authority, which allows the Air Force to acquire and field more resilient, responsive, and agile space capabilities. The Air Force utilized OTAs in our efforts to transition off the Atlas V, with the Russian-built RD-180 rocket propulsion system, to domestically sourced launch capabilities leveraging the innovation of the United States' robust launch industry. In 2016, the Air Force awarded four OTAs under the Rocket Propulsion Systems effort to re-invigorate the domestic rocket propulsion industrial base and mitigate risk for future launch vehicles. In 2018, the Air Force awarded three OTAs under the Launch Service Agreements effort to develop at least two domestic, commercially viable launch systems to provide Assured Access to Space. These public-private partnerships ensure emerging, innovative commercial launch systems meet all National Security Space Launch requirements.

The Space Enterprise Consortium (SpEC OTA) was awarded in November 2017 to provide a forum for rapid development of next generation space-related prototypes to achieve the Air Force's vision of a more capable, resilient, and affordable enterprise. The objectives of the SpEC are: minimize barriers to entry for small business and non-traditional vendors to do business with the Air Force and U.S. Government; identify and realize teaming opportunities among entities to promote integrated research and prototyping efficiencies; and reduce the cost of prototype development under a competitive environment. SpEC is popular with SMC industry partners and new companies join the consortium frequently. As of early March 2019, the SpEC is comprised of approximately 264 companies, 81 percent of which are considered non-traditional defense contractors. SMC has awarded 37 SpEC OTA prototyping efforts exceeding \$207 million in total value. The timeline for a solicita-

tion-to-award averages 90 days, with some variation based on the complexity of the effort, or approximately half the time of a traditional solicitation. Mission partners like the Missile Defense Agency (MDA) and the Air Force Research Laboratory (AFRL) have also utilized SpEC. Through the SpEC OTA, MDA was able to award nine prototype projects for its Missile Defense Tracking System Phase 1 effort in April 2018. To date, the SpEC OTA has been utilized for prototypes across the space enterprise to satisfy critical warfighter requirements for everything from missile warning to protected satellite communications to position, navigation and timing.

RE-ARCHITECTING THE AIR FORCE SPACE ACQUISITION ENTERPRISE: SMC 2.0

The efforts to push decisions down to the lowest practicable levels and utilize innovative acquisition strategies have resulted in years of time saved and faster delivery of capabilities. However, to truly effect change, we must move fast to stay competitive and we must fundamentally transform what we buy, how we buy it, and who we buy it from. Under SMC 2.0 we are re-architecting SMC to manage as an enterprise by optimizing resource allocation, enhancing collaboration, accelerating decision making and developing a more innovative workforce. SMC 2.0 represents a total shift in the way SMC does business, focusing on the principles of an *enterprise-wide* approach, fostering *partnerships* with Allies, commercial companies, and other federal agencies, *innovation* in both how the Air Force does business and how technology is developed, a *culture* change to move away from bureaucracy and empower innovative ideas, all to enable *speed*. Together, these principles form the core of our message for SMC 2.0—to promote *EPIC Speed*. I declared Initial Operating Capability of SMC 2.0 on 15 October 2018, with the goal of achieving Full Operational Capability by the end of 2019.

The New SMC 2.0 Organization

SMC 2.0 encourages us to operate more as an integrated enterprise. Under the previous organizational construct, space capabilities were developed in separate mission area directorates; there was a directorate focused on providing military satellite communications, GPS capabilities, remote sensing, etc. This construct resulted in stove-piped organizations within SMC with limited cross-flow of ideas and innovation. In order to increase the flow of information and remove layers of bureaucracy, SMC is transitioning from a mission area-specific directorate structure to a Corps structure based upon where a program is in the acquisition process. With SMC 2.0, SMC will be divided into four main Corps: Development, Production, Enterprise, and Atlas along with a Portfolio Architect to integrate across programs, combat stove-piped development, and deliver resilient capabilities faster.

The Development Corps will focus on technology maturation and prototyping critical capabilities for the next generation of systems. Once a technology is matured, the capability will be transitioned to the Production Corps where the focus is on efficient delivery, capitalizing on cross-cutting opportunities, like standardized space vehicles and components. The Enterprise Corps will provide common services, such as space launch activities, and management of sustainment activities. The Atlas Corps provides the Center's critical business functions, such as contracting, manpower, and financial management, to facilitate the acquisition of the systems developed and produced by the other Corps. In order to flatten the organization and accelerate the pace of decision making, the Air Force has distributed the space portfolio of programs and delegated PEO authority to three new PEOs to increase the number of decision makers and link each program manager directly to their PEO. These fully qualified PEOs have acquisition authority over the programs within the Development, Production, and Enterprise Corps. The crosscutting nature of this framework reduces duplication, identifies commonalities among missions, and drives enterprise integration leading to higher resiliency across many platforms and systems.

The SMC Portfolio Architect drives the space enterprise strategy and framework to inform and prioritize what SMC acquires. The SMC Portfolio Architect works closely with the Air Force Space Command Enterprise Architect, ensuring space operators and space acquirers remain in lock step to provide the most resilient and agile capabilities for the warfighter.

Strengthening Partnerships

SMC is working with Allies, sister agencies, and industry to satisfy warfighting capability gaps quicker and cheaper while developing a more robust coalition space enterprise. This year SMC will establish agreements in Europe, the Pacific, and at home to expand our space capabilities via technology development and demonstration as well as development of operational capability by leveraging friendships and resources across the globe. I recently returned from a multi-nation trip, which in-

cluded stops in Japan and Australia, to reinforce and grow our alliances and partnerships with the international community.

The Chief Partnership Office, within the Portfolio Architect team, is tasked with growing partnerships between SMC and related agencies, Allies, and industry. As mentioned in Lieutenant General David Thompson's testimony, our highest profile mission partnership is the collaborative effort with the National Reconnaissance Office known as Silentbarker. Silentbarker will provide the primary layer of critical space-based space situational awareness to the warfighter. The system will rapidly detect, identify, track, and collect data on resident space objects in deep-space orbits on the short timelines required to conduct indications and warning of threats against U.S. high-value assets. The Air Force contributes to this effort through the Space-Based Space Surveillance Follow-On program. By pursuing this collaborative effort with a key mission partner, the Air Force estimates there will be approximately \$400 million in overall cost avoidance over a traditional acquisition.

The Air Force is also working to expand its relationships with key Allies in order to strengthen existing alliances and grow partnerships with new nations. For example, the Air Force is partnering with Space Norway on a hosted payload solution for a protected satellite communications capability in the North Polar Region known as the Enhanced Polar System-Recapitalization (EPS-R). EPS-R provides assured, anti-jam, and low-probability-of-detection and intercept satellite communications for tactical users north of 65 degrees latitude. This capability provides a 26-fold increase in capacity over the legacy, Interim Polar System through our partnership with Space Norway. The Air Force is projected to close a two year capability gap to provide critical warfighter support sooner than a traditional acquisition of a free-flyer satellite and save significant costs through partnering.

In addition to forging stronger ties with our international and mission partners, SMC is working to strengthen our partnerships with both aerospace and innovative technology industries. Throughout the SMC 2.0 transformation, we have held industry days and panels to solicit feedback from our defense industry partners. Additionally, we are working with our partners in the private sector to employ commercial best practices for how we acquire space systems and open the door for non-traditional defense companies and universities. The Air Force's Responsive Environmental Assessment Commercially Hosted (REACH) program is a space weather and space situational awareness project demonstrating the viability and effectiveness of a commercially hosted, disaggregated space situational awareness architecture. REACH payload sensors provide an unprecedented amount of space weather measurements for more rapid satellite anomaly attribution. Earlier this year, the REACH program successfully completed its eighth and final launch. A total of 32 REACH payloads were launched into orbit in under 24 months. The successful launch of these payloads and the critical data they provide are a key example of SMC 2.0 in action, finding innovative ways to partner with industry to rapidly field new capabilities while reducing cost and schedule.

Fostering Innovation

As the space domain transitions from an uncontested environment to one which is more unpredictable, complex, and competitive, it is important to collapse traditional lengthy requirements, development, testing and fielding processes. Today, SMC must shift to a construct prioritizing flexibility and speed, to enable effective adaptation to rapidly evolving technologies and unpredictable competitors. The partnership pilot program between SMC Mission Innovation, the AFRL Space Vehicles Directorate, and the 14th Air Force Combat Development Division (CDD) shows how our acquisition community is not only capitalizing on commercial development, but becoming the premier Multi-domain Enterprise Global Node. Our collaboration efforts pivot to support this rapidly evolving technological landscape while finding non-traditional methods to provide lethal and practical tools to better support the warfighter. The efforts of this combined team is narrowing the gap between operator and engineer, addressing operator-driven pain points and developing a solution in a faster, more streamlined manner.

A good example of this partnership, was the 460th Space Wing's Combat Development Division AFWERX accelerator activity. A recent pilot program activity was able to produce prototypes for space operator visualization known as Space Cockpit and a defensive cyber operations tool, going from concept to prototype in only three months. Not only was turnaround quick, but operators were immediately able to demonstrate the product and provide feedback and corrective actions earlier in the product's life cycle than ever before. SMC is trailblazing this new style of space acquisitions in concert with the Combat Development Division through our Space Commercially Augmented Mission Platform (CAMP) and Enterprise Space Battle Management Command & Control (ESBMC2) efforts, which are already pulling

third party developers “off the street” to deliver new products specifically requested by operators. These tactics are the exact type of innovation and collaboration we are striving to implement across the Air Force.

To provide timely ESBMC2 capabilities to the warfighter, the Air Force has transitioned the effort and the remainder of the legacy Joint Space Operations Center (JSpOC) Mission System (JMS) into a new development effort known as Space Command and Control (C2). The Space C2 effort takes the lessons learned from previous software development programs and institutes a more iterative and operator-focused approach. Instead of building software and writing code for multiple years that could result in an end product which does not meet evolving mission requirements, the Space C2 initiative is centered on 90-day Program Increment cycles. The Program Increment offers a predictable and timely delivery to users as well as an opportunity to receive direct feedback from the operators to immediately correct user issues. A Retrospective and Planning document is generated at the conclusion of an increment. This codifies the progress made during the previous Program Increment, the expected end-state of the entering Program Increment, money spent to date, and the return on investment, as well as other successes or issues to be addressed. ESBMC2 follows this 90-day Program Increment cadence to develop, integrate, and deliver capabilities, operating on four 3-week sprints per increment, enabling ESBMC2 to continuously deliver capabilities. The first Program Increment was delivered to and accepted by the warfighter at the end of January 2019.

The AFWERX accelerator activity is just one point in which SMC and AFSPC are achieving greater collaboration between the operators who use the capabilities and the acquirers. In concert with Space Cadre development efforts spearheaded by General Raymond, SMC is working to ensure we have space operators in our acquisition program offices. AFSPC and SMC are working to ensure we have a crossflow of officers between the acquisition and the space operations career fields. Right now SMC has approximately 100 acquirers with space operations experience across the Center, with plans to double that number. I believe this crossflow develops better acquisition officers who can fully understand the operational domain of the warfighting customer.

SMC 2.0 Pacesetter Programs

It is important to remember the Air Force is working to not only acquire capability faster, but also smarter. As part of the SMC 2.0 approach, nine “pacesetter” programs have been designated to validate rapid acquisition strategies outlined above and provide a model for future acquisitions to follow. These pacesetter programs serve as both a means to pave the way for alternative acquisition approaches and as a litmus test to ensure the changes implemented under SMC 2.0 are viable and can be applied to a broad range of missions. Under the Portfolio Architect, there are two pacesetter initiatives, international partnerships and a prototype project for disaggregated architectures. The SMC pacesetter effort, known as CASINO, will expand the efforts of the Defense Advanced Research Projects Agency project known as Blackjack, to increase resilience by disaggregating various mission capabilities using large, Low Earth Orbit constellations.

The Development Corps’ key pacesetter programs are two section 804 programs, the Next Generation OPIR program to replace the legacy Space Based Infrared System (SBIRS) and the Protected Tactical Satellite Communications (PTS) program to replace the tactical capabilities of the existing Advanced Extremely High Frequency and MILSTAR constellations. The PTS program will be a constellation of distributed, hosted payloads and free-flying satellites which provide increased anti-jam performance to tactical users currently using wideband communications satellites. The program received section 804 designation from Dr. Roper in November 2018, and was directed to develop two hostable payloads to be launched in fiscal year 2024. The payloads will leverage the government-owned, fully processed Protected Tactical Waveform to provide anti-jam, protected tactical satellite communications to joint warfighters in anti-access/area denial environments. By utilizing the previously mentioned SpEC OTA in addition to section 804 authorities, the Air Force will deliver critical, tactical satellite communications capabilities to the warfighter three years sooner than a traditional DOD 5000 series acquisition.

The Production Corps’ key pacesetter efforts consist of a pilot for satellite commonality for spacecraft in order to drive affordability across SMC programs, and the commercial procurement of the Wideband Global Satellite Communications System through innovative business practices. Our commonality effort is driving efficiencies across three of our major programs: AEHF, SBIRS, and GPS. For example, we are establishing common standards for parts qualification, system testing and review processes. In the Consolidated Appropriations Act, 2018, Congress appropriated \$600 million for two additional space vehicles for the Air Force’s wideband commu-

nications system, known as WGS. The Air Force is working with the WGS prime contractor to acquire the congressionally-directed spacecraft. The Air Force will leverage commercial best practices to accelerate spacecraft delivery.

Under the Enterprise Corps, SMC is working to institute enterprise-wide Defensive Cyber Operations, procure the Enterprise Ground Services program using agile development and rapid fielding of a common satellite C2 infrastructure, and has created a multi-mission manifesting office to provide flexible access to space for all types of payloads and satellites. SMC created the Mission Manifest Office to enable rapid, resilient and responsive launch capabilities to meet National Security Space objectives. As the front door for operational launch, the Mission Manifest Office analyzes current and planned National Security Space launches to determine potential multi-manifest missions. As a result, the Air Force maximizes on-orbit capability, ensures little excess space for each launch mission and lowers cost to the DOD by reducing overall launch service procurements. The Mission Manifest Office identifies DOD, Civil, and Intelligence Community launch opportunities to enable and execute these multi-manifest mission designs. As one of the SMC 2.0 pacesetters, the Mission Manifest Office will be integrating National Security Space payloads on the National Aeronautics and Space Administration (NASA) Landsat-9 launch mission in fiscal year 2021, setting a valuable Interagency Agreement and collaboration for many years to come.

The way ahead set by these pacesetter efforts is already paying off. Nine additional space programs have used the techniques proven by the pacesetters to save an additional 19 years in acquisition time from their original schedules. SMC is making great strides in achieving *EPIC Speed* in areas outside the pacesetters previously outlined. Our Space C2 program is breaking government software development paradigms by working with the DOD to create a new acquisition program type and more effectively acquire agile software systems. Just last month, the program office established a new development-to-operations (DevOps) environment located in a commercial business space. The new environment encourages partnerships with a variety of software vendors for extreme programming agile software development.

None of the efforts to speed up the pace of space acquisition would be possible without the men and women who make up the workforce of SMC. To ensure our workforce understands the current space operating environment, I directed all military and civilian employees of the Center, to receive a threat brief at each employee's appropriate security clearance level. We will continue that initiative this year, and invite our contractor employees to participate. As a step towards institutionalizing the change in culture, and the other *EPIC Speed* tenets from the ground up, SMC launched an innovative effort to inspire, energize, and uniquely develop our junior acquisition corps. In the coming months, we will take a dramatic step forward in ensuring our civilian workforce is poised to execute the tenets of SMC 2.0. Furthermore, as we continue to work towards achieving Full Operational Capability for SMC 2.0, later this year, we will continue to adjust course to meet the threat.

THE WAY AHEAD

Since taking command in May 2017, SMC has undergone rapid and significant change, and we are making progress in speeding up the pace of the acquisition of the Nation's vital space capabilities. Although a lot of progress has been made, the men and women of SMC understand that despite a history of remarkable achievement, we must get even faster and smarter about how we deliver space warfighting capability; and we must continue to invoke the principles of *EPIC Speed* to meet and outpace the adversary threat. None of the changes implemented under the SMC 2.0 construct would be possible without the support of our Air Force Space Command team and the support of senior leaders within the Air Force, the DOD, and the Administration. Most importantly, none of these changes would be possible without the continued support of Congress. We are using the new authorities given to us by Congress to ensure we transparently acquire the premier space capabilities to enable space operators. The Fiscal Year 2020 President's Budget builds off considerable gains the space investment portfolio has seen in recent years with a proposed 17 percent increase over fiscal year 2019. This request supports SMC's re-architecture and the key missions of the National Defense Strategy while also supporting the drive towards the Air Force We Need.

Finally, I thank the Committee for its continued leadership, oversight, and support of the men and women of SMC and the national security space enterprise.

Senator FISCHER. Thank you, General.

Next we have General "DT" Thompson. And I believe you are referred to now as "East Coast." But, General, welcome.

**STATEMENT OF LIEUTENANT GENERAL DAVID D. THOMPSON,
USAF, VICE COMMANDER, AIR FORCE SPACE COMMAND**

Lieutenant General David THOMPSON. Yes, ma'am, thank you.

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Committee, I'm honored to appear before you along with these distinguished colleagues today.

Today, I represent our commander, General "Jay" Raymond, the Commander of Air Force Space Command. I'm privileged to be one of the 26,000 men and women of that Command who serve under General Raymond's leadership. These men and women remain the best in the world at developing, fielding, operating, and sustaining vital space capabilities that serve our national leaders, our Joint Forces, allies, and partners, and the world, in general. The asymmetric advantage these capabilities provide ensure that our Armed Forces have no equal.

Today, there is unprecedented agreement among the Nation's leadership that space is a warfighting domain, just like air, land, sea, and cyberspace. The National Security Strategy and National Defense Strategy reflect this reality, emphasizing peace through strength while demanding that we maintain U.S. leadership and freedom of action in the space domain.

Accepting that potential adversaries have made space a warfighting domain, we are now dealing with the implications. We are driving tremendous change in order to sustain our leadership and that freedom to operate in space. With your strong support, we are making significant advances to ensure the national security space enterprise is prepared to play its role in military operations under all conditions.

The fiscal year 2020 budget builds on our efforts over the past 2 years, proposing a 17 percent increase in space funding over 2019, and a \$14 billion investment overall. With my posture statement on the record, I'd like to summarize a few of its key points:

First of all, we're increasing the lethality and readiness of our force as we continue to invest in and accelerate defendable space. Among that includes new, more defendable systems and architectures, the space domain awareness and command and control needed to operate in a contested domain, and an operational training infrastructure to develop space warfighters to the need. All of this enables us to sustain superiority in space so that we ensure we support joint warfighters operating in all domains around the globe.

Second, we are enhancing and expanding partnerships with the intelligence community, allies and partners, and industry. This includes joint programs with the National Reconnaissance Office, hosted payloads with several of our allies and partners, and operations, training, exercises, and wargames with allies that are building a coalition of like-minded nations.

Finally, we're capitalizing on innovative business practices, including the rearchitecting of Space and Missile Systems Center that "West Coast Thompson" mentioned and is leading, establishing a Space Rapid Capabilities Office, pursuing special practices and innovative agreements that drive those innovative activities across the broader commercial and industry base, and, finally, adopting open architectures and standards to strengthen integra-

tion in multidomain command and control and with the operations of the rest of the Joint Force.

Let me close by reiterating that we do not want war to extend to space. But, the best way to deter that from happening is to prepare to fight and win, should deterrence fail. With your support, that's exactly what we're doing.

Thank you again for the opportunity to testify. And I look forward to your questions.

[The prepared statement of Lieutenant General David Thompson follows:]

PREPARED STATEMENT BY LIEUTENANT GENERAL DAVID D. THOMPSON

INTRODUCTION

Chairman Fischer, Ranking Member Heinrich and distinguished Members of the Committee, I'm honored to appear before you today in my capacity as Vice Commander of Air Force Space Command (AFSPC). With General Jay Raymond in command, we have the distinct privilege to lead and represent the 26,200 dedicated men and women of AFSPC who underpin successful operations for our joint force and the Nation. In the past year we have seen tremendous change and progress in the National Security Space arena with the Nation's on-going efforts to address the reality that strategic competitors have made space a warfighting domain. Among these initiatives are the President's issuance of four Space Policy Directives, direction to establish a space-focused combatant command—U.S. Space Command, and the Department of Defense proposal for a new branch of the armed forces—the U.S. Space Force. We expect this next year will be equally full of progress across these and other National Security Space endeavors.

STRATEGIC SITUATION

Today, great power competition from a revisionist China and Russia continues to be the primary challenge to United States and global security. Both of these nations seek to challenge peace, stability and U.S. superiority in all domains: land, sea, air, cyberspace, and space. In the space domain in particular, these competitors are seeking to deny the U.S. and its Allies freedom of action, while also developing their own space capabilities to enable power projection and enhance military strength.

Fortunately, this comes at a time when our National Security Strategy, National Defense Strategy, national and military leadership, and Air Force Space Command plans, programs and operations are in unprecedented alignment. The National Security Strategy mandates we must maintain leadership and freedom of action in space, while advancing space as a priority domain. It also declares unfettered access and freedom to operate in space to be a vital interest. Our National Defense Strategy establishes five priority missions: (1) defend the Homeland, (2) provide a safe, secure, and effective nuclear deterrent, (3) defeat a powerful conventional enemy, while we (4) deter opportunistic aggression, and (5) disrupt violent extremists in a cost-effective manner. Our space capabilities play a vital role in each one of the missions, supporting our joint warfighters and our allies and partners around the globe. Our national and military leadership declare in unison that space is a warfighting domain, like land, sea, and air. Our goal remains to deter conflict from extending to space, and the best way we know how to do this is to be prepared to fight and win a conflict that extends to space should deterrence fail. My testimony will focus on how our activities are aligned with Department of Defense (DOD) priorities to build a more lethal force, strengthen alliances and attract new partners, and reform the Department's business practices.

BUILD A MORE LETHAL FORCE

We are increasing the combat readiness of Space Operators to increase joint warfighter lethality by investing to build multi-domain Airmen to fight and win as part of the Joint Force.

Developing our Warfighters

Foundational to building a more lethal force is the development of joint warfighters. The Air Force is transforming the way we develop our space combat tacticians and acquisition professionals, and laying the foundation for a trained, ready crew force. We have taken a number of actions to do so. For example, we di-

rected a significant increase in rigor and content in the initial training of our space operators, known as Undergraduate Space Training, to meet the demands of current and emerging challenges to national security space. This revised “UST Next” is on track to start on 1 October 2019 and includes an additional 34 training days to cover evolving space threats and U.S. responses in greater depth. We have also expanded our Operational Training Infrastructure to produce a more relevant training environment, which allows weapon systems and operators to interact in a highly dynamic, threat-representative, realistic manner, including aspects of multi-domain command and control. The Air Force has approved \$74.8 million in funding to advance our space training simulators along these lines.

Additionally, AFSPC and the Air Force Weapons School established an Enlisted Space Warfighter Advanced Instructor Course and have selected the first class of students. This new course, held at Nellis Air Force Base, will provide advanced academic and tactical training for enlisted space professionals, and is a stepping stone for incorporating our enlisted operators into the existing Air Force Weapons School.

Advanced Space Operations School Re-designated as the 319th Combat Training Squadron

Air Force Space Command re-designated the Advance Space Operations School as the 319th Combat Training Squadron (319 CTS) on 28 August 2018 in an effort to normalize the squadron with the Air Force’s 16 other combat training squadrons that have similar training missions. As a combat training squadron, this unit will prepare space professionals for real-world operations in an increasingly contested space domain through exercises such as Space Flag. The 319 CTS will provide training to tactical units with the purpose of developing critically-thinking operators who have mastered their weapon system to a degree such that they are able to fight through all levels of conflict.

Schriever Scholars

The Air Force is growing a cadre of strategic space leaders through the Schriever Scholars program at Air Command and Staff College. This new space concentration program for field grade officers consists of a demanding curriculum spanning space history, policy, strategy, and doctrine. The program also provides unique opportunities for engagement with senior DOD leadership and unprecedented access to top-level policymakers, including representatives at the White House, State Department, Department of Commerce, Department of Transportation, and NASA. This initial class of thirteen students graduate in June and will be prepared to ensure American advantage in the space domain for decades to come.

Space Flag

Space Flag is AFSPC’s premier in-domain space protection exercise. This year we have expanded this advanced training to three times a year, providing space operators the experience of planning and executing space operations in a contested, degraded, and operationally-limited environment against a thinking adversary. In August 2019, we plan to incorporate our coalition partners in Space Flag for the first time.

STRENGTHEN ALLIANCES AND ATTRACT NEW PARTNERS

AFSPC has made significant progress in expanding interagency, commercial, and international partnerships that enhance our position across the national security space portfolio. Recognizing that it is impossible to accomplish our mission alone, AFSPC is committed to identifying new partners and solidifying existing relationships as a core activity.

Joint Space Operations Center to Combined Space Operations Center

This year we have accelerated our efforts and increased our coalition footprint to conduct combined space operations. On 18 July 2018, the Joint Force Space Component Command (JFSCC) transitioned the Joint Space Operations Center (JSPOC) to a Combined Space Operations Center (CSpOC). The transition formalized our ongoing, decade-long effort to integrate Allied and partner nation personnel and capabilities into our space enterprise. We have also established persistent connectivity with partner space operations centers in Australia, Canada, and the United Kingdom, and together we are working to identify additional tools to improve information sharing between our respective centers. In late 2019, we plan on expanding more classified operations and planning efforts with our FVEY partners through the establishment of a Combined Technical Operations Cell (CTOC).

Schriever Wargame

AFSPC annually conducts the Schriever Wargame, a scenario-based wargame designed to explore critical space issues in depth, investigate military utility of new space systems, identify solutions to common challenges shared by all participants, and advance space doctrine to better align with and support air, land, sea, and cyberspace doctrine. This annual wargame also helps increase international cooperation and integration among space-faring allies. This year's wargame included our FVEY partners (Australia, Canada, New Zealand, and the United Kingdom) along with France, Germany, and, for the first time, Japan. The outcomes of the Schriever Wargame Series continue to inform future AFSPC requirements, examine organizational constructs, and provide a venue for advancing space operational concepts and procedures. For example, it was the first time the participants employed a combined command and control (C2) cell for Special Access Programs (SAP). As previously mentioned, it is through this effort that participants agreed to stand up the first ever CTOC, the real world SAP C2 cell at the CSpOC, by the end of this year.

As a related effort, the Multinational Space Collaboration (MSC) Office at Vandenberg Air Force Base provides the means for direct dialog with multiple international partners extending beyond combined space operations, supporting strategic engagement objectives via bilateral and multilateral collaboration. Eight countries were initially invited to participate: Australia, Canada, France, Germany, Italy, Japan, New Zealand, Republic of Korea, and the United Kingdom. The MSC office currently includes liaisons from three partner nations: France, Germany and the United Kingdom, and MOUs are pending with Italy, Japan and the Republic of Korea.

Allies in Training

In coordination with Air Education and Training Command, AFSPC is working to increase coalition participation in its space courses. This fiscal year, AFSPC will offer Space 100 (foundational level space) to a growing coalition audience including: Australia, Brazil, Canada, Chile, Colombia, France, Germany, India, Israel, Italy, Japan, NATO, New Zealand, Republic of Korea, Sweden, Thailand, and the United Kingdom. Space 200 (operational level space) is now open to New Zealand, and participation from the other FVEY partners has doubled with 20 allied personnel scheduled to attend this year. Space 200 will also open to France, Germany, and Japan with mobile classes available in 2019 and in-residence classes available in 2020. Finally, Space 300 (strategic level space) will have its first FVEY partner course in April 2019 with Australia, Canada, and United Kingdom personnel in attendance.

Hosted Payloads and Future Allied Partnerships

The Space and Missile Systems Center (SMC) is leveraging new business practices and methodologies to more rapidly field critical capabilities by placing hosted payloads on Allied satellites. Specifically, Norway will integrate Enhanced Polar System Recapitalization (EPS-R) payloads on two space vehicles and launch both satellites into a highly elliptical orbit in December 2022. EPS-R will provide protected communications for military tactical and strategic forces, as well as other users in support of Joint and Allied Force operations above 65 degrees north longitude.

Under the leadership of the Air Force Chief of Staff, we will host an international Air Chiefs Space Conference at the Space Symposium in Colorado this April. With 12 countries expected to participate, this inaugural event represents the first-ever global meeting of Air Chiefs to discuss partnering in the space domain. This demonstrates our commitment to pursue international relationships that promote common values and at the same time send a clear message to strategic competitors that cooperation between space-faring nations will complicate any pursuit of hostile action.

U.S. Government Partnering

Our partnering focus includes efforts within the United States government as well. Our teaming relationship with the National Reconnaissance Office (NRO) has never been stronger; we have worked together across a spectrum of projects, to include development of a strategy to protect and defend our space capabilities, shared Concepts of Operations (CONOPS) to realize that strategy, and partnerships on an enterprise space architecture and individual programs for mutual benefit. An example of the latter is our collaborative work on the space-based space surveillance effort called Silent Barker. While the Space-Based Space Surveillance Follow-On program remains under Air Force Service Acquisition Executive authority and control, it contributes funding and personnel to the NRO for executing Silent Barker. Silent Barker, with Air Force support, increases mission capability and is more cost-effective.

tive. The Air Force and the NRO will mutually invest in non-recurring engineering costs, enabling the potential for a larger initial constellation buy and lowering unit costs. The Air Force is requesting an increase in funding across the Future Years Defense Program for expanded coverage across the geosynchronous belt and updating mission data processing and scheduling for the ground segment to leverage the full capability of the National Space Defense Center (NSDC).

In accordance with the President's direction in Space Policy Directive 3, we are teaming with the Department of Commerce to transfer the responsibilities for space traffic management (STM) to that Department. Together we will strengthen STM for all, while improving space situational awareness (SSA) data interoperability and enabling greater SSA data sharing.

REFORM THE DEPARTMENT'S BUSINESS PRACTICES

AFSPC has embraced an atmosphere of profound change, bringing forth business reforms that govern how we procure critical space assets in concert with our industry partners. This represents a culture change that is more agile and less risk-averse. To achieve our goals we must be willing to break down bureaucracy and embrace smart risk in order to accelerate capabilities development to meet the threat.

COMSATCOM Procurement Authority Transfer

To comply with the 2018 National Defense Authorization Act, responsibilities for DOD procurement of commercial satellite communications (COMSATCOM) services transferred from the Defense Information Services Agency to AFSPC on 11 December 2018. Beginning on 20 December 2018, AFSPC started to bring together both government and industry partners to chart a way forward to both enhance satellite communications (SATCOM) provisioning and our ability to provide SATCOM in a contested environment. We are using this transfer as a mechanism to improve military and commercial SATCOM support across the board and the AFSPC team is finalizing the first of a series of concepts and strategy documents that will shape our SATCOM investments.

Space and Missile Systems Center 2.0

The Space and Missile Systems Center has embarked on a transformation to deliver resilient, war-winning space capabilities more quickly. SMC 2.0 removes layers of bureaucracy, linking program leadership directly to acquisition decision authorities in order to speed decision making. The strategic outcome of SMC 2.0 will be to dominate with superior lethality throughout the space domain, aggressively deliver warfighter needs from a resilient, integrated enterprise, and drive innovation in a way that outpaces adversarial threats.

Space Rapid Capabilities Office (SpRCO)

The SpRCO was created through the Fiscal Year 2018 National Defense Authorization Act (NDAA), with subsequent authorities defined in the fiscal year 2019 NDAA. The office is governed by a Board of Directors, chaired by the Secretary of the Air Force, and consists of the Air Force Chief of Staff, Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics, the AFSPC Commander, and USSTRATCOM/JFSCC Commander, with authorities and processes outlined in an approved charter. AFSPC continues to grow the SpRCO and make progress with AFSPC's ability to rapidly field space capabilities. The Board of Directors signed the governing charter on 1 November 2018 and USSTRATCOM validated five SpRCO programs through the JFSCC. The initiation of three out of the five programs was formalized by the Board of Directors on 31 January 2019. Acquisition, security, and contracting authorities have all been codified and infrastructure, personnel, and security resources are in place to initiate these programs. Interim acquisition and security authorities are being provided by Air Force Rapid Capabilities Office Director; authorities will transition to the newly hired SpRCO Director by April 2019.

Prototyping: Space Enterprise Consortium

The Space Enterprise Consortium (SpEC) is a team of industry leaders, academic research institutions, and innovative early-stage and start-up companies working together to develop next generation space technologies. Prototyping awards now broadly represent many of our most critical warfighter requirements, to include protected satellite communications, missile warning, missile defense, space situational awareness, and standardized satellites, payload and commanding interfaces.

A RESILIENT SPACE ENTERPRISE

AFSPC has made significant progress across all mission areas that span the breadth of our space capabilities. Execution of the Department's strategy to protect

and defend our space capabilities is persistent, ongoing, and present across all mission areas.

Command and Control

For operational level C2, Enterprise Space Battle Management Command and Control (ESBMC2) provides the C2 and SSA capabilities to gain and maintain space superiority. It also serves as the Air Force space system element of Air Force Multi-Domain Command and Control efforts. Our early ESBMC2 prototypes have demonstrated initial interoperability with Air Combat Command (ACC), the Intelligence Community, and the Missile Defense Agency to synchronize operations. We continue to support Air Force efforts to advance interoperability with ACC's Airborne Battle Management System.

One of the more important aspects of ESBMC2 is its open architecture. ESBMC2 uses Open Missions Standards (OMS) as its architecture standard and the Universal C2 Interface (UCI) as its communication standard to enable interoperability amongst the entire DOD space portfolio. We have seen success of this approach in early ESBMC2 prototypes allowing integrated C2 on timelines that the JSpOC Mission System could never have provided. This open approach also encourages companies to develop applications and compete in an environment in order to foster innovation. The price of entry for commercial companies to develop applications for ESBMC2 is simply to adhere to OMS and UCI specifications.

Space Situational Awareness

SSA is the foundation upon which the Department maintains spaceflight safety, provides warning, assesses intentions, and attributes adversary actions towards U.S., Allies, and commercial partner satellites. Coupled with operational intelligence to complete the SSA operating picture, competency in this area is critical in protecting our space assets, informing the design of future architectures, and fostering access and responsible use of space for all space-faring nations. The following key efforts represent SSA capabilities necessary to protect U.S. Government satellites and interests in space.

The new Space Fence is an S-Band radar designed for space surveillance located on the Kwajalein Atoll, Republic of Marshall Islands, 2,100 nautical miles southwest of Honolulu, Hawaii. It is expected to increase the number of tracked objects in space from 23,000 to more than 60,000, as well as increase the accuracy of orbit predictions, and improve our ability to characterize previously untracked objects and conduct collision avoidance analysis for all objects in space. Expected to achieve initial operational capability (IOC) within the next year, Space Fence will be the largest dedicated space surveillance radar operated by AFSPC.

The National Space Defense Center

The NSDC continues to mature its partnership between the DOD and Intelligence Community as we push to improve our nation's ability to rapidly detect, characterize, attribute, warn and defend against threats to our nation's vital space systems. In January 2018, the NSDC transitioned from an experimentation-focused entity to limited 24/7 operations. The fiscal year 2020 budget request supports efforts to leverage the full capability of the NSDC and I am pleased to report that the NSDC has continued to mature throughout the year and has now taken on all Protect and Defend responsibilities previously executed by the CSpOC.

The Air Force Research Lab has been working to deliver a Joint Emerging Operational Need (JEON) effort for the NSDC to provide capabilities to integrate systems and information at a "system high" level. By operating at the highest security levels throughout the operations center, the NSDC will become a singular center for the full picture of space activities. The completion of JEON-associated work in June 2019 will mark the delivery of a functioning prototype capability and then transition to an initial operational capability by year's end.

Position, Navigation, and Timing

The first Global Positioning System (GPS) III satellite was successfully launched in December 2018 on the SpaceX Falcon 9 rocket. Ultimately, GPS III will provide signals that are three times more accurate and provide up to eight times more anti-jam resilience for the warfighter than previous generations. The GPS Next-Generation Operational Control System (OCX) Block 0 supported GPS III Space Vehicle (SV) 01 launch and the team is completing early orbit checkout without issue. The OCX program addresses cyber vulnerabilities through a robust information assurance architecture and is on-track to deliver its full capability by April 2022.

The GPS III program is preparing GPS III SV 02 to support a summer 2019 launch and continues to assemble, test, and integrate the remaining eight satellites. In addition, SMC awarded the GPS III Follow-on (GPS IIIF) contract for 22 sat-

ellites in September 2018. This year's budget request includes full funding for SV 13 and continued incremental RDT&E funding for GPS IIF SVs 11 and 12.

Missile Warning

In the fiscal year 2019 budget request, the Air Force took the bold step to stop procurement of Space-Based Infrared System (SBIRS) vehicles 7 and 8 in acknowledgement of their inability to survive in today's contested space environment. The Next-Generation Overhead Persistent Infrared system will succeed the current SBIRS system by providing improved missile warning, missile defense, battlespace awareness, and technical intelligence capabilities that are more survivable against emerging adversary threats. The Air Force is applying acquisition authorities (per section 804 of the fiscal year 2016 NDAA) to manage the program's largest risks through competitive prototyping, and to significantly improve execution speed. Using these authorities, and with funding support from Congress, the program let two prime contracts within three months, posturing the Air Force to reduce the time to IOC by three and a half years. This pace setter proves that a five year acquisition timeline to deliver resilient missile warning capability, versus a ten or fifteen year timeline, is possible. Additionally, the Air Force has aligned the fiscal year 2020 budget request to support program execution and as expected deliver the first resilient geosynchronous satellite to meet warfighter needs by 2025.

Environmental Monitoring

Every DOD operational mission begins with a weather briefing; either space weather, terrestrial weather, or both. Although the data required to generate forecasts for our warfighters is largely dependent on complex models, approximately 95 percent of the data that feeds these models comes from either space-borne assets or ground-based observatories looking at space. Our ground-based infrastructure consists of unique assets strategically situated around the globe to observe the sun and the ionosphere from below and collect the data we need to complement the space-borne information. The data required for DOD missions is often unique and necessitates 24/7 global ability to forecast weather in austere and denied environments.

Weather is also a partnership business. We continue to leverage the outstanding contributions of NOAA, NASA, our European EUMETSAT colleagues, and Japan. As an example, we will also soon accept a NOAA geostationary satellite, repurposed for our DOD mission, and relocate it over the Indian Ocean.

We are currently updating the space piece of the overarching Air Force weather strategy for both terrestrial and space weather support. Our long term vision, in addition to the avenues we already have, is to determine how commercial ventures could add to and diversify our ability to collect our required data from space. This is a very new and potentially beneficial partnership, which we will be able to more completely characterize after we do some investigation and development of their abilities.

Satellite Communications

The Advanced Extremely High Frequency (AEHF) satellite constellation provides protected tactical and strategic, nuclear-hardened communications for the President and other decision makers. With three operational satellites on orbit, a fourth is undergoing on-orbit checkout and will be operational in July 2019. The final two satellites are scheduled to launch in fiscal years 2019 and 2020 respectively. Ongoing Space Modernization Initiative efforts include AEHF expanded spacecraft resilience features and enhanced ground cyber protection. The Air Force is currently pursuing the next generation of protected, strategic communications with the acquisition of the Evolved Strategic SATCOM system which utilizes section 804 authorities to deliver capability two years sooner than a traditional acquisition. The Air Force is currently preparing the release of a request for proposal for rapid prototyping for this next generation of protected strategic communications.

The Protected Tactical Enterprise Service effort has been enabled by section 804 authorities to deliver prototype capability for two Navy carrier strike groups 18 months early. This ground system will provide worldwide, anti-jam, Low Probability of Intercept communications for tactical warfighters. The Protected Tactical Satellite Communications (PTS) effort will save about 36 months of schedule by implementing rapid acquisition via section 804 authorities. PTS will provide advanced tactical SATCOM capabilities to enable tactical operations in anti-access/area denial environments. PTS awarded 13 prototyping projects using SpEC Other Transaction Authority (OTA) to help design and reduce risk of critical technologies.

Enhanced Polar System (EPS) hosted payloads launched in 2015 and 2017 and will provide tactical protected communications in the North Polar Region; EPS will achieve full operational capability in late fiscal year 2019. However, the need for

tactical communication capabilities in the North Polar Region is anticipated to expand as U.S. and allied military and commercial needs continue to grow. As previously mentioned, the Enhanced Polar System—Recapitalization (EPS-R) is the protected SATCOM follow-on to the EPS, providing a 24/7 protected SATCOM capability to the North Polar Region. EPS-R payloads on two separate Space Norway spacecraft remain on track for a dual launch in fiscal year 2023 and will provide continuity of protected satellite communications services and bridges the gap between the current system and EPS at a significantly reduced cost.

Wideband Global Satellite (WGS) Communications SVs 8 and 9 entered operations in 2017 and SV 10 successfully launched on 15 March 2019. As the primary wideband satellite communications capability for DOD, SV 10 will extend functional availability to 2028. Per the Consolidated Appropriations Act of 2018, the Air Force is acquiring and further developing a funding plan for launch and operation and maintenance activities for a modernized WGS satellite with a digital payload comprising twice the capacity of the current version.

Assured Access to Space

For the first time in 20 years, the Air Force is prepared to meet all national security launch needs through competition among multiple viable launch providers. With unprecedented mission success in placing National Security Space (NSS) assets into orbit, the National Security Space Launch (NSSL) program, formerly known as the Evolved Expendable Launch Vehicle (EELV) program, provides assured access to space for our most important national security satellites, while demonstrating good stewardship of launch funds. Our priority remains to ensure the Air Force can launch all NSS payloads when and where we need to, utilizing launch services from certified domestic, commercial launch providers in a viable competitive market.

As the Air Force moves to recapitalize the NSSL program and end the use of the Russian-built RD-180 engine, AFSPC has entered into public-private partnerships, the best way to ensure emerging commercial launch solutions meet our most stressing NSS launch requirements. The SMC Enterprise Directorate awarded three Launch Service Agreements to develop domestic, commercially viable launch systems. The three agreements went to Blue Origin's New Glenn rocket, Northrop Grumman's OmegA rocket, and United Launch Alliance's Vulcan rocket. These partnerships leverage commercial launch industry investment to deliver launch capabilities ahead of the RD-180 procurement deadline of 2022. NSSL Phase 2 launch contracts will facilitate full and open competition to procure launch services from fiscal year 2020 through 2024 for launch starting in 2022.

Last year Congress recognized the prospect of cost savings associated with launch vehicle reusability; the Air Force has embraced this concept and is actively evaluating the risks, benefits, and potential costs or savings from reusable launch vehicles for future missions. With launch service providers demonstrating success at a rapid pace, reusable launch systems could offer higher reliability, increased responsiveness, and greater flexibility in support of NSS missions. In an effort to lean forward on reusing hardware for launch, SMC and SpaceX completed a contract modification allowing the reuse of the Falcon Heavy side core boosters for the Air Force's Space Test Program-2 mission. This first mission with a re-used booster further demonstrates our commitment to balance risk with increased responsiveness and flexibility.

In 2019, the DOD Space Test Program partnered with SMC's Enterprise Corps and Defense Innovation Unit to pursue the first launch of a venture-class small launch service through the Rapid Agile Launch Initiative (RALI). Under this partnership, the Air Force procured five small launch services through venture-class launch service providers using OTA agreements. RALI demonstrates rapid procurement and the responsiveness of commercial launch, dedicated launch for small payloads to militarily-relevant orbits, on-demand responsiveness, and increased operational tempo over legacy national launch architecture. RALI leverages an expanding commercial market and launch opportunities to increase DOD's access to space.

AFSPC places a high priority on streamlining space launch operations and identifying opportunities to improve our speed, innovation and resiliency to improve efficiency, satisfy national security needs, and increase safety. This includes an architecture transformation across both launch ranges that started in 2019 and will continue through 2023. Changes in flight and ground systems will put us on a path to support a 2025 implementation of the Autonomous Flight Safety System for all commercial space launches. This enables us to increase the pace of launch, reduce costly infrastructure, and maintain public safety.

Cyberspace Defense of the Space Enterprise

To protect our space enterprise from cyber threats, Headquarters AFSPC and SMC, together with our federally funded research development centers, will implement a full lifecycle effort for space and associated ground systems, applying robust cyberspace and defensive security protocols that will include adaptable, upgradable, hardened products and other best practices “baked in” at the time of product delivery. AFSPC is leading the Air Force, implementing a Defensive Cyber Operations for Space (DCO-S) strategy and organizational construct across a tiered defense posture to execute cyber defense in depth for space mission assurance.

Air Force Space Command is working with U.S. Cyber Command, joint partners, the Intelligence Community, research labs, and industry to develop and deploy cyberspace security and defense solutions to protect the space enterprise from cyber threats. AFSPC continues to develop and educate cyber protection and defense personnel who work alongside space mission system operators to detect and respond to system vulnerabilities and adversarial activity. To rapidly enable DCO-S capabilities, AFSPC is executing a rapid acquisition approach to prototype and field improved technologies that will protect critical systems, investigate cyber events, respond to cyber incidents, and accomplish cyberspace security and defense objectives across the space enterprise.

THE WAY AHEAD

The fiscal year 2020 budget request strengthens the considerable gains AFSPC has made over the previous fiscal year with a proposed \$14 billion investment in our space portfolio, a 17 percent increase over our fiscal year 2019 budget. This budget request supports our warfighting approach to the space domain and supports changes to how we prototype and field innovative space technologies in order to stay ahead of our competitors.

I thank the Committee for your leadership and support; together we will build a resilient and ready National Security Space enterprise that will continue to serve as the foundation to our desire to maintain our military advantage and promote American prosperity.

Senator FISCHER. Thank you, General.

Next, Ms. Chaplain. Welcome.

STATEMENT OF CRISTINA T. CHAPLAIN, DIRECTOR, ACQUISITION AND SOURCING MANAGEMENT, GOVERNMENT ACCOUNTABILITY OFFICE

Ms. CHAPLAIN. Chairman Fischer, Ranking Member Heinrich, and Members of the Subcommittee, thank you for inviting me today to discuss DOD’s space programs.

Space is at a pivotal point right now. In the face of growing threats and lengthy development cycles, DOD is embracing new approaches to help speed up acquisition of space systems, establish better partnerships with the commercial sector to increase innovation, and change its acquisition culture. There is also a proposal before Congress on strengthening leadership for space.

Bringing about this broad span of change will be challenging, to say the least, and not without some risk. More specifically, while DOD is undertaking this change, it will need to concurrently focus on completing older programs that are still struggling. The ground system for Global Positioning System (GPS), known as Next Generation Operational Control System (OCX), for example, is nearly 5 years late. And, while the contractor has improved the pace of building and testing the software, we still see a lot of schedule risk in that program. The Air Force also recently stopped development work on Joint Space Operations Center (JSpOC) Mission System (JMS), a ground system for processing space situational-awareness data, because it didn’t deliver as expected. We’re also still faced

with long gaps between the delivery of satellites and ground systems needed to make use of their capabilities.

Moreover, there's a myriad of challenges facing space programs that are just getting underway:

First, even with the new Space Force proposal, there are still a lot of open questions about leadership. For example, at this time, it appears there will be a number of space acquisition activities outside of the Space Force, including the Missile Defense Agency, the NRO, and some military space service activities, but, so far, it's uncertain what the overall governance structure will be. If there are conflicts in requirements, funding, or priorities among agencies that are not under the Space Force, who resolves them and makes a final decision? There is also a new entity being rolled out, the Space Development Agency, which has very worthwhile goals of developing or adopting innovative technologies for space, but, at this time, it's unclear how it will mesh with other similar agencies, and also still unclear who's in charge of future architectures for space. These questions may well be resolved as details for the Space Force and SDA get worked out, but new programs will be operating with uncertainty for the time being.

Second, while streamlining might help speed up programs and change the culture, we know, from past efforts to streamline, that there's also risk of inviting programs to move too quickly and disregard the engineering and acquisition discipline that is so very important to space. Keep in mind that space is different than other types of weapons. You cannot easily fix satellites once they're in orbit. We consistently see programs suffer major setbacks because one quality procedure wasn't followed or one small flaw in one small part was not detected. This does not mean streamlining cannot be done, or should not be done. It just means we should heed lessons from the past, maintain good insight, oversight, and expertise, and be prepared to cancel programs that falter.

There's a question about DOD's capacity to manage multiple new programs concurrently. Yes, there's a healthy increase being proposed for space, but consider at least nine significant programs are getting underway. They will likely require heavy investments up front and then DOD will also be seeking money for a new Space Force, for space protection, for a Space Development Agency, and a new missile-defense space layer, as well as for priorities outside of space, such as the nuclear triad.

There are also questions about workforce capacity. We recently reported that just tracking who's in the space acquisition workforce is a challenge, and there are also gaps in technical expertise that will be stretched with multiple new programs.

Moreover, all of the programs will be software-intensive—these new programs—but DOD has challenges managing software. We recently found that space software programs struggle to effectively engage system users, which is critical to their success. We understand that many new programs are attempting to be more agile and to use more modern tools, but it remains to be seen how successful DOD can be in adopting these new ways.

Again, good things are happening in space. There's attention from highest levels of government, more resources, and a recognition that different approaches and culture are needed. What's key

to making this happen is not to lose focus on improving acquisition management and oversight, building capacity as we speed up programs, and continuing to reduce fragmentation.

Thank you. This concludes my statement, and I'm happy to answer any questions you have.

[The prepared statement of Ms. Chaplain follows:]



United States Government Accountability Office

Testimony

Before the Subcommittee on Strategic
Forces, Committee on Armed Services,
U.S. Senate

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SPACE ACQUISITIONS

DOD Faces Significant Challenges as it Seeks to Accelerate Space Programs and Address Threats

Statement of Cristina T. Chaplain, Director,
Contracting and National Security Acquisitions

GAO Highlights

Highlights of [GAO-19-458T](#), a testimony before the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate

Why GAO Did This Study

DOD space systems provide critical capabilities that support military and other government operations. They can also be expensive to acquire and field, costing billions of dollars each year.

As DOD seeks to replenish its satellite constellations, it faces a number of challenges to ensuring funds are used effectively. Because space-based capabilities are fundamental to U.S. national security and civilian activities, it is essential that DOD manage its space system acquisitions carefully and avoid repeating past problems.

This statement provides an update on DOD's space acquisitions, focusing on challenges facing acquisitions of new space systems.

This statement is based on GAO reports issued over the past 10 years on DOD space programs. In addition it draws on recent work performed in support of GAO's 2019 annual reports on the progress of major defense acquisition programs as well as duplication, overlap, and fragmentation across the federal government, among other sources.

What GAO Recommends

Past GAO reports have recommended that DOD adopt acquisition best practices to help ensure cost and schedule goals are met. DOD has generally agreed and taken some actions to address these recommendations.

View [GAO-19-458T](#). For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

March 27, 2019

SPACE ACQUISITIONS

DOD Faces Significant Challenges as it Seeks to Accelerate Space Programs and Address Threats

What GAO Found

DOD is simultaneously undertaking new major acquisitions to replenish its missile warning, protected communications, navigation, and weather satellites. At the same time, it is boosting efforts to increase space situational awareness and protect space assets. Such widespread acquisition activities could face a wide range of resource and management challenges that GAO has reported on, including:

- Growing threats to satellites.** Threats to satellites from both adversaries—such as jamming and cyber attacks—and space debris are increasing. DOD is making changes to how it designs its space systems to increase the resilience and survivability of space capabilities. But it has been challenged in adopting new approaches, such as using commercial satellites to host payloads, and in prioritizing cybersecurity for all of its weapon systems. For hosted payloads, GAO recommended, and DOD concurred, that the department bolster and centralize collection and analysis of cost, technical, and lessons learned data.
- Implementing leadership changes.** DOD is planning major changes to leadership for space. It recently proposed legislation to establish a United States Space Force—initially to be housed within the Department of the Air Force—that would, according to the President's Space Policy Directive, consolidate existing military space activities and minimize duplicative efforts across DOD. GAO found in July 2016 that changes are needed to reduce fragmentation that has negatively affected space programs for many years. But open questions remain about governance as new programs get underway and whether the changes themselves may result in further fragmentation. For example, it is unclear at this time how the new Space Development Agency will mesh with organizations currently involved in testing and acquiring new space technologies.
- Having the right resources and know-how.** While there is increased attention on funding for space and building the Space Force, new programs can still face resource challenges. DOD has begun over 9 new space programs at a time when it is also seeking increased investments in ships, aircraft, and the nuclear triad, among other programs. Moreover, it is unclear whether DOD has a sufficient workforce to manage its new programs. GAO issued a report earlier this month that found DOD does not routinely monitor the size, mix, and location of its space acquisition workforce. Further, DOD has difficulty attracting and retaining candidates with the requisite technical expertise. GAO recommended that DOD collect and maintain data on its space acquisition workforce. DOD did not concur, but GAO maintains that DOD should have better information on such personnel, especially in light of its proposal for establishing the Space Force. GAO also found in March 2019 that key software-intensive space programs often did not effectively engage users to understand requirements and obtain feedback. GAO recommended, and DOD concurred, that the department ensure its guidance addressing software development provides specific, required direction on the timing, frequency, and documentation of user involvement and feedback.

United States Government Accountability Office

Chairman Fischer, Ranking Member Heinrich, and Members of the Subcommittee:

I am pleased to have the opportunity to discuss the Department of Defense's (DOD) space system acquisitions. DOD's space systems provide critical capabilities that support military and other government operations and can take years to develop, produce, and launch. These systems can also be expensive to acquire and field, amounting to billions of dollars each year. Given the time and resource demands of DOD's space systems and the need for funds to be used effectively, and because space-based capabilities are fundamental to U.S. national security and civilian activities, it is essential that DOD manage space system acquisitions carefully and avoid repeating past problems.

My statement will focus on (1) the current status and cost of major DOD space programs and (2) challenges facing acquisitions of new space systems.

This statement is based on our reports on DOD space programs issued over the past 10 years and recent work performed in support of our annual weapon systems assessments to be issued later this year. It is also based on space-related work in support of our forthcoming 2019 annual report on duplication, overlap, and fragmentation across the federal government; and our updates on cost increases, investment trends, and improvements in the last year. More information on our objectives, scope, and methodology is available in our related products, which are listed at the end of this statement.

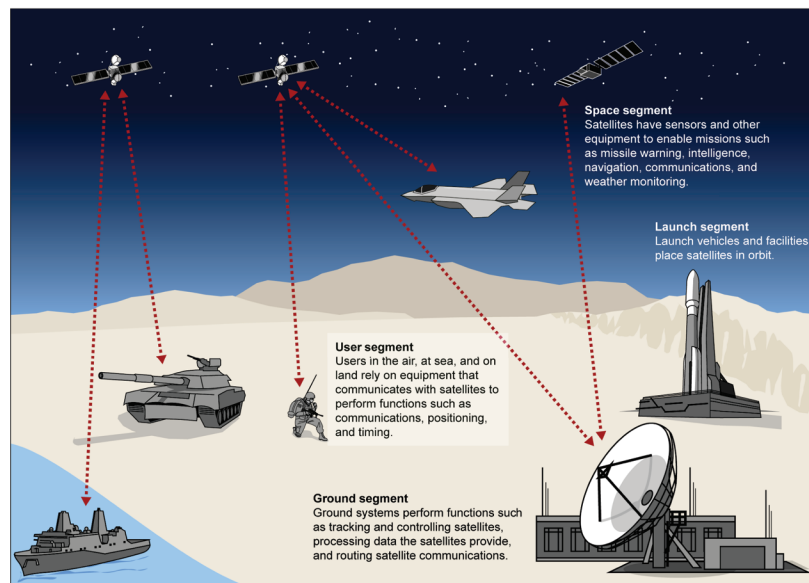
More detailed information on our objectives, scope, and methodology for our work can be found in the issued reports. We conducted the work on which this statement is based in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to 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.

Status of Major Space Systems

DOD space systems support and provide a wide range of capabilities to a large number of users, including the military services, the intelligence community, civil agencies, and others. These capabilities include positioning, navigation, and timing; meteorology; missile warning; and secure communications, among others. Space systems can take a long

time to develop and involve multiple segments, including space, ground control stations, terminals, user equipment, and launch, as figure 1 below shows. DOD satellite systems are also expensive to acquire. Unit costs for current DOD satellites can range from \$500 million to over \$3 billion. The associated ground systems can cost over \$6 billion to develop and maintain and the cost to launch a satellite can climb to well over \$100 million.

Figure 1: The Segments of Space Systems



Source: GAO analysis of Department of Defense (DOD) documentation. | GAO-19-458T

Table 1 provides highlights of the current status of DOD's major space programs. As the table shows, DOD is also in the beginning phases of acquiring several constellations of new satellites and ground processing capabilities—including for missile warning, protected communications, space-based environmental monitoring, and space command and control. We have work underway to assess the Air Force's space command and control development efforts and examine DOD's analysis of alternatives for wideband communication services. For a more complete description of these major space programs, see appendix I. In addition, DOD is exploring alternatives for acquiring wideband satellite communications as well as funding development of new launch vehicles as it pursues a new acquisition strategy for procuring launch services.¹

Table 1: Status of Major Department of Defense (DOD) Space Acquisitions

Program	Cost and percentage change from first full estimate (in FY 2019 billion dollars)	Quantity	Associated new programs
Advanced Extremely High Frequency (AEHF) (satellite communications)	\$15.5 116.7%	Original: 5 Current: 6	Evolved Strategic SATCOM (ESS); Protected Tactical SATCOM (PTS); Protected Tactical Enterprise Service (PTES)
Enhanced Polar System (EPS) (satellite communications)	\$1.5 -0.9%	Original: 2 Current: 2	Enhanced Polar System Recap (EPS-R)
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T) Command Post Terminals (CPT) (satellite communications terminals)	\$1.9 7.2%	Original: 95 Current: 109	FAB-T Force Element Terminals (FET)
Global Positioning System (GPS) III (positioning, navigation, and timing)	\$5.8 31.8%	Original: 8 Current: 10	GPS IIIF
Global Positioning System Next Generation Operational Control System (GPS OCX) (command and control system for GPS III satellites)	\$6.2 68.1%	Original: 1 Current: 1	Not determined
Joint Space Operations Center Mission System (JMS) Increment 2 (space situational awareness data system)	\$0.5 42.0%	Original: 1 Current: 1	Space Command and Control (C2)

¹We have work underway to examine the Air Force's space command and control programs as well as DOD's analysis of alternatives for wideband communications. We expect to issue the results of that work by fall 2019.

Program	Cost and percentage change from first full estimate (in FY 2019 billion dollars)	Quantity	Associated new programs
Military GPS User Equipment (MGUE), Increment 1 (GPS receiver)	\$1.5 -5.1%	Original: N/A Current: N/A	MGUE Increment 2
Mobile User Objective System (MUOS) (satellite communications)	\$7.1 -6.0%	Original: 6 Current: 5	Not determined
National Security Space Launch (NSSL) (launch)	\$57.0 193.2%	Original: 181 Current: 161	Not determined
Space Based Infrared System (SBIRS) (missile warning, infrared intelligence, surveillance, and reconnaissance)	\$19.9 265.0%	Original: 5 Current: 6	Next Generation Overhead Persistent Infrared (Next Gen OPIR); Future Operationally Resilient Ground Evolution (FORGE); Enterprise Ground Services (EGS)
Space Fence Ground-Based Radar System Increment 1 (space object detection)	\$1.6 -5.7%	Original: 1 Current: 1	Not determined
Wideband Global SATCOM (WGS) (satellite communications)	\$4.2 ^a 216.3%	Original: 3 Current: 10	To be determined following Analysis of Alternatives
Weather System Follow-on (WSF) (weather)	\$0.9 N/A	Original: 2 Current: 2	Electro-Optical/Infrared Weather Systems (EWS); Electro-Optical/Infrared Weather Systems Geostationary (EWS-G)

Source: GAO analysis of Department of Defense information | GAO-19-458T

Note: Dollar figures are rounded to the nearest tenth and reported in fiscal year 2019 dollars based on the programs' original and most recent Selected Acquisition Reports or program office updates.

^aThis value does not include the cost of 2 satellites funded by international partners.

Our prior work has shown that many major DOD space programs have experienced significant cost increases and schedule delays. For instance, the total program cost for the Advanced Extremely High Frequency (AEHF) satellite program, a protected satellite communications system, has grown 117 percent since the program's original cost estimate and its first satellite was launched more than 3.5 years late. For the Space Based Infrared System (SBIRS), a missile warning satellite program, the program cost grew 265 percent from its original estimate and the launch of the first satellite was delayed roughly 9 years. Both programs moved to the production phase where fewer problems tend to surface, and where there is typically less risk of significant cost and schedule growth. A more recent major satellite program, Global Positioning System (GPS) III, has seen an almost 4-year delay due to technical issues and program cost growth of about 32 percent.

Cost and schedule growth has also been a challenge for satellite ground systems and user equipment. Ground system delays have been so lengthy, that satellites sometimes spend years in orbit before key capabilities can be fully exploited. For example,

- The command and control system for GPS III satellites, known as the Next Generation Operational Control System, or OCX, is approximately 5 years behind schedule. As a result, the Air Force has had to start two separate back-up efforts to modify the current ground system to ensure the continuity of GPS capabilities and to make anti-jamming capabilities available via Military Code, or M-code, until OCX is delivered. Our ongoing review of GPS includes an assessment of OCX schedule risk and potential impacts on OCX delivery, acceptance, and operation. We expect to issue our report on GPS in spring 2019.
- Development of GPS user equipment that can utilize the M-Code signal has lagged behind the fielding of GPS M-code satellites for more than a decade, due to prolonged development challenges. In December 2017, we found that while DOD had made some progress on initial testing of the receiver cards needed to utilize the M-code signal, additional development was necessary to make M-code work with the over 700 weapon systems that require it.² We also found that DOD had begun initial planning to transition some weapon systems to use M-code receivers, but significantly more work remained to understand the cost and schedule of transitioning to M-code receivers across DOD. Further, in December 2017, we found that multiple entities were separately maturing their own receiver cards. We recommended that DOD assign responsibility to a single organization to collect test data, lessons learned, and design solutions so that common design solutions are employed and DOD could avoid duplication of efforts. DOD concurred with the recommendation, but has not yet taken action on it.
- We have previously reported that over 90 percent of the capabilities to be provided by Mobile User Objective System communications satellites—currently, five satellites are in orbit, the first of which launched in 2012—are being underutilized because of difficulties with

²GAO, *Global Positioning System: Better Planning and Coordination Needed to Improve Prospects for Fielding Modernized Capability*, GAO-18-74 (Washington, D.C.: Dec. 12, 2017).

integrating the space, ground, and terminal segments and delays in fielding compatible user terminals.³

- Largely because of technical and management challenges, the Joint Space Operations Center Mission System (JMS) Increment 2 program—intended to replace and improve upon an aging space situational awareness and command and control system—was almost 3 years behind schedule and 42 percent over budget before the Air Force stopped development work last year. Earlier this month, we reported that operational testing in 2018 found that JMS Increment 2 was not operationally effective or suitable due, in part, to missing software requirements, urgent deficiencies that affected system performance, and negative user feedback.⁴

Cost and schedule growth in DOD's space programs is sometimes driven by the inherent risks associated with developing complex space technology; however, over the past 10 years we have identified a number of other management and oversight problems that have worsened the situation. These include making overly optimistic cost and schedule estimates, pushing programs forward without sufficient knowledge about technology and design, and experiencing problems in overseeing and managing contractors, among others. We have also noted that some of DOD's programs with operational satellites, such as SBIRS, were also exceedingly ambitious, which in turn increased technology, design, and engineering risks. While SBIRS and other satellite programs provide users with important and useful capabilities, their cost growth has significantly limited the department's buying power at a time when more resources may be needed to protect space systems and recapitalize the space portfolio.

Challenges Facing Acquisitions of New Space Systems

DOD faces significant challenges as it replenishes its satellite constellations. First, DOD is confronted with growing threats in space, which may require very different satellite architectures and acquisition strategies. Second, DOD is in the midst of planning major changes to its leadership for space. While these changes are designed to streamline decision-making and bring together a dispersed space workforce, they

³GAO, *Space Acquisitions: DOD Continues to Face Challenges of Delayed Delivery of Critical Space Capabilities and Fragmented Leadership*, [GAO-17-619T](#) (Washington, D.C.: May 17, 2017).

⁴GAO, *DOD Space Acquisitions: Including Users Early and Often in Software Development Could Benefit Programs*, [GAO-19-136](#) (Washington, D.C.: Mar. 18, 2019).

could cause some disruption to space system acquisition programs. Third, in fiscal year 2016, Congress gave DOD authority to speed up acquisition timeframes by streamlining acquisition processes and oversight. GAO is examining DOD's application of streamlining to its weapons programs. For space, challenges with past streamlining efforts may offer some lessons learned. And fourth, DOD may face resource and capacity challenges in taking on multiple space acquisitions at one time. For example, our work and other reports point to potential gaps in the space acquisition workforce and ongoing difficulties managing software development.

**Growing Threats to
Satellites Require New
Approaches**

According to Air Force Space Command and others, U.S. space systems face intentional and unintentional threats that have increased rapidly over the past 20 years. These include radio frequency interference (including jamming), laser attacks, kinetic intercept vehicles, and ground system attacks. Additionally, the hazards of the already-harsh space environment (e.g., extreme temperature fluctuations and radiation) have increased, including numbers of active and inactive satellites, spent rocket bodies, and other fragments and debris. According to a February 2019 Defense Intelligence Agency report, China and Russia in particular are developing a variety of means to exploit perceived U.S. reliance on space-based systems and challenge the U.S. position in space. The report also states that Iran and North Korea have demonstrated some counterspace capabilities that could pose a threat to militaries using space-based services.

In response, recent governmentwide and DOD strategic and policy guidance have stressed the need for U.S. space systems to be survivable or resilient against such threats and DOD has taken steps to be more resilient in some of its new programs. As we found in October 2014, one way to do this is to build more disaggregated systems, including dispersing sensors onto separate satellites; using multiple domains, including space, air, and ground to provide full mission capabilities; hosting payloads on other government or commercial spacecraft; or some combination of these.⁵ With capabilities distributed across multiple platforms, rather than centralized onto just a few satellites, it may be more difficult for an adversary to target all assets to attack full system

⁵GAO, *DOD Space Systems: Additional Knowledge Would Better Support Decisions about Disaggregating Large Satellites*, [GAO-15-7](#) (Washington, D.C.: Oct. 30, 2014).

capabilities, and if an attack does take place, the loss of one smaller satellite or payload could result in less capability loss than damage to, or loss of, a large multifunctional satellite. In addition to disaggregation, DOD could make satellites more maneuverable and build in defense capabilities to protect themselves as a means to increase survivability.

We also found in October 2014 that some of these options could have beneficial impacts on acquisition.⁶ For example, acquiring smaller, less complex satellites may require less time and effort to develop and produce. This may be in part due to improved requirements discipline, as more frequent production rates may allow program managers to delay new requirements to the next production cycle instead of incorporating them into ongoing timelines midstream. Building more, less-complex satellites might also provide DOD the opportunity to use commercial products and systems that have already been tested in the market. At the same time, however, addressing the need to make satellites more resilient could introduce complications. For example, DOD may need to acquire higher quantities of satellites, which may make it more difficult to manage acquisition schedules. In addition, potentially more development and production contracts may result in more complexity for program offices to manage, requiring increased oversight of contractors. Adding more satellites and new technologies may also complicate efforts to synchronize satellite, terminal, and ground system schedules, limiting delivery of capabilities to end users.

Our work has also found potential barriers to making satellites more resilient. For example, in October 2014, we found that disaggregation could require DOD to make significant cultural and process changes in how it acquires space systems—for instance, by relying on new contractors, relinquishing control to providers who host government payloads on commercial satellites, using different contracting methods, and executing smaller but more numerous and faster-paced acquisition programs.⁷ It will likely require DOD to be more flexible and agile when it comes to satellite acquisitions, especially with regard to coordinating satellite delivery with interdependent systems, such as user equipment. Yet, as we have previously found, DOD's culture has generally been resistant to changes in space acquisition approaches, and fragmented responsibilities have made it very difficult to coordinate and deliver

⁶GAO-15-7.

⁷GAO-15-7.

interdependent systems.⁸ Senior leaders have recognized the need to change the space acquisition culture, and as discussed below, changes are being made to space leadership and acquisition approaches.

More recently, in July 2018, we found that two factors have contributed to DOD's limited use of commercially hosted payloads.⁹ 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 from using hosted payloads, DOD as a whole has limited information on costs and benefits of hosted payloads. Further, the knowledge DOD obtained 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. We recommended, and DOD concurred, that the department bolster and centralize collection and analysis of cost, technical, and lessons learned data on its use of hosted payloads.

Lastly, in October 2018, we found that DOD faced mounting challenges in protecting its weapon systems—satellites and their ground systems included—from increasingly sophisticated cyber threats.¹⁰ We reported that this was due to the computerized nature of weapon systems, DOD's late start in prioritizing weapon system cybersecurity, and DOD's nascent understanding of how to develop more secure weapon systems. In operational testing, DOD routinely found mission-critical cyber vulnerabilities in systems that were under development, yet program officials GAO met with believed their systems were secure and even discounted some test results as unrealistic. Using relatively simple tools and techniques, testers were able to take control of systems and operate largely undetected, due in part to basic issues such as poor password management and unencrypted communications. DOD has recently taken

⁸GAO-17-619T.

⁹GAO, *Military Space Systems: DOD's Use of Commercial Satellites to Host Defense Payloads Would Benefit from Centralizing Data*, GAO-18-493 (Washington, D.C.: July 30, 2018).

¹⁰GAO, *Weapon Systems Cybersecurity: DOD Just Beginning to Grapple with Scale of Vulnerabilities*, GAO-19-128 (Washington, D.C.: Oct. 9, 2018).

several steps to improve weapon system cybersecurity, including issuing and revising policies and guidance to better incorporate cybersecurity considerations. Further, in response to congressional direction, DOD has also begun initiatives to better understand and address cyber vulnerabilities.

**Space Leadership
Changes Are a Positive
Step, But Have Some Risk**

We and others have reported for over two decades that fragmentation and overlap in DOD space acquisition management and oversight have contributed to program delays and cancellations, cost increases, and inefficient operations. For example, in February 2012 we found that fragmented leadership contributed to a 10-year gap between the delivery of GPS satellites and associated user equipment.¹¹ The cancellations of several large programs over the past 2 decades were in part because of disagreements and conflicts among stakeholders.

In July 2016, in response to a provision of a Senate Report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2016, we issued a report that reviewed space leadership in more depth and concluded that DOD space leadership was fragmented.¹² We identified approximately 60 stakeholder organizations across DOD, the Executive Office of the President, the Intelligence Community, and civilian agencies. Of these, eight organizations had space acquisition management responsibilities; eleven had oversight responsibilities; and six were involved in setting requirements for defense space programs. At the same time, many experts stated that no one seemed to be in charge of space acquisitions. Our report highlighted the pros and cons of various options to reorganize space functions recommended in prior congressionally-chartered studies. The issue has taken on more importance in recent years, as DOD has realized satellites are highly vulnerable to attacks and needs to make dramatic changes in space system architectures and operations. We have found that leadership has not been focused enough to overcome interagency rivalries and resistance to change, and it has not been able to get concurrence on future architectures.

¹¹GAO, 2012 Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue, [GAO-12-342SP](#) (Washington, D.C.: Feb. 28, 2012).

¹²GAO, 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).

The President's Administration and DOD have taken significant steps to change space leadership. Most recent is the President's Space Policy Directive-4, issued on February 19, 2019, and DOD's subsequent legislative proposal submitted on March 1, 2019, to establish a United States Space Force as a sixth branch of the United States Armed Forces within the Department of the Air Force.¹³ The Policy Directive states that this is an important step toward a future military department for space and that the Space Force will (1) consolidate existing forces and authorities for military space activities, as appropriate, to minimize duplication of effort and eliminate bureaucratic inefficiencies; and (2) not include the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the National Reconnaissance Office, or other non-military space organizations or missions of the United States Government.

According to the Policy Directive, the Space Force would include the uniformed and civilian personnel conducting and directly supporting space operations from all DOD Armed Forces, assume responsibilities for all major military space acquisition programs, and create the appropriate career tracks for military and civilian space personnel across all relevant specialties. Pertaining to organization and leadership, the Policy Directive creates a civilian Under Secretary of the Air Force for Space, to be known as the Under Secretary for Space, appointed by the President, and establishes a Chief of Staff of the Space Force, who would serve as a member of the Joint Chiefs of Staff.

Furthermore, the Policy Directive states that as the Space Force matures, and as national security requires, it will become necessary to create a separate military department, to be known as the Department of the Space Force. This department would take over some or all responsibilities for the Space Force from the Department of the Air Force. The Policy Directive requires the Secretary of Defense to conduct periodic reviews to determine when to recommend that the President seek legislation to establish such a department.

Our past work has identified fragmentation in space leadership, but because implementation has not yet occurred, it remains to be seen

¹³Space Policy Directive-4, 84 Fed. Reg. 6049 (Feb. 25, 2019); *Legislative Proposal to Establish the U.S. Space Force* (Mar. 1, 2019), available at <https://media.defense.gov/2019/Mar/01/2002095010/-1/-1/1/UNITED-STATES-SPACE-FORCE-LEGISLATIVE-PROPOSAL.PDF> (last visited Mar. 15, 2019).

whether this policy directive and proposed legislation would resolve these issues. In implementing these changes there are many complexities to consider. For example, because space capabilities are acquired and used across the military services and defense agencies, it will be important to address many details on how to implement a Space Force among these equities. Our past work suggests that without close attention to the consequences of the compromises that will inevitably have to be made to carve out a new force structure from existing space functions, there is risk of exacerbating the fragmentation and ineffective management and oversight the Space Force is intended to address. For instance, earlier this month, DOD established the Space Development Agency to unify and integrate efforts across DOD to define, develop, and field innovative solutions.¹⁴ But it is unclear how this new organization will mesh with the Air Force Space and Missile Systems Center, which acquires satellites, the Defense Advanced Research Projects Agency, which creates breakthrough technologies and capabilities, and similar organizations.

Moreover, even if changes are implemented effectively, they are only a first step toward addressing space acquisition problems. As we discuss below, programs will still need to embrace acquisition best practices, such as using demonstrable knowledge to make decisions. Our prior work has found that they will also need to be open to flexible and innovative approaches, and work effectively with a very wide range of stakeholders, including those that will not be part of the Space Force, such as the intelligence agencies, civilian space agencies, the current military services, as well as entities within the Office of the Secretary of Defense who help oversee and manage acquisitions.¹⁵ Senior leaders have acknowledged that additional changes are needed and have taken steps to help bring them about, such as the restructuring of the Air Force's Space and Missile Systems Center, which is designed to break down stovepipes and streamline acquisition processes.

Past Streamlining Efforts Offer Lessons Learned

DOD is managing a number of new space acquisition programs using a new authority, established under Section 804 of the National Defense Authorization Act for Fiscal Year 2016, which is to provide a streamlined alternative to the traditional DOD acquisition process. Specifically, the

¹⁴DOD, *Establishment of the Space Development Agency* (Washington, D.C.: Mar. 12, 2019).

¹⁵GAO-18-493, GAO-16-592R, and GAO-17-619T.

programs—which include follow-on missile warning and protected communications satellites, among others—will be exempted from the acquisition and requirements processes defined by DOD Directive 5000.01 and the Joint Capabilities Integration and Development System.¹⁶ Instead, program managers are encouraged to use a tailored approach to documentation and oversight to enable them to demonstrate new technologies or field new or updated systems within 2 to 5 years. We have ongoing work looking across the military departments at how middle-tier acquisition authority is being implemented, including for the Air Force's space acquisition programs, and plan to issue a report later this spring.

GAO and others have highlighted lessons learned from past efforts to streamline, specifically with an approach adopted for space systems in the 1990s known as Total System Performance Responsibility (TSPR). TSPR was intended to facilitate acquisition reform and enable DOD to streamline its acquisition process and leverage innovation and management expertise from the private sector. Specifically, TSPR gave a contractor total responsibility for the integration of an entire weapon system and for meeting DOD's requirements. We found in May 2009 that because this reform made the contractor responsible for day-to-day program management, DOD did not require formal deliverable documents—such as earned value management reports—to assess the status and performance of the contractor.¹⁷ As a result, DOD's capability to lead and manage the space acquisition process diminished, which magnified problems related to unstable requirements and poor contractor performance. Further, the reduction in DOD oversight and involvement led to major reductions in various government capabilities, including cost-estimating and systems-engineering staff. This, in turn, led to a lack of technical data needed to develop sound cost estimates.

Best practices that we identified in the aftermath of TSPR include retaining strong oversight and insight into programs; using quantifiable data and demonstrable knowledge to make decisions to proceed, not allowing development to proceed until certain thresholds are met,

¹⁶DOD Directive 5000.01, the Defense Acquisition System (Aug. 31, 2018); and Chairman of the Joint Chiefs of Staff Instruction 5123.01H "Charter of the Joint Requirements Oversight Council (JROC) and Implementation of the Joint Capabilities Integration and Development System (JCIDS)" (Aug. 31, 2018).

¹⁷GAO, *Space Acquisitions: DOD Faces Substantial Challenges in Developing New Space Systems*, GAO-09-705T (Washington, D.C.: May 20, 2009).

empowering program managers to make decisions on the direction of the program but also holding them accountable for their choices, and canceling unsuccessful programs. Similarly, in its study of TSPR programs, the Defense Science Board/Air Force Scientific Advisory Board Joint Task Force emphasized the importance of managing requirements, sufficiently funding programs, participating in trade-off studies, and assuring that proven engineering practices characterize program implementation, among other actions. See appendix II for a more complete list of the best practices we have identified for developing complex systems.

DOD May Face Resource and Capacity Challenges in Taking on Multiple Programs at One Time

DOD is simultaneously undertaking new major acquisition efforts to replenish its missile warning, protected communications, GPS, and weather satellites. At the same time, it is boosting efforts to increase space situational awareness and protect space assets. It is also helping to fund the development of new launch vehicles, and it is considering additional significant acquisitions in wideband satellite communications and in support of missile defense activities. While there is increased attention within DOD on funding for space and building the Space Force, such widespread acquisition activities could still pose resource challenges. For example:

- Funding requests for space system modernization have in the past 10 years represented a small percentage (3.9 to 5 percent) of total weapon system modernization funding DOD requested. Space is competing with ships, aircraft, and the nuclear triad, among other programs for funding. This can be challenging, because over the past 2 years, DOD has begun over 9 new space acquisition programs to recapitalize current space capabilities and enhance system resiliency.¹⁸ In the past, we have found that it has been difficult for DOD to fund multiple new space programs at one time, particularly when it was concurrently struggling with cost overruns and schedule delays from its legacy programs. For example, OCX system development challenges have resulted in a \$2.5 billion cost increase and approximate 5-year delay to the system becoming operational—using more resources for a longer time—at a cost to other programs.

¹⁸These programs include Electro/Optical Weather System; Enhanced Polar System Recapitalization; Evolved Strategic SATCOM; GPS III Follow-on; Military GPS User Equipment, Increment 2; Next Generation Overhead Persistent Infrared (OPIR) – Ground; Next Generation (OPIR) – Space; Protected Tactical Enterprise Service; Protected Tactical SATCOM; and Space Command and Control.

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- It is unclear whether DOD has a sufficient workforce to manage multiple new space programs. We issued a report this month that found DOD did not routinely monitor the size, mix, and location of its space acquisition workforce.¹⁹ We collected and aggregated data from multiple DOD space acquisition organizations and found that at least 8,000 personnel in multiple locations nationwide were working on space acquisition activities at the end of 2017. Echoing concerns raised in our prior work, we also found that DOD had difficulty attracting and retaining candidates with the requisite technical expertise. Officials from the Air Force's Space and Missile Systems Center were concerned that there are not enough experienced mid-level acquisition personnel and also expressed concern that the bulk of military personnel assigned to program management positions were more junior in rank than the Center was authorized to obtain. We recommended that DOD (1) identify the universe of its space acquisition programs and the organizations that support them, and (2) collect and maintain data on the workforce supporting these programs. DOD concurred with our first recommendation but not the second.²⁰
 - Software is an increasingly important enabler of DOD space systems. However, DOD has struggled to deliver software-intensive space programs that meet operational requirements within expected time frames. Although user involvement is critical to the success of any software development effort, we found in our report issued earlier this month on DOD software-intensive space programs that key programs that experienced cost or schedule breaches often did not effectively engage users to understand requirements and obtain feedback.²¹ Program efforts to involve users and incorporate feedback frequently did not match plans. The lack of user engagement has contributed to systems that were later found to be operationally unsuitable. The programs we reviewed also faced challenges in delivering software in shorter time frames, and in using commercial software, applying outdated tools and metrics, as well as having limited knowledge and

¹⁹GAO, *Defense Space Systems: DOD Should Collect and Maintain Data on Its Space Acquisition Workforce*, [GAO-19-240](#) (Washington, D.C.: Mar. 14, 2019).

²⁰In response to DOD's non-concurrence with our second recommendation, we stated that we continue to believe that taking steps to identify military and civilian personnel supporting space acquisition programs would support DOD's strategic workforce planning, particularly considering DOD's recent legislative proposal for establishing the United States Space Force.

²¹[GAO-19-136](#).

training in newer software development techniques. DOD acknowledged these challenges and is taking steps to address them, including identifying useful software development metrics and ways to include them in new contracts. We recommended, and DOD concurred, that the department ensure its guidance addressing software development provides specific, required direction on the timing, frequency, and documentation of user involvement and feedback. Moreover, it should be noted that software development has been a struggle for other non-space weapons programs as well. The Defense Innovation Board recently reported that the department's current approach to software development is broken and is a leading source of risk to DOD—it takes too long, is too expensive, and exposes warfighters to unacceptable risk by delaying their access to the tools they need to assure mission success.

Chairman Fischer, Ranking Member Heinrich, and Members of the Subcommittee, this concludes my statement. I am happy to answer any questions that you have.

GAO Contact and Staff Acknowledgements

If you or your staff have any questions about this statement, please contact me at (202) 512-4841 or chaplainc@gao.gov. Contacts for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals who made key contributions to this statement include Rich Horiuchi, Assistant Director; Burns C. Eckert; Emily Bond; Claire Buck; Maricela Cherveney; Erin Cohen; Susan Ditto; Laura Hook, and Anne Louise Taylor. Key contributors for the previous work on which this statement is based are listed in the products cited.

Appendix I: Status of Major Department of Defense Space Acquisitions

Table 2: Current Status of Major Department of Defense (DOD) Space Acquisitions

Program	Cost and quantity change from first full estimate (in FY 2019 billion dollars)	Current status	Associated new programs
Advanced Extremely High Frequency (AEHF) (satellite system to provide survivable, jam-resistant, worldwide, secure satellite communications for strategic and tactical operations)	Cost and percentage change: \$15.5 billion, 116.7% Original quantity: 5 Current quantity: 6	Four satellites have been launched. The 5th and 6th to be launched in 3rd quarter fiscal year 2019 and 2nd quarter fiscal year 2020. The program's first launch was delayed by more than 3.5 years.	Evolved Strategic SATCOM (ESS); Protected Tactical SATCOM (PTS); Protected Tactical Enterprise Service (PTES)
Enhanced Polar System (EPS) (satellite system to provide protected, extremely high frequency satellite communications in polar region)	Cost and percentage change: \$1.5 billion, -0.9% Original quantity: 2 Current quantity: 2	Operational testing for the second payload is scheduled to begin by 3rd quarter fiscal year 2019, with initial operational capability scheduled for 4th quarter fiscal year 2019.	Enhanced Polar System Recap (EPS-R)
Family of Advanced Beyond Line-of-Sight Terminals (FAB-T) Command Post Terminals (CPT) (user terminals to provide protected and survivable satellite communications for airborne and ground-based users)	Cost and percentage change: \$1.9 billion, 7.2% Original quantity: 95 Current quantity: 109	As of December 2018 the contractor had delivered 22 terminals and the program had installed 5 to begin testing. The program expects to reach initial operational capability by June 2021, an 18 month delay from its previously reported estimate	FAB-T Force Element Terminals (FET)
Global Positioning System (GPS) III (system to provide positioning, navigation, and timing to military and civil users)	Cost and percentage change: \$5.8 billion, 31.8% Original quantity: 8 Current quantity: 10	The first satellite launched in 2018 and a second will be available for launch in mid-2019. The third satellite is expected to be launched in late fall 2019. The program continues to face delayed deliveries of certain satellite components which could affect the schedules for satellites 4 through 10.	GPS IIIIF
Global Positioning System Next Generation Operational Control System (GPS OCX) (ground system to provide command and control for current and new GPS III satellites)	Cost and percentage change: \$6.2 billion, 68.1% Original quantity: 1 Current quantity: 1	A new cost and schedule baseline was approved in September 2018. The program has yet to fully mature the critical technologies that underpin the full OCX system.	Not determined

Appendix I: Status of Major Department of
Defense Space Acquisitions

Program	Cost and quantity change from first full estimate (in FY 2019 billion dollars)	Current status	Associated new programs
Joint Space Operations Center Mission System (JMS), Increment 2 (provide applications, net-centric services and databases, and dedicated hardware to improve space situational awareness)	Cost and percentage change: \$0.5 billion, 42.0% Original quantity: 1 Current quantity: 1	While the program had planned to deliver the full capabilities in Increment 2 by 2016, the program ended development in October 2018 and only delivered a limited number of capabilities. Requirements that were not met by JMS were deferred to the follow-on program, Space Command and Control (C2)	Space Command and Control (C2)
Military GPS User Equipment (MGUE), Increment 1 (military-code capable GPS user equipment)	Cost and percentage change: \$1.5 billion, -5.1% Original quantity: N/A Current quantity: N/A	It is unclear when M-code capable receivers will be fielded. The program expects to complete operational testing in April 2021.	MGUE Increment 2
Mobile User Objective System (MUOS) (satellite system to provide worldwide narrowband satellite communications)	Cost and percentage change: \$7.1 billion, -6.0% Original quantity: 6 Current quantity: 5	Constellation complete with four satellites and an on-orbit spare. The program did not pass operational testing in 2015. Another operational test is planned to begin in May 2019.	Not determined
National Security Space Launch (NSSL) (provides spacelift support for DOD, national security, and other government missions with viable domestic launch service providers)	Cost and percentage change: \$57.0 billion, 193.2% Original quantity: 181 Current quantity: 161	The program awarded launch service agreements to 3 companies in October 2018 to develop launch system prototypes that will be able to launch national security space missions beginning in fiscal year 2022.	Not determined
Space Based Infrared System (SBIRS) (satellite and ground system to provide missile warning, infrared intelligence, surveillance, and reconnaissance)	Cost and percentage change: \$19.9 billion, 265.0% Original quantity: 5 Current quantity: 6	Planned launch dates for GEOs 5 and 6 planned for early 2021, and 2022, respectively. The baseline program was delivered about 9 years later than planned. GEOs 5 and 6 are at risk for delay.	Next Generation Overhead Persistent Infrared (Next Gen OPIR); Future Operationally Resilient Ground Evolution (FORGE), Enterprise Ground Services (EGS)
Space Fence Ground-Based Radar System, Increment 1 (detect and track objects in low and medium Earth orbit in support of DOD's space surveillance network)	Cost and percentage change: \$1.6 billion, -5.7% Original quantity: 1 Current quantity: 1	The program plans to conduct operational testing in Spring 2019, and expects to reach initial operational capability by July 2019.	Not determined

Appendix I: Status of Major Department of
Defense Space Acquisitions

Program	Cost and quantity change from first full estimate (in FY 2019 billion dollars)	Current status	Associated new programs
Wideband Global SATCOM (WGS) (worldwide communications services to U.S. warfighters, allies, and other special users)	Cost and percentage change: \$4.2 billion,* 216.3% Original quantity: 3 Current quantity: 10	Funding for the Air Force to procure two additional WGS satellites was included in the Explanatory Statement accompanying the Consolidated Appropriations Act, 2018. Analysis of Alternatives (AoA) to identify options for providing capabilities beyond WGS completed its analysis phase in June 2018.	To be determined following AoA
Weather System Follow-on (WSF) (satellite to provide remote sensing of weather conditions using polar-orbiting satellite)	Cost and percentage change: \$0.9 billion, N/A Original quantity: 2 Current quantity: 2	Program is to enter development in March 2019. First satellite expected to be launched late 2023.	Electro-Optical/Infrared Weather Systems (EWS); Electro-Optical/Infrared Weather Systems Geostationary (EWS-G)

Source: GAO analysis of Department of Defense information | GAO-19-458T

Note: Dollar figures are rounded to the nearest tenth and reported in fiscal year 2019 dollars based
on the programs' original and most recent Selected Acquisition Reports or program office updates.

*This value does not include the cost of 2 satellites funded by international partners.

Appendix II: Best Practices GAO Has Identified for Space and Weapons Systems Acquisitions

Our previous work on weapons acquisitions in general, and space programs in particular, identified best practices for developing complex systems. We summarize these best practices in table 3, below.

Table 3: Summary of Best Practices GAO Has Identified to Address Space and Weapons Acquisition Problems

Before undertaking new programs
Prioritize investments so that projects can be fully funded and it is clear where projects stand in relation to the overall portfolio.
Follow an evolutionary path toward meeting mission needs rather than attempting to satisfy all needs in a single step.
Match requirements to resources—that is time, money, technology, and people—before undertaking new development efforts.
Research and define requirements before starting programs and limit changes after they are started.
Ensure that cost estimates are complete, accurate, and updated regularly. Commit to fully fund projects before they begin.
Ensure that critical technologies are proven to work as intended before programs begin. Assign more ambitious technology development efforts to research departments until they are ready to be added to future generations (or increments) of a product.
Use systems engineering to close gaps between resources and requirements before launching the development process.
During program development
Use quantifiable data and demonstrable knowledge to make decisions to proceed, covering critical facets of the program such as cost, schedule, technology readiness, design readiness, production readiness, and relationships with suppliers.
Do not allow development to proceed until certain thresholds are met—for example, a high proportion of engineering drawings completed or production processes under statistical control.
Empower program managers to make decisions on the direction of the program and to resolve problems and implement solutions.
Hold program managers accountable for their choices.
Require program managers to stay with a project to its end.
Encourage program managers to share bad news, and encourage collaboration and communication.
Hold suppliers accountable for delivering high-quality parts for their products through activities including regular supplier audits and performance evaluations of quality and delivery.

Source: GAO | GAO-19-458T

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Senator FISCHER. Thank you very much.

Thank you all for your opening statements. We'll begin questioning for the first round.

I have a question for General Thompson, West Coast. As I'm sure you're aware, arguments are being made in the press against the way the Air Force has structured its efforts to replace the RD-180 and develop the next generation of launch systems. And I know that the terms of phase 2 have not been finalized as of yet, so we have to be careful to keep our discussion very general. But, I would ask that you talk us through some of the tradeoffs that we need to keep in mind when we hear arguments against down-selecting the two providers or questioning the intent to split launches on

that 60–40 between them. So, help us understand some of the original thinking behind the way that this was structured, please.

Lieutenant General John THOMPSON. Thank you, Chairman. That's a fantastic question.

You know, 5 years ago, the Congress challenged us to get off Russian-made RD–180s and assure access to space using two domestic launch providers capable of launching to our most stressing national security space orbits. The Air Force rose to that challenge, competitively awarding technology maturation, rocket propulsion system and launch vehicle service agreements to mature commercial technologies and capabilities for national security space assets. Industry rose to that challenge, as well.

We are ready to issue a Request for Proposal (RFP) for the launch service procurements. All potential offerors have sufficient maturity, and we expect a full and open and robust competition. Award is anticipated in the spring of 2020. Offerors will be able to update their proposals throughout the evaluation period if they have technological maturities or design review completions. We're confident we're on the right path for our Nation's warfighting capability, and that we're being good stewards of the taxpayers' dollars.

Madam Chairman, when you referenced the 60–40 split, the 60–40 split is really essential for us, for three reasons. Number one is, it gives us flexibility on the manifest to be able to move some of our Nation's most important satellites from provider to provider. Number two, it's almost like a block-buy concept, where we're able to take advantage of competition and savings while still rewarding the best offeror. And then, finally, which is something that I really need to articulate to everyone, is that 60–40 is a two-way split. A number of folks have asked us if it's possible to split it three ways. Our launch manifest that we need to purchase between 2020 and 2024 simply does not support three offerors in that trade space at the same time. None of the offerors' business cases would close if we tried to open it up to three different offerors.

Now, as we move forward, after we take a look at the proposals and have details based on those proposals and what the technical approaches are, after we've assessed those risks, when we make the award next spring, then my guess is that we'll have an opportunity to discuss, for those offerors that did not receive awards, how we will keep them in the game so that they can compete for phase 3, which would be our next launch service procurement (LSP) in the future.

Senator FISCHER. If I'm hearing you correctly, sir, are you saying that, due to the amount of business that would be available, having three companies might not be sustainable, and it would be, in your view, better to have two companies that are healthy and able to move forward through this process?

Lieutenant General John THOMPSON. Chairman, that's absolutely correct, from the standpoint of the national security space portfolio. There are also commercial kinds of activities that other offerors could participate in. Whether or not the commercial industrial base in that time period will support three launch providers, I would have to take for the record and get back to you.

[The information referred to follows:]

The decision to competitively award two National Security Space (NSS) launch service procurement contracts is based upon comprehensive market analysis. This analysis considered warfighter requirements, statutory limitations, independent market research, and 6 years of industry engagement. The Government will select for award the two offerors that, when combined, represent the overall best value to the Government. The current launch manifest requires 35 NSS launch service procurements, or about 7 launches per year split between two providers (3 or 4 launches per provider per year), over the fiscal year 2020–fiscal year 2024 Phase 2 ordering period. Since 2014 the government has solicited, via formal and informal means, industry feedback to determine the number of NSS missions each would require to close their business case. Based on this information, the Air Force determined that Phase 2 launch services procurement requirements cannot support more than two providers. In order to maintain 100 percent mission success, the Air Force implements a robust Government Mission Assurance process that depends on in depth launch systems knowledge. Retaining more than two launch systems dilutes this critical mission assurance function increasing risk of failure. Additionally, National Security Space Launch-class satellites are very complex and require extensive integration with the launch vehicles. Maintaining more than two launch systems sub optimizes the satellite ability to fulfill its mission. The Secretary of the Air Force has asked us to independently assess the commercial launch market, using a Federally Funded Research and Development Center. We expect interim results in June 2019 with a final report delivered in early November 2019.

Senator FISCHER. Thank you. That will be helpful. Thank you.

Also, General, the Air Force has talked about the development of the next-generation—

I'm going to hold this question till the next round. I see I'm out of time. Thank you. Senator Heinrich. I'm not going to abuse my power.

[Laughter.]

Senator HEINRICH. We'll save that for another day.

Senator FISCHER. Another day.

Senator HEINRICH. Lieutenant General "JT" Thompson, you used the term "block buy" in reference to the 60–40 split. So, that begs the question, I think, to you, Ms. Chaplain—the Air Force has a long history of launch block buys. Can you describe those and what issues you saw in them, in terms of pricing and competition, that we should be thinking about?

Ms. CHAPLAIN. Yes. Like you say, it's been a long history. When they were about to do their last set of block buys, we reported on a lot of issues, in terms of the knowledge not being there that they needed—pricing, cost, manifest, things of that nature. Those emanated from the nature of Evolved Expendable Launch Vehicle (EELV) and how it started as a commercial-like acquisition, that you couldn't obtain certain pieces of knowledge under the contracts that they had. But, when you neck down to one provider, that became an issue. The Air Force did listen to our recommendations at the time, regrouped, got the knowledge it needed to make that block buy. But, there's always a risk, going forward, if you're going to be awarding fixed-price contracts with limited information, and you somehow end up with one provider again, that you might be back in that same situation, in terms of having the right insight.

One concern we have with the approach, going forward, is, there may not be enough commercial launches for three providers, there might not be enough to sustain two. So, that's a question, given the demand on the DOD side and what assumptions we have about the commercial sector, and how hard it is just to predict what's going to happen in the commercial sector.

Senator HEINRICH. Lieutenant General Thompson—“JT” Thompson, give us some insight into how you’re confident that it will support two. And then, are you also confident that, that these long-term blocks will be cost-competitive?

Lieutenant General John THOMPSON. So, Senator, in terms of why we’re confident that we will be able to support two is, we know, essentially, the manifest that we have to support in the 2020 through 2024 timeframe, in terms of when we would purchase the rockets, or when we would purchase the services—and then from 2022 to 2026, when those rocket services would actually launch. We know that we have anticipated what the costs would be, and we’re confident that we can support two, with a 60–40 split, through the National Security Space Launch Program.

Senator HEINRICH. In followup to that—I’m trying to understand something that happened last week, on March 20th. The Air Force released a Notice of Intent for early integration studies.

Lieutenant General John THOMPSON. Yes, sir.

Senator HEINRICH. All four contractors competing for launch services were listed, including SpaceX. Does that study reopen the opportunity for SpaceX or the next down-selected to compete for Federal funding? Or what is the impact of that early integration study as to all four contractors?

Lieutenant General John THOMPSON. Senator, the early integration studies are, basically, a standard operating procedure that we use 3 years before we award a satellite launch. It’s, essentially, low-dollar study money for vendors to be able to begin working with satellite providers to understand the satellites that are on the manifest that year and what the interface requirements and technical terms are between the rocket and the satellite, the launch vehicle and the satellite vehicle.

Senator HEINRICH. Let me switch to Space RCO. Obviously, what we used to call Operationally Responsive Space, now Space RCO, was really designed by Congress to be disruptive. And, in fact, Congress had to fight the Department from terminating the office, in my view, for most of a decade, because it was so disruptive. Today, it seems that leaders in the Pentagon really value that disruption. So, Lieutenant General “DT” Thompson, I want to ask you, if Space RCO were provided the appropriate resources, would it be able to conduct missions, like building a network of small satellites in low-Earth orbit (LEO) with a mix of communications, gear, and sensors designed to detect hypersonic weapons?

Lieutenant General David THOMPSON. So, Senator Heinrich, first of all, thank you for that question. I would say, up front, yes, that acquisition organization, and any other organization with the right resources, would be able to pursue that activity.

I’d like a few minutes to talk a little bit more about Space RCO. First of all, as you noted, with the help of Congress, we have succeeded in turning the Operationally Responsive Space office into a true rapid acquisition organization. In addition, with the change directed by Congress, we rearchitected and re-resourced the entire office. It is now focused on what I will call space superiority programs that don’t have a home anywhere else in the acquisition enterprise today, but are urgently needed to help us with our defend-and-protect missions. We’ve got the people we need, we have re-

sources. It is crafted and shaped after the Air Force RCO model, with an Air Force Board of Directors led by the Secretary of the Air Force, streamlined authorities, streamlined decisionmaking processes. So, it is up and running, effective, and helping us with our most urgent defend-and-protect priorities.

But, yes, it could also take on other responsibilities, in that sense, if appropriately resourced.

Senator HEINRICH. Madam Chair, I apologize. Now I've abused my time.

Senator FISCHER. Never. Thank you, Senator.

Senator ROUNDS.

Senator ROUNDS. Thank you, Madam Chair.

For General "JT" Thompson, first of all, how many RD-180 motors do we have in hand right now?

Lieutenant General John THOMPSON. I believe the number is 12. I can confirm that, for the record, for you, sir.

[The information referred to follows:]

The fiscal year 2015 NDAA, and as amended by the fiscal year 2016 and fiscal year 2017 NDAAs, authorizes the Department of Defense to procure up to 18 Russian RD-180 engines (via launch services contracts) before 31 December 2022. To date, the Air Force has procured 6 of these 18 authorized RD-180s leaving 12 available for order.

Senator ROUNDS. How many do you intend to purchase?

Lieutenant General John THOMPSON. There were 15, but, in our most recent source selection, we awarded 3. So, there's 12 remaining, out of the 18 that we're authorized for the National Security Space Launch Program.

Senator ROUNDS. So, we had a total of 18 that we had authorized. You've currently used six of them. So—okay.

General "DT" Thompson, with regard to the command and control and the need for your cyber operations to be integrated within this, where is the responsibility for the cybersecurity laid? Is that within a separate order, or are you finding that within the cyber mission forces that we have today?

Lieutenant General David THOMPSON. Senator there's elements of both. First of all, inside of Air Force Space Command, inside of our operational squadrons today that are operating the satellite, there is a requirement for what we call mission defense teams organic to the squadrons. They live and work on the cyber terrain, the command-and-control systems that we use to command and control the satellites today. They understand those systems deeply, they have special cyber training and special understanding of the systems to be what we would call "the beat cops" and the first line of defense under an initiative we call Defensive Cyber Operations for Space. That's the Air Force Space Command responsibility.

Then the next tier comes from the cyber mission forces that are organized under the Air Force today under Air Combat Command, but directed by U.S. Cyber Command. They take a broader look. They look at the threats out there. They work with those sorts of persistent threats, and they are also a resource we can bring in to help us when further expertise is needed or capabilities that they don't have. So, it's a layered approach.

Senator ROUNDS. I know, within your discussion points in your statements, there is clear evidence of the understanding of the mul-

tiple domains that we have: air, land, sea, cyber, and space. We're prepared today, and we assume that we're in a position to defend within, as an example, the air domain or the land domain or the sea domain. We know what that means, in that we have weapons capabilities, we have defense capabilities. Offensively and defensively, we're there. When you move into cyber, we have offensive and defensive capabilities. What does it mean in space? Are we in a position where we are now acknowledging that, as a domain, we have to have the same types of capabilities, both offensive and defensive capabilities, or are we restricting ourselves right now to defensive capabilities only?

Lieutenant General David THOMPSON. So, Senator, I would say, very clearly, we have acknowledged, with space as a warfighting domain, we have a special need to defend and protect the capabilities we have. Because we have those capabilities, we are so much better at using them and integrating them, and they provide us such an advantage, we know that, first and foremost, we need to protect them, because an adversary is going to try and take those away from, in conflict.

What I would say is, we also recognize we need to deny the use of space to an adversary. We will not restrict ourselves, and we do not restrict ourselves, to any specific instrument or tool or medium. We need to be able to respond at the time, place, and in the manner of our choosing. And we have a lot of instruments in that regard. Certainly, I believe that probably the Nation needs more discussion about what that might mean in the space domain itself.

Senator ROUNDS. Thank you.

Ms. Chaplain, I'm just curious. You laid out a series of challenges that the Air Force has with regard to the operations within space, some in which we're being successful, some in which we're not and we're recognizing, in those where we have shut down some systems and so forth. Could you share just a little bit with regard to what you see as our capabilities for defending our space capabilities and the challenges that we have today? I recognize this is not a classified setting, but is there a way that you can share with us what our needs are or what you see as areas that we're lacking today?

Ms. CHAPLAIN. I can share a little bit. We recently did a review of cyber protection for weapon systems as a whole, and found that, for weapons in development, they can be easily hacked in the testing process. A lot of that goes to pretty simple things, like password management, cyber hygiene, patching systems. And there were some space systems included in our review. So, while, on one hand, there's a lot of attention being devoted to cyber, a lot of resources, the Department understands the priority and has taken a lot of good steps now. I think there's a lot in the culture that needs to come a ways to just do the basic things that everybody has to do to protect their systems. They're not expensive, and it would put the Department in a much better place.

Senator ROUNDS. I would note that the Navy most recently had a similar review, and came up with some surprising things, as well.

Ms. CHAPLAIN. Yeah. Very surprising.

Senator ROUNDS. Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator.

Senator King.

Senator KING. Thank you, Madam Chair.

I don't want to be argumentative, but I'm skeptical. I want somebody to explain to me why we need a Space Force, particularly when it's not going to include NRO, NASA, Office of Space Commerce (OSC), the private launch companies, or missile defense. I mean, it strikes me as a solution in search of a problem. You really can't manage this now, under the auspices of the Air Force? I'm not anti-, but I'm skeptical, I guess.

Secretary RAPUANO. So, Senator, I'll take a first shot at that.

Fundamentally, we are concerned about the risk of losing our advantage in space.

Senator KING. So, how does an organizational change of moving the boxes around affect that, one way or the other?

Secretary RAPUANO. Well, I would just go further in saying that, historically, we have operated in space in a permissive environment. We have tremendous dependencies and capabilities that are space-based or space-enabled. We now have adversaries, peer-level potential adversaries, who are quite focused. In fact, in 2015, China and Russia reorganized their military for increased focus on their space capabilities. And they're looking at how they can negate our advantages in space.

Senator KING. Well, I certainly understand that. And today's headline is, "India Successfully Tests Satellite Killer." I mean, that's this morning. I understand the change in the dynamic and offensive and defensive capabilities. I just don't understand how creating a new box with a new name within the Air Force increases our ability to deal with these issues. That's what I'm troubled by. I understand the challenge, and I understand the importance of meeting it, but this is not comprehensive. There's a lot of the space infrastructure that's not included in this new entity.

Perhaps I ought to ask your office. What does this gain us, in terms of capability? It just seems to me it's drawing new boxes and having new people.

Ms. CHAPLAIN. Sure. I think there's two sides to it. One is the threat side and needing to really focus people on that and prioritize it.

Senator KING. Are we not focused now? The Air Force isn't paying attention to this now?

Ms. CHAPLAIN. It's part of U.S. Strategic Command's (STRATCOM) mission to defend space, and the person running that mission has a lot of other priorities. So, there's one thought to segment space in the defense of space to one individual, one organization. The other thought is just on the acquisition side. What we reported on is, there are a lot of players involved in space, there's a lot of fragmentation, and you find that really affects the ability to get capability out quickly. There seems to be a lot of disconnects that happen just because of the way—

Senator KING. But, it seems to me that's a management challenge. Do you have an estimate of the incremental cost of creating this entity, over and above current expenditures for all of these purposes?

Ms. CHAPLAIN. Yeah, I think DOD has done its cost estimate.

Senator KING. What's the number?

Secretary RAPUANO. So, the first year of the Space Force would be \$72 million. At the end of the Future Years Defense Program (FYDP), at the end of fiscal year 2024, it would be up to \$500 million annually. You're talking about \$2 billion total over the next 5 years.

Senator KING. So, \$500 million a year, half a billion dollars a year, in organizational change. I mean, are you coming before us, saying, "We can't manage this now, and we need to spend half a billion dollars a year"? You understand what I'm asking, I'm sure. Convince me that this makes some sense, that it's worth \$500 million a year.

Secretary RAPUANO. Again, the transition from operating in space in a permissive environment, with all of the capabilities and dependencies, to a warfighting environment really requires a focused approach. We're doing it at three legs of the triad, essentially. The first is the U.S. Space Command. That's the operational employment of the Joint Force on a day-to-day basis.

Senator KING. Is that going to go away under this proposal?

Secretary RAPUANO. No. In fact, it was recently directed by the President, and the confirmation of the Commander of U.S. Space Command is pending with the Senate. I believe it arrived this week. So, that's the employment of the force.

The critical organize, train, and equip component is the service component. And that really is the doctrine, the training, the plans, the personnel development. It is the unified and singular focus on space as a warfighting domain that is very difficult to achieve unless you have that unified, sole responsibility and custody—

Senator KING. I'm out of time, but I—I'd appreciate it if you could supply, for the record, a 1- or 2-page justification for the incremental cost of the organizational change, and outline what the tangible benefits will be of this change.

Secretary RAPUANO. Yes, I will, Senator.

[The information referred to follows:]

Secretary RAPUANO. The establishment of the Space Force would be phased over five years—fiscal year 2020 to fiscal year 2024. The President's Budget for fiscal year 2020 requests \$72.4 million of initial resources necessary to establish a Space Force headquarters with approximately 200 personnel. Establishing a sixth branch of our military with dedicated leadership will elevate, unify, and focus the development of space doctrine, capabilities, and expertise to outpace future threats; institutionalize advocacy of space priorities; and further build space warfighting culture.

Over the next five years, the Department would methodically grow the Space Force. The total additional cost growth over those five years is estimated to be less than \$2 billion, or approximately 0.05 percent of the DOD budget for the same period. During that time, as missions are transferred to the Space Force, existing personnel and budget authority would transfer into the Space Force from the other Military Services. By the end of the transition period, more than 95 percent of the Space Force annual budget is estimated to consist of resources that would have been transferred from existing DOD budget accounts, along with an estimated 15,000 transferred personnel.

Additional resources would be dedicated to building out the Space Force headquarters and establishing and maintaining investments in space-specific personnel development, including space training and education centers, a warfare center for space, a space personnel center, and a space doctrine development center. These functions would further develop the unique expertise, culture, and ethos necessary for the complex warfighting domain of space. Once the Space Force is fully established, these additive costs are estimated to be \$500 million annually, which would represent approximately 0.07 percent of the DOD annual budget. A breakdown of the estimated additive costs is as follows:

	\$ in Millions
Total Estimated Additive Funding	\$500
Headquarters	\$300
Education and Training	\$110
Warfare Center for Space	\$20
Space Personnel Center	\$50
Doctrine Development Center	\$20

Through the organizational change of standing up a Space Force, the Department will experience many tangible benefits. First, a space training and education center would provide focused military education for space specialists. Next, a warfare center for space would help to develop the tactics, techniques, and procedures for space operations in a contested domain. A space personnel center would ensure that our space cadre is recruited, retained, and managed to develop the skills we need in a space-focused force. Lastly, a space doctrine development center would elevate space doctrine for a distinct warfighting domain on par with air, land, and maritime doctrine. All of these investments would have significant impacts on ensuring we are prepared to maintain our leadership and to defend our interests in space.

Senator KING. Thank you.

Senator FISCHER. General Thompson, at one point, you looked like you wanted to jump into this conversation. I think Senator King's looking for an answer, if you'd like to respond.

Lieutenant General David THOMPSON. Thank you, Madam Chairwoman.

Senator King, I would like to add a little bit, if I can. Certainly, there are aspects of the need to fix some of the problems when you talk about the number of organizations and agencies and activities inside the Department today that are focused on acquisition, that are focused on architecture, and focused on some of them. We certainly need to unify those, give them the right purpose and synchronization and direction in a unifying step.

The second is, as Secretary Rapuano mentioned, the specific focus of a service staff whose responsibility is to organize the forces, train them, equip them, and present them for the warfighting purpose that, in this case the U.S. Space Command, would operate.

But, I would also look at it as not just a "Are we trying to fix a problem?" It's a question of, "Is the Nation prepared? And are we organized to accept and take on the challenge that comes with space as a warfighting domain?" And I would use as an example, 1947 and the formation of the United States Air Force. The War Department and the Army had done a tremendous job creating air capabilities that won World War II—strategic bombardment, air superiority, tactical support, and military transport. No one could argue that the War Department had not done a tremendous job in creating a space arm, but the Nation decided that, at that time, as we looked to the future, as the needs and the requirements and expectations that we expected of airpower, it needed a separate service, it needed a proponent, it needed a four-star advocate on the equivalent scale with the other Services. I would argue, now's the opportunity for the Nation to look at that, have that conversation, and decide, if we're in a similar position, to ensure that we're organized and structured appropriately to meet the challenges of the future. So, it's not just a matter of, "Are we trying to fix problems?"

Is this the right structure for the Nation, going forward, to address these challenges?

Thank you.

Senator FISCHER. Thank you.

Senator COTTON.

Senator COTTON. Mr. Secretary, which nation's armed forces depend most on space?

Secretary RUPANO. So, the United States leverages space more than any country in the world. Our partners and allies, working with us, in terms of those alliances and partnerships, have their own developed capabilities, and we leverage and use them to force-multiply our capabilities. So, the Five Eyes—France, Canada, Australia, New Zealand, the United States—and a number of other partners have space-based capabilities, as well. The South Koreans have some space capability. And it's multiplying. And, as noted earlier, the commercial sector has exploded, in terms of scope and scale of the activities and the speed of the development of capabilities. So, you're seeing a proliferation of that technology now spreading much more rapidly than ever before.

Senator COTTON. So, it's all good with our allies, but, ultimately, that comes back to the central position that space plays a role in the way we fight wars. What about our adversaries, Russia and China? How dependent are they upon space for their armed forces?

Secretary RUPANO. China has expanded by orders of magnitude. The Russians have grabbed back, they have newly invested in space, and have developed some relatively exquisite capabilities. But, the scale of the Chinese investment is the lead, in terms of everyone else out there, including Russia. They have more rocket launches this year than the United States. They're the lead rocket-launch nation in the world.

Senator COTTON. How much of that Chinese investment is designed specifically to counteract the advantage that we had enjoyed in space over the years?

Secretary RUPANO. We are concerned that they are making significant investments to do that.

Senator COTTON. There's no way to avoid space being central to our way of war, is there? I mean, some of it is a legacy based on our technological advantages, going back to the early days of the space era, but it's also just the fact that we live in the new world, and they all live in Eurasia, and we have to project power across a global scale, which depends on space. Secondly, we have made the choice, over the last 30-to-35 years, to fight information-centric warfare. I don't just mean long-range precision strikes or fancy cyberattacks. What does it mean to a private on the ground with a rifle if we lose dominance in space?

Secretary RUPANO. It's pivotal. Our targeting, our communications, positioning, timing, location for GPS, and then all of the Intelligence, Surveillance, and Reconnaissance (ISR) capabilities, in terms of surveillance and reconnaissance that we get from space, realtime situational awareness of adversaries' locations and activities. To lose those capabilities would be very significant. And that is why we are so focused on defending and protecting them.

Senator COTTON. Let's talk about defending them. Where are we today versus, say, where we were a year ago in our space assets?

Are we more or less vulnerable to, say, a kinetic strike from an anti-satellite missile?

Secretary RAPUANO. So, we are improving our capabilities from investments that started several years ago. In fact, even late in the Obama Administration, there were some significant investments, as you're aware, from this committee and others. In terms of the details of those activities, we could discuss that in a closed hearing.

Senator COTTON. More or less vulnerable to cyberattack, both in orbit and on the ground?

Secretary RAPUANO. As noted earlier, we're very focused on the cyber piece, so we don't know what we don't know, in some respects, in terms of what an adversary may be doing, but we are hardening the entry points, and there are fewer entry points in space—some space systems versus other systems that are more connected and networked. We're making progress there. But, it's a priority, and we are continuing to approach it quite urgently.

Senator COTTON. More or less vulnerable to the kind of laser attacks that might dazzle or destroy a satellite system?

Secretary RAPUANO. We are concerned about ground-based effects on satellites, and we are seeing potential adversaries invest in them.

Senator COTTON. I raise these questions knowing that you can't get into the greatest detail in this open forum, but just to highlight the vulnerabilities of our space systems, both our sensors, but also the critical systems on which everyone in our military depends, to include that private out on the ground. We may not want to have a space race. We may not want to weaponize space or have weapons in space. But, if our adversaries are competing there, we don't really get a choice whether we compete. We only get a choice whether we win or lose.

Thank you, gentlemen.

Secretary RAPUANO. Yes, Senator. Thank you.

Senator FISCHER. Senator Manchin.

Senator MANCHIN. Thank you, Madam Chair.

Thank you all for being here. Sorry, I was in another committee meeting before I got here, so I think this was covered, but I'm not sure. I wanted to ask.

General John Thompson, I know there are two acquisition programs and reforms as part of the Space and Missile Systems Center. I think you mentioned 65 percent savings in the timeline that you laid out, which sounded good on the surface. Was that correct, in your statement?

Lieutenant General John THOMPSON. Sir, I'm sorry, could I ask you to rephrase the question?

Senator MANCHIN. The 65 percent savings in timeline which was laid out—

Lieutenant General John THOMPSON. Oh, sure. Sure. Thank you very much.

Senator MANCHIN. Okay.

Lieutenant General John THOMPSON. So, what you're referring to is a rearchitecture that we've done to the Space and Missile Systems Center, called the SMC 2.0. When I arrived at SMC, about 2 years ago, what I found was a bunch of outstanding people that really knew the space acquisition business, but they were orga-

nized very hierarchically and in stovepipes by mission area. There was very little crosstalk among major programs of record. Decisions took a long time to make, because the decision packages had to fight their way up through the staff.

What we have entertained now is an SMC 2.0 construct, which turns our—what I would refer to as an Industrial Age business-model kind of organization into a new, modern corporation, something like that you might see in Silicon Valley. So, a much flatter organization. We've delegated authority down to senior civilians and senior military officers who know what they're doing. We've added three new program executive officers, in addition to me, and put them closer to the program offices so that they can make decisions faster. Making decisions faster—in many cases, what we've seen on major program-of-record milestone decisions is, we've been able to save 60 to 70 percent of the time required by eliminating layers of the bureaucracy and getting those decisionmakers closer to the program offices.

Senator MANCHIN. Any one of you all—with so many agencies out there, I'm concerned, because, on the cyber end of it, espionage and things that are happening, there are so many smaller contractors. We don't seem to have good oversight or good controls of the main contract with its security clearances and also the programs it is using. That's where I think an awful lot of espionage has gone on, and a lot of cybertheft is going on. And I don't see anybody changing that or going after that total control. If you have an RFP, and you have a main contractor, that person should be held accountable and responsible for anybody and everybody they bring onboard. And we're finding that's not the case.

Secretary RAPUANO. Senator, thank you for that question.

We are highly focused on the defense industrial base, all of those companies who support the development of Department of Defense—

Senator MANCHIN. I understand. We found out that there could be four or five subcontractors all from the Department of Defense that go in to the main contractor. By the time that contractor goes down to subcontractors, they're all trying to protect their domain to give them a competitive edge and make money. It's all fine. But, you want to know why China's been able to ramp up so quick? This is loosey-goosey down here. They can almost pick up anything, and no one's tightening that up.

Secretary RAPUANO. We are in the process of tightening that up. And part of that are the contract requirements that need to be modified to ensure that those who are performing on DOD contracts are required by the contract stipulations to ensure that cybersecurity—

Senator MANCHIN. I'm told that some of the smaller subcontractors don't have the wherewithals. So, the prime should be held totally responsible to make sure that they have the wherewithals, or they don't work with the subcontractor that doesn't. Nobody's holding anybody accountable, because the prime can say, "That's a sub-contract," or, "That was subbed out to another sub." Does that make sense?

Secretary RAPUANO. That is part of the challenge. Absolutely.

Senator MANCHIN. You all do recognize that that's a big problem.

You recognize that China's rapid advancement has been because they've been able to tap into some of our most strategic and confidential and high-security information, they've been able to get fairly rapidly, fairly easily?

Secretary RUPANO. We see it as a vulnerability, and we are focused on addressing it.

Senator MANCHIN. Anybody else want to comment on this? Please do.

Lieutenant General John THOMPSON. Senator, that is a fantastic question, and we agree 100 percent with you.

Sir, General "DT" Thompson and I happen to work with General "Jay" Raymond, who is the current Air Force Space Command Commander, and he has made it abundantly clear, to both "DT" and me, in a very forceful manner, that the situation that you state is unsatisfactory. We have a number of initiatives underway to battle exfiltrations of our weapon systems data from our cleared defense contractors. And holding the primes accountable to ensure that their subs, whether they're one level down, two levels down, or three levels down, is one of the principal—

Senator MANCHIN. We're finding out that some of the primes have no idea, third and fourth and fifth in the chain, who they are.

Lieutenant General John THOMPSON. Sir, in the acquisition domain, specifically in the space portfolio, we are working after that. I would ask you to let me submit something in the record that gives you the details of that plan.

[The information referred to follows:]

The Space and Missile Systems Center (SMC) has not been made aware of classified weapon system information being compromised by foreign adversaries. Controlled unclassified information (CUI) on space mission systems is being exfiltrated from Cleared Defense Contractors (CDCs) at an alarming rate. CDC networks tend to be easily breached permitting propagation and exfiltration of data relating to the development and operation of space mission systems. Contracts awarded before November 2016 generally do not include clauses stipulating: encryption of DOD information; network traffic monitoring; prompt system patching; no posting of DOD information to public websites; etc. Newer contracts conform with the more recent Defense Federal Acquisition Regulation System (DFARS) clause for cybersecurity compliance and National Institute of Standards and Technology (NIST) standards and safeguarding requirements for CUI, but these minimums may not be sufficient to safeguard information. Recent DFARS clauses establish the minimum standard for basic cybersecurity requirements, but SMC is taking additional, multiple steps to better secure our controlled unclassified information on cleared defense contractors' networks. To quickly attack this issue, SMC hired an experienced Federally Funded Research and Development Center (FFRDC) to rapidly scan and establish exposure levels for three prioritized weapon systems: Advanced Extremely High Frequency (AEHF), Global Positioning System (GPS), and Space Based Infrared System (SBIRS) and to develop a methodology to assess the remainder of SMC's portfolio of contracts. The most significant takeaway is the need to mandate cybersecurity requirements above existing Defense Federal Acquisition Regulation Supplements and information management control plans from prime to subcontractors and specify these requirements in contract language for all future contracts. Working with the Air Force Inspector General and the Air Force Office of Special Investigations, SMC is conducting compliance audits to identify industry best practices to better strengthen corporate networks where CUI is stored or processed. With assistance from the Defense Cyber Crime Center, SMC will begin advanced adversary emulation to assess the vulnerability of CDC networks and identify weaknesses in corporate cyber security posture. SMC continues to investigate ways to cooperatively and proactively monitor CDC networks where our CUI will exist in an effort to shorten the response time from compromise to recovery. Knowing that no network will ever be 100 percent secure, SMC is implementing advanced data obfuscation on every future contract to further complicate and stress adversaries' cyber activities. To prevent our CUI riding on weak CDC networks, SMC is testing requiring

companies to submit a vulnerability scan of their network with their responses to our Request for Proposals. Finally, SMC is implementing changes to incentive plans to encourage CDCs to be more proactive in their cyber security efforts, and, if positive incentives do not work, SMC will explore negative incentives. SMC understands the importance of continuing to protect sensitive weapon system information on cleared defense contractors' information systems. We are working with industry partners and across the Air Force and Department of Defense to ensure we can adapt to threats now and into the future. We look forward to working with Congress as we work to ensure our sensitive data and our weapons systems are protected from adversary threats.

Senator MANCHIN. Happy to.

Lieutenant General John THOMPSON. Then, perhaps, if you're interested, we could go to another forum and talk about it in classified setting.

Senator MANCHIN. Senator Rounds and myself have a Subcommittee on Cybersecurity, and we're getting into procurement. This is a big thing with us right now, because you just have to look back not that far to find out how China and others have been so successful at rapidly deploying and getting up to speed at a much quicker rate. You know, they say, except for the second engine, their F-35 mimics ours to a tee. There's no way to do that, except being able to get all the pertinent information needed.

Madam Chairman, we just have a terrific problem, here. And it goes into procurement, and it goes all the way down the chain. We don't hold the prime, which is the big boy accountable—and a subcontractor does not get a contract from them, because they're not large enough to do it on their own, so they end up being a sub, and they're held hostage by the prime. The prime is not held accountable to the sub and what the sub's doing and how it secures its systems. It goes down to second, third, and four tier, you've really got a problem. And I think they realize it. It's been out there for quite some time. With your Subcommittee and our Subcommittee working together, hopefully we can make some major changes.

Senator FISCHER. Hopefully, General Thompson will get that information to you and to all of us, Senator Manchin, and then maybe we can follow up and do a classified so we can get in more to the details on it, if that would be helpful.

Thank you, Senator Manchin.

Senator Hawley.

Senator HAWLEY. Thank you, Madam Chair.

Mr. Secretary, I want to go back to something you said to Senator Cotton. You said that China has expanded its capabilities in space by orders of magnitude. I just wanted to dig into that a little bit more. The Defense Intelligence Agency (DIA) produced an unclassified report this past January, "Challenges to Space Security," in which it described a number of disturbing patterns of our competitors. China, it appears, is directing an Asia-Pacific Space Cooperation Organization. I'd note that the rotating membership includes nations like Iran and Pakistan. Russia, this report says, has the largest foreign network of ground-based optical space surveillance sensors in its Keldysh Institute of Applied Mathematics, coordinates sensor tasking and fuses information from nearly 100 ground-based optical sensors on 40 observatories spread across 16 countries. Is it fair to say that China and Russia have a coordinated international effort to threaten the United States in and from space?

Secretary RAPUANO. With regard to complicity between China and Russia, less clear, but, in terms of the objectives of individually, China and Russia, absolutely. They are looking to asymmetrically undermine our space capabilities.

Senator HAWLEY. This is a top priority for them, is it fair to say?

Secretary RAPUANO. Fair to say.

Senator HAWLEY. The expenditures that you were detailing earlier, both from the Chinese and the Russian Government side, show a renewed emphasis for both of them on a modern-day space race. Is that fair to say?

Secretary RAPUANO. That is fair.

Senator HAWLEY. Let me come back to something you said to Senator King. You were talking about the triad to approach this issue. You talked about U.S. Space Command, you talked about the service component. You didn't get to the third piece.

Secretary RAPUANO. Yes, thank you. Thank you for asking.

The third piece is really about the development. And that's where the space development piece comes in, in terms of SDA. It is about, really, leveraging innovation, it's about leveraging commercial practices and capabilities that are developed on the commercial side, and it's really looking at the transformational capability set. So, one of the areas that SDA will be focused on is a massively distributed sensor communications architecture in LEO to be more resilient, degrade more gracefully under attack, and provide us more reliability, as well as reconstitution if we lose assets. That would be a critical capability fill, in terms of operating in a warfighting environment, where we have adversaries who are looking to get at our assets.

Senator HAWLEY. Understood. Let me just ask you a budget question. Do you think your request for a 56 percent increase in the space situational awareness part of the budget is sufficient to meet the threat that we're seeing from our adversaries?

Secretary RAPUANO. We are comfortable with the President's \$14 billion request for the next fiscal year. We believe that it covers our major requirement areas.

Senator HAWLEY. General David Thompson, let me ask you about another piece of the budget. It includes a request for a 115 percent increase in science and technology, which seems very wise, given the scale of the challenge that we're facing. I just wonder, Who have been your biggest partners in this effort, particularly in the research, private-sector, and startup communities?

Lieutenant General David THOMPSON. So, Senator, thank you. I would say right now what we're trying to focus on most is recognizing and understanding what's out in the commercial sector, the innovation that's there in the commercial market, the emerging commercial market. There are lots of companies there that are looking at, for example, large-scale constellations that might be fielded cheaply, with tremendous capability.

So, we're currently looking for a couple of opportunities. One is the technology that goes with a low-cost space capability, the actual mission performance, whether it be remote sensing or it be satellite communications or things like that, but the third thing we're looking at is opportunities to partner with them for things like hosted payloads and other things that we might be able to use mission ca-

pability with. So, it's especially focused on the investment you see in the burgeoning commercial space sector.

Senator HAWLEY. Have you encountered any particular difficulties in working with the private sector along these lines?

Lieutenant General David THOMPSON. We have not. They are certainly welcome and open to investment. Really, what is the challenge on our part is twofold. First is picking the right places to invest for strategic purposes. Then, as you talked about, there is certainly an investment there, but there are always more opportunities and needs than there are investment dollars. So, making smart use of our investment dollar.

Senator HAWLEY. Thank you very much.

Thank you, Madam Chair.

Lieutenant General John THOMPSON. Senator, just as a quick addition to that, we've tried to create lower boundaries for entry for a lot of our commercial partners, our nondefense-oriented, non-traditional partners that are bringing new, innovative things to the table. One of our most successful vehicles is called the Space Enterprise Consortium. It's a consortium where we've invited and had join about 270 different contractors, small businesses, and large businesses. About 80 percent of them are nontraditional—in other words, commercial—space companies. We've been able to utilize that vehicle to do a lot of prototyping. We have over \$200 million on contract for 37 different space prototyping efforts, and many of those—in fact, most of those—have a nontraditional component to them. So, we're reaching out to the private sector, looking for those innovative opportunities, going into the future.

Senator FISCHER. Thank you, Senator.

General Thompson, I'm going to follow up with a question I was going to ask you earlier. We are going to do a second round, here.

The Air Force has really touted its development of the next generation of infrared early-warning satellites as an example of its ability to rapidly acquire space capabilities in response to those warfighting demands. When announcing changes to the program last year, the Air Force stated its intention to cut 4 years off the procurement process. Can you talk about the progress you've made in meeting that ambitious goal?

Lieutenant General John THOMPSON. Chairman, relative to the help that the Congress has provided us, the rapid prototyping authorities that we receive through section 804 have been a godsend. Using those rapid prototyping authorities from section 804, we were able to put both layers, if you will, of our Next-Generation Overhead Persistent Infra-Red (OPIR) on contract within 6 months, saving at least a year of time, from the standpoint of what we'd have had to do if we were conducting a traditional source selection.

The process that we went through was simple, but also rigorous. In other words, we don't want to lose the oversight in our section 804 prototyping efforts, similar to what Ms. Chaplain said earlier. We want to make sure that the rigor and the robustness of the oversight that we're providing our contractors is there from the get-go. We also want to make sure that our board of directors, the Congress, is kept fully apprised of what we're doing in our section 804 rapid-prototyping endeavors.

On Next-Gen OPIR, we have a quarterly requirement to come over here. And I will tell you right now, if you want us to come more often than that, we will. We have triennial reports that we're submitting on all of our section 804s, including Next-Gen OPIR, and our goal, from Dr. Will Roper, who is the service acquisition executive, is to offer so much transparency to the Hill on our 804 programs that you'll actually ask us, "Why are you doing this by the DOD 5000 series? We want some more of that 804 kind of execution."

Senator FISCHER. Yeah. Well, I appreciate your attention to the OPIR. It's an extremely important program, and I'm happy to see that it's advancing. Do you believe that the budget that's been presented is going to support that aggressive schedule that you're on right now?

Lieutenant General John THOMPSON. Chairman, the requirement is, for 2025, to have an initial launch capability. We originally envisioned being able to go as fast as 2023. However, the costs in the budget were just not able to make us to that gold-medal level. So, we still consider the fact that we've accelerated the program a little over 2 years, at this point, and we believe that the fiscal year 2020 budget and out years fully supports that. However, there are two above-threshold reprogrammings that we have been trying to work through the Department and over here on the Hill, one for fiscal year 2018 and one for fiscal year 2019. Obviously, we missed the President's budget before we had the requirement to accelerate to 2025. So, we're still looking for about \$600 million worth of above-threshold reprogrammings that we're working very closely on with the Department and the Hill. The fiscal year 2018 Above Threshold Reprogramming (ATR) was approved by the Hill. Thank you for that. But, not all the sources were. So, we're trying to get the sources in line, and then a \$400 million above-threshold reprogramming in 2019 is still required to meet the 2025 need date.

Senator FISCHER. Okay. Thank you.

Ms. Chaplain, I understand that the Government Accountability Office (GAO) recently completed an assessment of the Department's space acquisition workforce, and see that some of your findings are described in your testimony. If you could just, in the remaining time, talk a little bit about the difficulty in tracking and identifying acquisition professionals working on space programs? This isn't really a clear and distinct group of people, is it? You kind of referenced that in your opening remarks.

Ms. CHAPLAIN. Right. I think the Department's pretty good at tracking acquisition professionals in certain lines of effort, like program management, and certain types of engineering. What the Department as a whole doesn't do is track acquisition professionals tied to certain missions, like space. So, the fact that they couldn't do this for space isn't unusual. It's sort of an issue across the Department. But, we believe that maybe we do want to add some fields to the databases that track people so that we can help identify who is in space, especially if we're going to move together some organizations.

Also in our review, we came across comments and concerns about gaps in expertise in certain areas for space, mostly in the technical things, and trying to keep people on for long periods of time and

get professionals in at the mid-level. Those are persistent concerns that we've reported on over the years. I know there's been a lot of effort to strengthen the workforce, but it's still an issue for space.

Senator FISCHER. Okay. Thank you.

Senator Heinrich.

Senator HEINRICH. One of you mentioned space situational awareness a few minutes ago, and that, in conjunction with the open-source reporting that Senator King mentioned about India and its ASAT test today, got me thinking: I think it was 2007 when we went through the initial Chinese effort at this, that scattered junk all over low-Earth orbit and made a mess for everyone. What do we know at this point that you can share in this environment on the Indian story? More importantly, do we need some sort of international structure—a space code of conduct, for example—to make sure that, if nations are going to test, they're going to do it in a way that doesn't create the kind of enormous problems, which led, in many cases, to the kind of funding that we have to put into space situational awareness today?

Lieutenant General David THOMPSON. Senator Heinrich, thank you.

I'll talk to you a little bit about the Indian ASAT test that did occur this morning. First of all, we were aware that it was coming, because of some flight bans that India had announced and some information they had published previously. But, the launch occurred at 1:39 a.m., Eastern Time. First of all, let me say clearly, it was detected and characterized and reported by Air Force systems—missile warning systems and our airmen at Buckley Air Force Base.

Senator HEINRICH. Right.

Lieutenant General David THOMPSON. Immediately after the ASAT struck the target vehicle—the Joint Space Operation Center and the Air Force's 18th Space Control Squadron began collecting information about the breakup of the vehicle.

Senator HEINRICH. Yeah.

Lieutenant General David THOMPSON. Currently, they're tracking about 270 different objects in the debris field. Likely, that number is going to grow as the debris field spreads out and we collect more sensor information.

Senator HEINRICH. Do we know what the elevation of that debris field was at the breakup?

Lieutenant General David THOMPSON. Senator, we do, but I'm going to ask to pass that in different channels. I'm not convinced I know that that's an unclassified fact.

Senator HEINRICH. Okay.

Lieutenant General David THOMPSON. But, we do know the altitude at which it occurred. We immediately started providing public notice on our Space Track website, and will provide direct notification to satellite operators if those satellites are under threat. I will also say, at this point in time, the International Space Station is not at risk. That's another thing that we do, and provide warning routinely. But, that's just an example of how no other nation, no other military force, no other civil or other body could have detected, characterized, and begun warning and providing the world the way we do with Air Force and other joint assets. So, that rep-

resents a tremendous capability, but we have more investment to turn that from what I'll call a matter of routine spaceflight safety approach to searching and finding and detecting threats who are attempting to hide from us, as well.

Senator HEINRICH. Do you want to touch on the issue of whether or not we need to engage in some sort of multilateral effort to ensure that someone doesn't make the kind of mistake that China made back in 2007? Do we need some parameters where people agree to, for example, not test at very high altitudes?

Lieutenant General David THOMPSON. I would say—certainly, in a broad sense. And this will be a specific example. There's a lot of work to do with the rest of the world on what are established norms of behavior, rules of engagement, and the code of conduct in space. And I know that's a matter that the State Department and the Department of Defense, led by the Office of the Secretary of Defense (OSD), is working with the rest of the world. It's certainly a need that we all need to address.

I don't know if Mr. Rapuano wants to add more in that regard, but it's a need.

Secretary RAPUANO. We are involved with discussions internationally, and we have participated in nonbinding confidence-building measures associated with activities in space. We are certainly proponents of safe and sustainable space and minimization of space debris. So, that is an active and ongoing conversation.

Senator HEINRICH. Okay.

I'm getting close to the end, here. And given that I went over earlier, I'm not going to make that mistake twice. So, thank you Madam Chair.

Senator FISCHER. Thank you, Senator.

Senator King.

Senator KING. I just want to reiterate the point that Senator Manchin was making. I've been in numerous hearings, and every single Chief Executive Officer (CEO), Secretary of State, whoever, is sitting where you're sitting, when you say, "How's your cyber protection?" says, "We're good. We're safe." None of them know that. So, I want to urge you, if you go to one of your prime contractors and say, "How's it going?" or if you get a contractual assurance, don't believe it. My suggestion is Red Teaming them. There's nothing like a skull and crossbones that appears on the CEO's computer screen that says, "Congratulations, you've been hacked by the U.S. Air Force. Your award is the termination of your contract." I mean, we've got to be aggressive about this, because, to accept assurances everybody gives you those assurances. They don't really know, and they don't know until they've been tested. And you have the capability of doing that. The Pentagon has done bug bounty programs and Red Teams. I urge you to do this.

The intellectual property theft via subcontractors, as Senator Manchin was talking about, is the new frontier. It just came up this morning in a hearing with the Navy. We've had it with Secretaries of State. We've had it with CEOs of utilities. The Wall Street Journal just had a major story about a third-generation sub for a utility, who was a headhunter or something, and got up into the control system of the utility. So, I urge you to not take assurances,

but to be aggressive about this. I think a Red Team approach is one that could, maybe, put the fear in them.

Thank you.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator King.

I'd like thank my colleagues for their attendance and their good questions today, and thank the panel for the information you've provided. If Members do have questions, I hope that you will respond in writing and be able to get those to us in a timely manner.

With that, the hearing is adjourned.

[Whereupon, at 3:47 p.m., the Committee adjourned.]

[Questions for the record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR MARTIN HEINRICH

SPACE FORCE

1. Senator HEINRICH. Secretary Rapuano, the House proposed a Space Force or Corps in its Fiscal Year 2018 National Defense Authorization Act (NDAA) modeled after the Marine Corps. Do you agree that the Space Force proposal submitted with the President's budget is pretty close to what was proposed by the House in 2017?

Secretary RAPUANO. Both the Department's Space Force proposal and the House proposal would have established a sixth branch of the Armed Forces within the Department of the Air Force. The Department's proposal includes an Under Secretary of the Air Force for Space to provide dedicated civilian supervision of the Space Force. It also consolidates existing DOD space forces from across the Air Force, Army, and Navy. While DOD has identified a number of technical legislative changes needed for the new Space Force to function properly, the major concept is generally the same in both the DOD and House proposals to establish a new Armed Force within the Department of the Air Force.

2. Senator HEINRICH. Secretary Rapuano, what has changed since when Secretary Mattis, Secretary Wilson and Chairman Dunford opposed the idea of a Space Force or Space Corps the first time?

Secretary RAPUANO. Mindsets across the Department, including my own, shifted when we dug deeper into this problem. Over the last nine months, we have put a tremendous amount of effort and analytical rigor into understanding the current and future risks to our space missions and capabilities, and analyzed options in order to identify the most effective solution to address these problems. We have come to more fully appreciate the degree to which the world is changing and the Department must adapt accordingly in order to maintain U.S. leadership in space.

3. Senator HEINRICH. Lieutenant General David Thompson, if established, the total Space Force Active Duty would be roughly 10,500. Compare that to the Army, which has roughly 476,000 Active Duty members. Does it make sense to have an entire Service with that few Active Duty members?

Lieutenant General David THOMPSON. If enacted by Congress, the initial size of the Space Force would be 15,000 to 20,000 people, with the vast majority of initial Space Force resources—personnel and budget authority—transferred from the existing Military Services. Space is a unique operating environment with special needs and requirements; we believe it best served by a dedicated branch of service inside the Department of the Air Force. I believe the DOD proposal is sized to maximize warfighting capacity and advocacy for space while minimizing bureaucracy. That said, it is important to note this will be an ongoing process as the new “protect and defend” missions will grow the U.S. Space Force over time. While applying the inherent advantages of a separate service inside the national security enterprise, we also have the opportunity to design it from a 21st Century perspective.

4. Senator HEINRICH. Ms. Chaplain, when adding civilians and headquarters, the Space Force would have a total of around 16,000 people. In terms of overhead, how does this compare to other organizations and Services?

Ms. CHAPLAIN. We have not assessed the personnel requirements for a Space Force. However, in May 2019, the Congressional Budget Office reported on its assessment of the personnel requirements and costs associated with standing up new DOD space organizations, including a military service within the Department of the

Air Force.¹ In its assessment, the Congressional Budget Office made comparisons to other military organizations and estimated a new space service could include 27,000 to 29,700 personnel (based on full time equivalent positions)—22,900 of these positions (10,800 for space operations and 12,100 for support functions like management, acquisitions, and training) would transfer from existing space-related positions, and an additional 4,100 to 6,800 positions would be new for overhead and management. By contrast, according to an Office of Personnel Management website, the largest federal agencies, including the military departments, have more than 150,000 civilian personnel.

5. Senator HEINRICH. Secretary Rapuano, the legislative proposal to stand up the Space Force will give the Department authority to transfer civilian employees on a “on a voluntary or involuntary basis” and “is not subject to any other provision of law that provides appellate rights or procedures for civilian employees of the Department of Defense.” This authority seems overly broad. How are you going to be able to attract and retain a workforce if its work conditions are dealt with in such an arbitrary way?

Secretary RAPUANO. We would like to work with Congress on the right personnel authorities to meet our needs. The Space Force would require highly technical talent. Our objective was to provide flexibility and enable greater streamlining and competitiveness with the private sector. To that end, the Department has seen great success with Title 10 excepted service alternate personnel systems, including the ability to attract and retain its workforce while upholding merit system principles and safeguarding against prohibited personnel practices. The precise system we proposed was modeled on the Defense Civilian Intelligence Personnel System used by the National Reconnaissance Office and other DOD intelligence agencies. We can adapt this proven model to the Space Force. Transfers of civilian personnel would not occur arbitrarily. Civilian employees would transfer in place to the Space Force with the realignment of the mission and billet to which the employee was assigned, with no loss in pay. Employees could also volunteer to transfer to vacant Space Force excepted service positions for which they qualify.

ROCKET SYSTEMS LAUNCH PROGRAM—TACTICALLY RESPONSIVE LAUNCH OPERATIONS

6. Senator HEINRICH. Secretary Rapuano, Lieutenant General David Thompson, Lieutenant General John Thompson, and Ms. Chaplain, the fiscal year 2019 budget included multiple initiatives to improve space resilience, including a new dedicated Air Force procurement line for small launch services called the Rocket System Launch Program (RSLP). Can you speak to how the Air Force is leveraging tactically responsive capabilities for contingency small launch requirements, including expanding these capabilities to include more diverse payload configurations and launch systems, including air-launched space launch?

Secretary RAPUANO. The Department of Defense is exploring new space launch capabilities, such as the Rocket System Launch Program (RSLP), to ensure access to space and improve the resilience of our space architecture. Although I defer to the Air Force on the specifics of RSLP, the Department supports flexible and fast acquisition programs to supplement our more traditional National Security Space Launch (NSSL) programs.

Lieutenant General David THOMPSON. The RSLP funding identified in fiscal year 2019 is planned to deliver a variety of small experimental satellites in support of the Space Test Program (STP). The small launch program complements the National Security Space Launch (NSSL) program with multiple options to acquire dedicated spacelift and rideshare services for developmental, demonstration, and small operational space vehicles. In the course of providing space access for these missions, AFSPC is leveraging a rapid acquisition approach across multiple emerging small launch service providers. For example, on 5 May 2019, Rocket Lab successfully launched an Electron rocket carrying three technology demonstration satellites for the AF Space Test Program.

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¹ Congressional Budget Office, *The Personnel Requirements and Costs of New Military Space Organizations*, <https://www.cbo.gov/publication/55178>, (Washington, DC: May 2019).

small launch service providers. For example, on 5 May 2019, Rocket Lab successfully launched an Electron rocket carrying three technology demonstration satellites for the AF Space Test Program.

Ms. CHAPLAIN. We have not assessed the Air Force's dedicated procurement line for small launch services. However, in 2017, we found that several U.S. companies were developing launch vehicles and related technologies to provide low- and medium-weight payload launch capabilities on the commercial market.² Some of these companies began conducting test flights in 2017 with plans to begin carrying commercial payloads as early as 2018. We found that these emerging companies were implementing schedule flexibility as a key component of their business strategies to meet the demands of small to medium payload customers. These companies could potentially provide launch services to the government through the Air Force's Rocket System Launch Program. Moreover, in 2015, we found that DOD did not have a consolidated plan for developing a responsive launch capability primarily because of a lack of formal requirements for responsive launch, that is, no existing space program had them.³ However, we have not assessed DOD's plans more recently nor reviewed or assessed the criteria related to launch vehicle certification or mission assurance, for example, that the Air Force may have for these vehicles. This would be a good topic for future review, given trends in the launch vehicle market and the increased need for resiliency.

7. Senator HEINRICH. Secretary Rapuano, Lieutenant General David Thompson, and Lieutenant General John Thompson, today, nearly all U.S. national security satellites are launched from fixed coastal U.S. launch sites that could easily be disrupted. Is the Department of Defense (DOD) developing more diverse launch sites using new commercial tactically responsive launch capabilities, including the use of existing military installations to support resilient polar and equatorial launch?

Secretary RAPUANO. Section 1618 of the John S. McCain National Defense Authorization Act for fiscal year 2019 provides that "the Secretary of Defense shall seek to enter into a contract with a federally funded research and development center to conduct a study on space launch locations, including with respect to the development and capacity of existing and new locations." The Department has entered into a contract with the RAND Corporation to conduct that study, which should address the issues raised in this question.

Lieutenant General David THOMPSON. The Air Force is investing in spaceport enhancements at two separate space launch facilities to support responsive small launch capabilities. A combined total of \$30 million has been provided to the Mid-Atlantic Region Spaceport in Virginia and the Pacific Spaceport Complex in Alaska from fiscal year (FY) 2016 to fiscal year 2019. These spaceports are capable of supporting equatorial and polar launch respectively. These enhancements include telemetry and command destruct upgrades, physical and cyber security enhancements, fuel production plants to handle the demands of liquid fueled rockets, and new payload processing facilities to cover the needs of processing DOD payloads and newer classes of small launch vehicles at these facilities. The Air Force will continue to encourage emerging commercial launch capability and spaceport options, to include non-coastal regions, complementing future responsive launch needs.

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8. Senator HEINRICH. Secretary Rapuano, Lieutenant General David Thompson, and Lieutenant General John Thompson, do you support integration and execution of commercial air-launched space launch operations and services on additional military installations, specifically, operationally relevant demonstrations and/or pilot

²GAO, *Surplus Missile Motors: Sale Price Drives Potential Effects on DOD and Commercial Launch Providers*, GAO-17-609 (Washington, DC: Aug. 16, 2017).

³GAO, *Space Acquisitions: GAO Assessment of DOD Responsive Launch Report*, GAO-16-156R (Washington, DC: Oct. 29, 2015).

programs on Guam, in support of U.S. Pacific Air Forces (PACAF), U.S. Indo-Pacific Command (USINDOPACOM) and DOD-wide tactically responsive launch requirements?

Secretary RABUANO. I defer to the Air Force for specifics on the use of PACAF installations, but in general, the Department of Defense is supportive of new technological developments by the commercial space sector to improve and expand space launch capabilities.

Lieutenant General David THOMPSON. Yes, the AF is actively facilitating use of infrastructure at Guam to support commercial air-launch operations. The AF recognizes these types of operations may have utility in meeting future military requirements should they prove successful.

Lieutenant General John THOMPSON. Yes, the AF is actively facilitating use of infrastructure at Guam to support commercial air-launch operations. The AF recognizes these types of operations may have utility in meeting future military requirements should they prove successful.

SPACE DEVELOPMENT AGENCY

9. Senator HEINRICH. Lieutenant General David Thompson, it is my understanding that if we create a Space Force, a Space Development Agency (SDA) will be moved where the Space Rapid Capabilities Office (RCO) resides, or in another scenario, located at or near the Pentagon headquarters. Congress previously enacted language prohibiting a co-location of the Space RCO (formerly Operationally Responsive Space) in order to preserve the disruptive advantages that come with being separate. Shouldn't we, as a general rule, avoid reinventing the wheel, and are you at all worried that the Space RCO will be merged and diluted from its

Lieutenant General David THOMPSON. The location of Space Development Agency is still being determined by the Department of Defense, therefore I will refer any discussion as to its location to the Office of the Secretary of Defense. Leaders across the Department have been focused on the goal of achieving more rapid and agile delivery of space capabilities to the warfighter. The Space Development Agency, the Space Rapid Capabilities Office, the Defense Advance Research Project Agency, the Defense Innovation Unit, the Space and Missile Systems Center, and various other interagency partners all represent distinct and important lines of effort toward that goal. Space RCO is conducting rapid prototyping and acquisition in significant "protect and defend" capabilities that no other agency is pursuing. It has initiated several new programs in the past year and it is our expectation this important work will continue unaffected in a Space Force. Meanwhile, we remain committed to improving the rapid delivery of warfighter capabilities while minimizing duplication of effort and eliminating non-value-added processes and procedures in all DOD space acquisition organization.

NATIONAL RECONNAISSANCE OFFICE

10. Senator HEINRICH. Lieutenant General David Thompson, the White House's legislative proposal currently excludes the National Reconnaissance Office (NRO) from the legislative proposal. As a member of the Senate Intelligence Committee, I understand the NRO's value, and I don't believe we should try to fix something that isn't broken. Do you agree that NRO should continue to be excluded from the Space Force? Please explain why or why not.

Lieutenant General David THOMPSON. The DOD's current legislative proposal does not include the NRO as part of the Space Force. While the DOD and NRO have separate mission sets, we have a shared strategy, concept of operations, programs, and sit together at the National Space Defense Center conducting operations. Beyond that, Space Policy Directive 4 tasks the DOD and Intelligence Community to further improve our relationship, organizational constructs, and integrated support to global joint combined operations. I agree with this approach.

11. Senator HEINRICH. Lieutenant General David Thompson, in your testimony you mentioned that "[o]ur teaming relationship with the National Reconnaissance Office has never been stronger." In your view, is there any reason to believe that this partnership cannot continue and grow stronger still?

Lieutenant General David THOMPSON. I do believe the Air Force-NRO relationship has never been stronger and that it will continue to grow and strengthen. The two examples provided in my testimony, the Silent Barker program and partnership in the National Space Defense Center, involve collaboration on strategy, acquisition, personnel, mission data processing, and funding for the space domain awareness mission. Additionally, we are committed to an ongoing dialogue to identify areas of increased cooperation, improved interactions, shared resources, and expanded part-

nerships aimed at enhancing national space interests as tasked in Space Policy Directive 4. These discussions include future changes to the organization and management of space (roles and responsibilities), mission assurance (resiliency and OPIR), collaboration (S&T, international and commercial), and assured access to space (range support infrastructure).

12. Senator HEINRICH. Secretary Rapuano, the NRO is a civilian agency and the DOD is military, if there is a conflict in space how will you resolve the unity of command issue?

Secretary RAPUANO. As documented in Department of Defense Directive 5105.23, “National Reconnaissance Office (NRO),” the NRO is a Defense Agency, and the Secretary of Defense exercises authority, direction, and control over it. Furthermore, the NRO works in close coordination with other elements of the Department of Defense (DOD) to be ready for unified action in space, as detailed in U.S. Strategic Command’s Concept of Operations for Warfighting in the Space Domain, May 18, 2018.

The DOD and NRO have successfully operated for the past 50 years in a unity of effort construct during peacetime and conflict. This process is described in Joint Publication 3–14, “Space Operations,” April 10, 2018. Further, Space Policy Directive-4 on the Establishment of the United States Space Force, emphasized the continuation and improvement of the unity of effort construct and directs the Secretary of Defense and Director of National Intelligence to “create and enhance mechanisms for collaboration between the DOD and IC in order to increase unity of effort and the effectiveness of space operations.” That report, due to the President of the United States in August, 2019, will highlight the robust and collaborative foundation that the IC and DOD have already established, and will include plans to grow and mature the unity of effort and partnership necessary to persevere during a conflict in space.

Over the past several years, DOD and IC leaders have strengthened partnerships and collaboration that have laid a solid foundation for unity of effort. These include the Joint Space Warfighting Forum partnership between the U.S. Strategic Command and the NRO; the Space Enterprise Vision partnership between Air Force Space Command and the NRO; the National Space Defense Center partnership between U.S. Strategic Command, the NRO and the broader IC; and joint acquisition programs focused on space protection and situational awareness. Additionally, the DOD and IC have participated in an ongoing campaign of wargames and experiments to continue to forge and mature this critical partnership.

ACCOUNTABILITY—SPACE ACQUISITION

13. Senator HEINRICH. Ms. Chaplain, thank you as always for appearing—you are a steadfast hand helping the Senate Armed Services Committee (SASC) out in its oversight duties. Section 804 of the fiscal year 2016 NDAA gave broad authority to bypass many of the acquisition checks and balances in place for Major Defense Acquisition Programs. The Air Force is proposing to use this authority to accelerate many space programs, including the Next Generation Overhead Persistent Infrared (OPIR) satellite program, which will cost in excess of \$5 billion. Are you at all concerned about using this authority with such a large developmental program?

Ms. CHAPLAIN. Yes. Section 804 programs, like Next Generation Overhead Persistent Infrared (OPIR), are exempted from the acquisition and requirements processes defined by DOD Directive 5000.01 and the Joint Capabilities Integration and Development System. Instead, program managers are encouraged to use a tailored, streamlined approach to documentation and oversight to enable them to demonstrate new technologies or field new or updated systems within 2 to 5 years. In June 2019, we found that DOD had yet to fully determine how it would oversee these programs, including what information should be required to ensure informed decisions about program selection and how to measure program performance.⁴ Without consistent oversight, DOD is not well positioned to ensure that these programs are likely to meet expectations for delivering prototypes or capability to the warfighter quickly. GAO and others have highlighted lessons learned from DOD’s past efforts to streamline that diminished its capability to lead and manage the space acquisition process, magnifying problems related to unstable requirements, poor cost estimating and systems engineering, and poor contractor performance. In response to a provision in the Conference Report to a bill for the National Defense

⁴GAO, *DOD Acquisition Reform: Leadership Attention Needed to Effectively Implement Changes to Acquisition Oversight*, GAO–19–439 (Washington, DC: June 5, 2019).

Authorization Act for Fiscal Year 2019 (H.R. 115–863), we plan to initiate a review of DOD’s OPIR acquisition efforts this summer.

14. Senator HEINRICH. Lieutenant General John Thompson, can you describe what parameters bound your use of section 804 programs?

Lieutenant General John THOMPSON. Utilizing section 804 authorities emphasizes building operational capability that addresses the most critical developmental risk to determine what works in practice. In the current space domain, the transition from a benign to a contested domain has driven us to acquire space systems faster and smarter, section 804 authorities are just one of the means by which we are trying to go faster in space. The Air Force is taking great care to ensure we are pursuing section 804 authorities in order to have more aggressive and faster acquisition timelines in a small portion of the overall Air Force space portfolio. By emphasizing capability delivery with shortened time horizons and sometimes constrained costs, we can innovate more rapidly by delivering minimum viable products/capability. This allows programs two benefits: 1) Selecting the contractor with the greatest potential to achieve the result with real data and 2) fosters user feedback on early capability to inform requirements and/or technology evolution. After we have proven out section 804 prototype, a subsequent acquisition decision will be made to transition the prototypes to traditional acquisitions or the rapid fielding statue of section 804. This bounds the Air Force’s financial risk and exposure. All of the Air Force’s section 804 programs apply the same analysis, rigor, and documentation—albeit in formats tailored to the specific needs of the programs—as do Major Defense Acquisition Programs (MDAPs). To ensure transparency of our MDAP-equivalent section 804 programs the Air Force Service Acquisition Executive, Dr. Will Roper, will provide Congress a Selected Acquisition Report-like report three times a year. In addition, we provide quarterly 804 reporting to OSD. As the SMC Commander, I execute quarterly visits to meet with congressional stakeholders in order to make myself available to address concerns regarding all of the programs in my portfolio. It is Dr. Roper’s goal that Congress have more insight into programs executed under section 804 authorities than under a traditional 5000 series program.

15. Senator HEINRICH. Lieutenant General John Thompson, can you give examples of space programs that don’t qualify for section 804 and those that might?

Lieutenant General John THOMPSON. The following are examples of space programs that didn’t qualify for section 804:

- Air Force and Army Anti-jam Modem (A3M)—Field pre-production protected tactical waveform capability in current operational SATCOM terminals.
- Long Duration Propulsive Evolved Expendable Launch Vehicle (EELV) Standard Payload Adapter (ESPA) (LDPE)—Provides payload adapter to host auxiliary payloads as a rideshare on an existing scheduled spacelift mission, which provides affordable access to space for operational as well as scientific, research and development payloads.
- Global Positioning System IIIF—Based on previous Phase 1 production readiness feasibility assessment, all participants provided a reduction viable design enabling a 22 space vehicle production procurement. The above programs didn’t qualify as they were enabled by preceding activities that matured or prototyped the technologies allowing these programs to continue maturing the technologies for operational use/fielding. For example, the A3M program is utilizing capability proved out in a Protected Tactical Satellite Communication Field Demonstration (PTSFD). The demonstration proved the Protected Tactical Waveform (PTW) performed in an integrated system setting, produced prototype PTW modems (with crypto) and demonstrated integration into existing Wideband Global SATCOM (WGS) terminals. A3M will mature the prototyped PTW modems and field the capability in current operational terminals (such as the Air Force Ground Multiband Terminals and the Army Satellite Transportable Terminals). LDPE is a similar example where the capability was proved out with the Air Force’s Space Test Program-1, NASA’s Lunar Crater Observation and Sensing Satellite, and Air Force Research Lab ESPA Augmented Geostationary Laboratory Experiment before becoming an ACAT III program. The following are examples of section 804 space programs:
- Evolved Strategic SATCOM (ESS)—Creating a payload competitive environment to promote innovation, affordability and production timelines to deliver the next-generation, resilient space segment by FY30 using a constrained budget and schedule to get the most capability to include a non-flight demonstration.

- Protected Tactical Enterprise Service (PTES)—Using Agile Program Management to deliver a minimum viable product to the Navy as an early use prototype.
- Protected Tactical SATCOM (PTS)—Prototyping payload, ground and gateway segments, allows program to be incrementally deploying capabilities to the warfighter in fiscal year 2024.
- Next Generation Overhead Persistent Infrared (Next Gen OPIR)—Using competitive prototyping for dual-path design, development, and test, resulting in sensor prototyping.
- Modernized GPS User Equipment Increment 2 (MGUE Inc 2)—Competitive prototype miniature serial interface receiver card and ASIC design, development and manufacturing processes. The above programs qualified as section 804 by building operational capability that addresses the most critical developmental risk to determine what works in practice. This also allows us to innovate rapidly and deliver the operational community minimum viable products/capability. In the example of ESS, it is meeting a new strategic scenario that significantly increases the number of worldwide strategic users and service requests up to twice the current capability. Prototyping the payload under section 804 authorities informs the Air Force with real data to make requirements trades based on cost and schedule constraints. After we have proven out section 804 prototype, a subsequent acquisition decision will be made to transition the prototypes to traditional acquisitions or the rapid fielding status of section 804.

EMERGING SMALL LAUNCH PROVIDERS (OSP-4 CONTRACT)

16. Senator HEINRICH. Lieutenant General John Thompson, aside from larger national security space launch, there are a number of emerging commercial providers eager to play a role in delivering small payloads into low-earth orbit (LEO) as needed. The Orbital Services Program (OSP-4) contract was designed to be the on-ramp for all emerging dedicated small-satellite launch providers. Yet, it is my understanding the Air Force has not issued a single award. What is the status of this contract vehicle, availability of funding, and does the Air Force intend to use the contract?

Lieutenant General John THOMPSON. Since 2013 the Orbital Services Program-3 (OSP-3) contract has awarded 6 missions to include Discover, STP-2, and NROL-129. The OSP-3 ordering period will close in Nov 2019. The AF will expand on this effort with the Orbital Services Program-4 (OSP-4) contract to provide small launch services using a Multiple Award Contract-Indefinite Delivery/Indefinite Quantity (IDIQ) contract. With a low barrier to entry and future on-ramp opportunities, OSP-4 is intended to be the main contract vehicle for small orbital launches greater than 400 pounds. The IDIQ contract Request for Proposal will be released in July 2019. The first mission RFP (STP-S28) using Rocket Systems Launch Program procurement funds will be released shortly after the overarching OSP-4 RFP. Market research indicates that the small launch industry is ready to support National Security Space missions and we project approximately 20 missions to be awarded between fiscal year 2020–fiscal year 2029.

LEVERAGING COMMERCIAL SPACE

17. Senator HEINRICH. Secretary Rapuano, Lieutenant General David Thompson, Lieutenant General John Thompson, and Ms. Chaplain, I've met with a number of people in-and-outside of the military who have said that if the United States does not start to buy the emerging commercial offerings in terms of small satellite capabilities, and soon, then those commercial capacities are inevitably going to migrate elsewhere. How is the Air Force budgeting specifically toward procuring (or even experimenting with) emerging commercial capabilities?

Secretary RAPUANO. The National Defense Strategy recognizes the immense potential of emerging commercial space capabilities and the need for streamlined approaches for identifying promising commercial technologies, applying them to military systems, and regularly refreshing their electronics and software to facilitate continuous capability upgrades. The establishment of the Space Development Agency (SDA) was intended, in part, to be able to rapidly develop and field new space capabilities that leverage commercial space technology and access in support of warfighters. In addition, the Department has established a Space Rapid Capabilities Office to leverage existing technology development and operational capabilities to expedite development and fielding of select, critical space capabilities and systems. The SDA and the Space Rapid Capabilities Office will complement existing space research and development activities such as the Air Force's Rapid Capabilities Of-

fice and the Space and Missile Systems Center to leverage more fully the potential of the commercial space industry.

Lieutenant General David THOMPSON. Specifically, the Air Force uses the Research, Development, Test & Evaluation (RDT&E) funding and process to identify, experiment with, and test emerging commercial capabilities to determine whether they can be adapted for or applied to warfighter requirements and needs. The Space and Missile Systems Center Space Enterprise Consortium Other Transaction Authority, known as the SpEC OTA, provides a way for traditional and non-traditional defense contractors, as well as universities and labs, to work with the Government. The SpEC OTA is managed by the Space and Missile Systems Center's Innovation and Prototyping branch in the Development Corps located at Kirtland Air Force Base, New Mexico. Through the SpEC OTA, the Air Force and its mission partners have a forum to rapidly develop next generation space-related prototypes to achieve the Air Force's vision of a more resilient and affordable enterprise and leverage commercial industry's capabilities. SMC has awarded 37 SpEC OTA prototyping efforts exceeding \$228 million in total value. Mission partners like the Missile Defense Agency (MDA) and the Air Force Research Laboratory (AFRL) have also utilized SpEC. Using the SpEC OTA, MDA was able to award nine prototype projects for its Missile Defense Tracking System Phase 1 effort in April 2018. To date, the SpEC OTA has been utilized for prototypes across the space enterprise to satisfy critical warfighter requirements for everything from missile warning to protected satellite communications to position, navigation and timing. Through the SpEC OTA, the Air Force was able to highlight commercial rapid fielding techniques with the acquisition of the Tetra small satellite which acts as an on-orbit experiment to demonstrate threats to U.S. space assets. The Air Force leveraged an existing commercial capability and will be able to field the small satellite in a year from contract award to delivery. To date, 14 percent of the SpEC OTA's non-traditional members have received government funds through awards which helps to drive innovation and allows the Air Force and key mission partners to procure emerging commercial capabilities. As of early May, the SpEC has 295 members, 228 of which are non-traditional companies that can propose commercial solutions to meet Air Force requirements. Resources are also budgeted for Small Business Innovative Research (SBIR) annually and allow emerging commercial capabilities to be further developed and demonstrated for military applications. For example, AFRL is preparing to award for the development of a CubeSat to provide terrestrial weather to warfighters in a partnership with allies and industry. SMC plans to host a pitch day in the fall using SBIR funds to engage industry for multiple awards to innovative technologies and concepts with military applications.

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Ms. CHAPLAIN. GAO has not conducted focused work in this area. However, our ongoing review of DOD's Wideband Communications Services Analysis of Alternatives will describe some of DOD's efforts to consider emerging commercial satellite communications capabilities. We expect to issue a report on this review this fall.

18. Senator HEINRICH. Secretary Rapuano, Lieutenant General David Thompson, Lieutenant General John Thompson, and Ms. Chaplain, in what ways is the Air Force engaging small satellite providers and component manufacturers?

Secretary RAPUANO. The Department is paying close attention to the innovation, energy, and investments in the Small Satellite (SmallSat) industry, and the opportunity to integrate those technologies into a holistic architecture to address current and emerging needs in support of our National Defense Strategy. To accelerate the investment, development, and deployment of small satellite capabilities, the Office of the Secretary of Defense, led by the Office of the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)), has established the Small Satellite Coordination Activity (SSCA). The function of the SSCA is to coordinate and synchronize critical technology information, activities, and investments pertaining to SmallSats that are employed in support of national security missions. In addition, the Space Development Agency (SDA) seeks to leverage commercially-derived, mass-produced small satellites, payloads, and ground equipment to build the next-generation national security space architectures, far more rapidly and much more affordably than would otherwise be possible.

Lieutenant General David THOMPSON. Beyond the efforts of the Space Enterprise Consortium and its members, the Air Force continues to expand the use of Small Business Innovative Research to encourage domestic small 8 businesses to engage in research and development with incentive for commercialization and profit to help mitigate defense technology gaps. The Air Force is utilizing accelerator programs, both internally managed and through partnering with commercial accelerators, to rapidly identify and build up capabilities that the USAF foresees will be vital for our warfighters. As an example, commercial start-up accelerators, like Starburst and Techstars, are working with the Air Force Space and Missile Systems Center (SMC) to grow aerospace start-ups in the greater Los Angeles area and across the United States, and actively expanding in the global arena as well to exploit and share innovation with our international partners. The start-up companies are not limited to new-entrant satellite builders, others such as subcomponent vendors and manufacturers and specialty services and analytics providers are also highly valued. The Air Force is taking on a critical role in actively engaging our international partners (government and commercial) to utilize, expand, and exchange information, technologies, and capabilities that are of mutual benefit. The Air Force wants to ensure the health of the entire aerospace industrial base (domestic and foreign) for decades to come, and it is necessary to do so, with help from our allies, just to maintain America's superiority in space.

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decades to come, and it is necessary to do so, with help from our allies, just to maintain America's superiority in space.

Ms. CHAPLAIN. GAO has not conducted work in this area in recent years. In the past we have reported on challenges regarding DOD's engagement with small providers such as meeting DOD's unique requirements, obtaining security clearances, and breaking through what was perceived as an insular culture of space system acquisitions.

SPACEFLIGHT TESTING ENVIRONMENT

19. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, Virgin Galactic and Blue Origin are now flying low-cost commercial reusable suborbital vehicles that regularly access the spaceflight testing environment. How is the Air Force planning to utilize these new capabilities to test new technologies and reduce technical risks for future DOD space systems?

Lieutenant General David THOMPSON. The Rocket Systems Launch Program provides suborbital launch services through the recently awarded Sounding Rocket Program-4 (SRP-4) Indefinite Delivery/Indefinite Quantity contract. SRP-4 was awarded in Nov 2018, with on-ramp opportunities for new providers at approximately the two-year mark, to provide responsive access to space in order to test new space technologies and reduce technical risk of DOD systems. Through the Rapid Agile Launch Initiative (RALI) program, the Air Force has five upcoming venture-class launches in 2019 with three emerging launch providers. These launches will provide space access for experimental and Air Force small satellites.

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SPACE ACQUISITION—SECTION 804 RAPID ACQUISITION

20. Senator HEINRICH. Lieutenant General John Thompson, section 804 of the fiscal year 2016 NDAA gave broad authority to bypass many of the acquisition checks and balances in place for Major Defense Acquisition Programs. Can you describe what parameters bound your use of section 804 programs?

Lieutenant General John THOMPSON. Utilizing section 804 authorities emphasizes building operational capability that addresses the most critical developmental risk to determine what works in practice. In the current space domain, the transition from a benign to a contested domain has driven us to acquire space systems faster and smarter, section 804 authorities are just one of the means by which we are trying to go faster in space. The Air Force is taking great care to ensure we are pursuing section 804 authorities in order to have more aggressive and faster acquisition timelines in a small portion of the overall Air Force space portfolio. By emphasizing capability delivery with shortened time horizons and sometimes constrained costs, we can innovate more rapidly by delivering minimum viable products/capability. This allows programs two benefits: 1) Selecting the contractor with the greatest potential to achieve the result with real data and 2) fosters user feedback on early capability to inform requirements and/or technology evolution. After we have proven out section 804 prototype, a subsequent acquisition decision will be made to transition the prototypes to traditional acquisitions or the rapid fielding statue of section 804. This bounds the Air Force's financial risk and exposure. All of the Air Force's section 804 programs apply the same analysis, rigor, and documentation—albeit in formats tailored to the specific needs of the programs—as do Major Defense Acquisition Programs (MDAPs). To ensure transparency of our MDAP-equivalent section 804 programs the Air Force Service Acquisition Executive, Dr. Will Roper, will provide Congress a Selected Acquisition Report-like report three times a year. In addition, we provide quarterly 804 reporting to OSD. As the SMC Commander, I execute quarterly visits to meet with congressional stakeholders in order to make myself available to address concerns regarding all of the programs in my portfolio. It is Dr. Roper's goal that Congress have more insight into programs executed under section 804 authorities than under a traditional 5000 series program.

21. Senator HEINRICH. Lieutenant General John Thompson, can you give examples of space programs that don't qualify for section 804 and those that might?

Lieutenant General John THOMPSON. The following are examples of space programs that didn't qualify for section 804:

- Air Force and Army Anti-jam Modem (A3M)—Field pre-production protected tactical waveform capability in current operational SATCOM terminals .
- Long Duration Propulsive Evolved Expendable Launch Vehicle (EELV) Standard Payload Adapter (ESPA) (LDPE)—Provides payload adapter to host auxiliary payloads as a rideshare on an existing scheduled spacelift mission, which provides affordable access to space for operational as well as scientific, research and development payloads.
- Global Positioning System IIF—Based on previous Phase 1 production readiness feasibility assessment, all participants provided a production viable design enabling a 22 space vehicle production procurement. The above programs didn't qualify as they were enabled by preceding activities that matured or prototyped the technologies allowing these programs to continue maturing the technologies for operational use/fielding. For example, the A3M program is utilizing capability proved out in a Protected Tactical Satellite Communication Field Demonstration (PTSFD). The demonstration proved the Protected Tactical Waveform (PTW) performed in an integrated system setting, produced prototype PTW modems (with crypto) and demonstrated integration into existing Wideband Global SATCOM (WGS) terminals. A3M will mature the prototyped PTW modems and field the capability in current operational terminals (such as the Air Force Ground Multiband Terminals and the Army Satellite Transportable Terminals). LDPE is a similar example where the capability was proved out with the Air Force's Space Test Program-1, NASA's Lunar Crater Observation and Sensing Satellite, and Air Force Research Lab ESPA Augmented Geostationary Laboratory Experiment before becoming an ACAT III program. The following are examples of section 804 space programs:
 - Evolved Strategic SATCOM (ESS)—Creating a payload competitive environment to promote innovation, affordability and production timelines to deliver the next-generation, resilient space segment by FY30 using a constrained budget and schedule to get the most capability to include a non-flight demonstration .
 - Protected Tactical Enterprise Service (PTES)—Using Agile Program Management to deliver a minimum viable product to the Navy as an early use prototype.
 - Protected Tactical SATCOM (PTS)—Prototyping payload, ground and gateway segments, allows program to be incrementally deploying capabilities to the warfighter in fiscal year 2024.
 - Next Generation Overhead Persistent Infrared (Next Gen OPIR)—Using competitive prototyping for dual-path design, development, and test, resulting in sensor prototyping.
 - Modernized GPS User Equipment Increment 2 (MGUE Inc 2)—Competitive prototype miniature serial interface receiver card and ASIC design, development and manufacturing processes The above programs qualified as section 804 by building operational capability that addresses the most critical developmental risk to determine what works in practice. This also allows us to innovate rapidly and deliver the operational community minimum viable products/capability. In the example of ESS, it is meeting a new strategic scenario that significantly increases the number of worldwide strategic users and service requests up to twice the current capability. Prototyping the payload under section 804 authorities informs the Air Force with real data to make requirements trades based on cost and schedule constraints. After we have proven out section 804 prototype, a subsequent acquisition decision will be made to transition the prototypes to traditional acquisitions or the rapid fielding statute of section 804.

LAUNCH BLOCK BUYS

22. Senator HEINRICH. Ms. Chaplain, the Air Force has a long history of launch block buys. Can you describe them and what issues you saw with them in terms of pricing and competition?

Ms. CHAPLAIN. There have been 2 primary block buys under the National Security Space Launch (formerly known as Evolved Expendable Launch Vehicle—EELV) program. In 1998, DOD competitively awarded firm-fixed price contracts, one each to Boeing and Lockheed Martin, for a combined total of 28 Delta IV and Atlas V launch services under the Federal Acquisition Regulation (FAR) provisions governing commercial items. Under these contracts, DOD had limited insight into contractor costs because certified cost or pricing data is not required in the acquisition

of commercial items.⁵ At the time of award, the launch services contracts had a combined value of about \$2 billion. The launch service contract prices were based on the assumption of a robust commercial launch market in which DOD would be one of many launch service customers. The robust commercial launch market did not materialize.

In 2005, the Air Force revised the EELV acquisition strategy to reflect the changes in the commercial market and the new role of the government as the primary EELV customer. This revised strategy provided two contracts each to Boeing and Lockheed Martin. One, called the EELV launch services (ELS), was a fixed-price contract that covered the launch vehicle hardware and labor directly associated with building and assembling the launch vehicles. The second contract, called the EELV launch capability (ELC), was cost-reimbursable and covered the cost of maintaining the ability to launch when needed and funded items such as overhead on launch pads and engineering support. These contracts were negotiated under FAR Part 15, which allowed the contracting officer to obtain data, including cost data, from DOD-approved contractor business systems, data previously unavailable for this program.

Also in 2005, Boeing and Lockheed Martin announced plans to form a joint venture that would combine the production, engineering, test, and launch operations associated with U.S. government launches of Boeing's Delta IV and Lockheed Martin's Atlas V launch vehicles. According to both contractors, the joint venture, named the United Launch Alliance (ULA), would gain efficiencies and provide the government with assured access to space at the lowest possible cost by operating independently as a single company and providing launches on both Atlas V and Delta IV vehicles. ULA officially began operations in December 2006 as the sole-source contractor for EELV. The Air Force continued to obtain cost and performance data from ULA through both the 2005 contracts awarded to Boeing and Lockheed Martin, and through new contracts awarded to ULA. It was, however, unable to get these data for some of the hardware items that Boeing had purchased while it was under the prior commercial contract arrangement. In addition, it took ULA many years to set up its business systems to report the data and to get them approved by DOD. As a result, there were years where the Air Force had rights to the data but the data were from an unapproved system, and thus were not considered reliable.

In late 2009, projected increases in EELV program costs prompted the Air Force to reconsider the EELV business model. After studying the approach to buying government launches, the Air Force developed a new acquisition strategy. The strategy was designed to maintain mission success and incentivize price reductions in part through long-term commitments and steady production rates. Under the strategy, the Air Force combined its prior ELS and ELC contracts into one contract with ULA, called the Phase 1 contract, which was awarded in 2013 and commits the government to ordering 35 launch vehicle booster cores over a 5-year ordering period (provided available launch funds and a valid requirement), and pays for the capability to launch eight launches per year. According to the Air Force, this contract saved about \$4.4 billion over the prior Air Force-estimated cost of launch for this period. In addition, this contract retained for the Air Force the same levels of cost insight as in the previous ELC/ELS contract arrangement.

The advent of re-introducing competition in the launch program in 2015 has resulted in overall lower launch service costs for some launches. However, we have not conducted work to assess the extent of such savings.

23. Senator HEINRICH. Ms. Chaplain, do you worry at all about the Launch Service Agreement (LSA) program underway which will again move towards long term block buys of launch between two providers?

Ms. CHAPLAIN. While we have not conducted a review of the Air Force's new launch service procurement acquisition strategy, our primary, longstanding concern has been whether DOD has gained the knowledge it needs to make sound decisions before committing to an expensive, long-term block buy, including the health of the launch industrial base for sustaining more than one launch provider. Specifically, we found in our 2011 review of the Evolved Expendable Launch Vehicle program that DOD did not have some of the information it needed to make informed deci-

⁵ These firm-fixed-price launch services contracts were awarded under the FAR provisions governing commercial items—FAR Part 12. As a result of procuring the launch services as commercial items, under the FAR, the Air Force could not request certified cost or pricing data from the contractor.

sions in developing the new acquisition strategy for the program.⁶ Some of the knowledge gaps were in areas such as the launch industrial base, mission assurance and rocket engine costs, and future national security launch demand. Among other things, we recommended the Secretary of Defense to conduct an independent assessment of the health of the U.S. launch industrial base, paying special attention to engine manufacturers; assess the block buy contract length given the additional knowledge DOD is gaining as it finalizes its new acquisition strategy; refrain from waiving Federal Acquisition Regulation requirements for contractor and subcontractor certified cost and pricing data; ensure launch mission assurance activities are sufficient and not excessive, and identify ways to incentivize the prime contractor to implement efficiencies without affecting mission success; and examine how broader launch issues, such as greater coordination across federal agencies, can be factored into future launch acquisitions to increase efficiencies and cost savings. DOD agreed with our recommendations. In 2012, we found DOD had incorporated or planned to incorporate most of the recommendations.⁷

In 2015, we assessed the risks the Air Force faced as it planned for future launch acquisitions.⁸ At that time, the Air Force was beginning its approach to using full and open competition procedures in a commercial item acquisition to increase the potential to keep more than one launch company viable and avoid repeating past mistakes that led to cost growth. We recommended that the Air Force should take an incremental approach to planning the next acquisition phase to avoid making decisions without sufficient knowledge. In 2016, we found that the Air Force was gathering and analyzing information on the global launch market to help ensure multiple U.S.-based launch providers could remain viable to compete for future launches.⁹ However, history has proven that it is difficult to reliably predict growth in the demand for launch services. Many factors influence the quantity, size, and frequency of satellite launches for both government and commercial use.

SPACE RCO REPORTING STRUCTURE

24. Senator HEINRICH. Lieutenant General David Thompson, in the fiscal year 2018 NDAA we renamed the Operationally Responsive Space Program the Space Rapid Capabilities Office, or Space RCO, and moved it from the Space and Missile Systems Center (SMC) to report to the Commander of Air Force Space Command. Can you explain to the committee the merits of this new construct?

Lieutenant General David THOMPSON. The SpRCO uses rapid acquisition authorities and streamlined reporting/oversight to meet critical requirements as directed by the SpRCO Board of Directors. The SpRCO transitions resulting products and capabilities to a partner program office for long-term production and sustainment, as well as to operational units to conduct operations. The SpRCO is aligned as a direct reporting unit to the Commander of Air Force Space Command, which enables a more agile and streamlined approach to requirements development and approval, and ensures that the SpRCO is assigned the most critical warfighting projects. This alignment also helps to ensure that the SpRCO has a direct and robust linkage with the Space Warfighting Community throughout the development of their assigned projects, enabling a smooth transition of capabilities during the operations phase.

SPACE FENCE

25. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, space is becoming more congested and contested especially in LEO as plans for large constellations containing thousands of satellites come to market. In order to protect the United States' commercial interest as well as our military interests, how will the Air Force ensure timely, resilient, cyber-hardened, precision data is available to prevent collisions and protect our Nation's assets?

Lieutenant General David THOMPSON. [Deleted.]

Lieutenant General John THOMPSON. [Deleted.]

26. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, our warfighters depend on our satellites in all orbital regimes,

⁶GAO, Evolved Expendable Launch Vehicle: DOD Needs to Ensure New Acquisition Strategy Is Based on Sufficient Information, GAO-11-641 (Washington, D.C.: Sept. 15, 2011).

⁷GAO, Evolved Expendable Launch Vehicle: DOD Is Addressing Knowledge Gaps in Its New Acquisition Strategy, GAO-12-822 (Washington, D.C.: July 26, 2012).

⁸GAO, Evolved Expendable Launch Vehicle: The Air Force Needs to Adopt an Incremental Approach to Future Acquisition Planning to Enable Incorporation of Lessons Learned, GAO-15-623 (Washington, D.C.: August 11, 2015).

⁹GAO, Evolved Expendable Launch Vehicle: DOD is Assessing Data on Worldwide Launch Market to Inform New Acquisition Strategy, GAO-16-661R (Washington, D.C.: July 22, 2016).

especially geosynchronous earth orbit (GEO), for actionable battle management information. There are several ways to track satellites in GEO including the use of telescopes and radars, both space-based and ground-based. How is the Air Force addressing the growing adversarial threat at GEO in the USINDOPACOM region to ensure the United States can protect its critical assets in a persistent, all-weather environment within a critical five year timeline?

Lieutenant General David THOMPSON. With an architecture designed to leverage the types of systems you describe for the roles they are best suited to accomplish. Ground based telescopes to search for and discover objects and perform routine monitoring. They provide the foundation and maintain the background to enable threat custody and change detection by maintaining the background objects and supporting clutter discrimination/differentiation. Space Based telescopes and ground based radars work in concert to maintain custody and perform persistent tracking of objects of interest or concern, including threats. These assets are allocated to enable warning, key to protecting assets.

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27. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, the Committee understands that the test program for the first Space Fence radar site is underway in the Marshall Islands and will deliver an initial operational capability (IOC) in late 2019. The Space Fence program will dramatically improve the identification and tracking of space objects in all orbital regimes. Can the Air Force describe the plans and timeline to field the second radar site in Australia that will provide the full operational capability (FOC), ensuring better space situational awareness and battle management knowledge for the warfighter in the critical USINDOPACOM region?

Lieutenant General David THOMPSON. Space Fence Site-2 is an fiscal year 2021 Program Objective Memorandum consideration and is being weighed against all other AFSPC priorities. At this time and due to lack of funding, there are no specific plans or timelines in place to field the second radar site in Australia.

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SPACE SOFTWARE DEVELOPMENT

28. Senator HEINRICH. Secretary Rapuano and Lieutenant General John Thompson, DOD acknowledged the need to more quickly develop, deploy, and update software that works for user mission needs. However, the Defense Innovation Board recently noted that despite countless studies on DOD software acquisition deficiencies, little seems to be changing. What is your perspective on the reasons that DOD continues to struggle to implement newer approaches and tools and deliver more frequent software releases to users?

Secretary RAPUANO. The Defense Innovation Board's "SWAP Study" (Software Acquisition and Practices) determined that the current approach to software development is broken and is a leading source of risk to DOD: it takes too long, is too expensive, and exposes the warfighters to unacceptable risk of not having capabilities when needed. The reasons for this are many, but we must focus on the need to reform our approach to software and acquisition more broadly. Our acquisition system was designed to develop and procure industrial-age capabilities. Although there have been process improvements along the way, our approach to acquiring capabilities continues to reflect this hardware-centric heritage. The capabilities we rely on today and, increasingly, in the future are basically computers. We need an acquisition system designed for the information age and the institutional willingness to make the necessary changes to get there. Our effort to establish a Space Development Agency (SDA), which is designed primarily to address the growing threat to our space enterprise, is also intended to begin transforming our acquisition system to one more-suited to produce the capabilities we will need for the future. The SDA intends to pursue agile approaches and incorporate other best practices from indus-

try to put in place critical software builds on short timelines, including consolidated battle management and alternate navigation capabilities.

Lieutenant General John THOMPSON. The DOD's acquisition process is serial and centered on delivering hardware. Hence, culture and process are the two major impediments to an agile implementation. The Department has begun implementing the necessary changes to deliver meaningful software releases to users faster than we have historically demonstrated. Specifically, the Space and Missile Systems Center is making profound cultural changes to influence adoption of software centric processes such as Test Driven Development, User Centric Design, and providing the user with a Minimum Viable Product to be incrementally improved upon. Using these methods, the Kobyashi Maru (the name for the agile software acquisition factory for Space C2) team, working on the Air Force's Space Command and Control (C2) program, recently delivered an accredited application, dubbed Metroid, to the user in 57 days. Additionally, the Protected Tactical Enterprise Service (PTES), that just awarded its prime contract in November, implemented agile techniques into its contract and will be delivering functioning, tested code every two weeks, with operators connected directly to the test environment for rapid feedback into the development.

29. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, studies from the Comptroller General (GAO), DOD, and industry have found that user involvement is critical to the success of software development. Newer development approaches—such as Agile and DevOps—are based on integrating users into development. However, DOD programs have struggled to involve users early and continuously, and to incorporate user feedback into development. What are the barriers to user engagement, and do you think that DOD programs can develop software “hand in hand” with users?

Lieutenant General David THOMPSON. Waterfall acquisition processes have left the user doubtful that their inputs influence the final product. A long and serial acquisition process drove Program Managers to avoid “requirement creep” as they were judged based on meeting a static set of requirements evaluated at the end of the process, versus allowing the users to incrementally adjust requirement to meet current needs. Efforts such as Kessel Run have proven that shorter delivery windows combined with User Centered Design is essential to providing the user with viable products. The user is presented with changes to its recommendation in a matter of days instead of years. The Space Command and Control program team utilized combat coders to deliver an accredited application to the user in 57 days. Additionally, the Protected Tactical Enterprise Service (PTES) is delivering functioning, tested code into a cloud-based integration and test environment that users can reach from wherever they work. This allows users to experiment with the system, without impacting operations, and provide direct feedback to the developer.

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30. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, officials from Defense Digital Service, Director of Operational Test and Evaluation, Defense Innovation Board, and DOD leadership have all said that rapid development of software using newer software practices does not fit within the DOD acquisition process, or with DOD culture. To what extent do you agree these are software challenges, and what are the best ways for addressing them?

Lieutenant General David THOMPSON. Software acquisition does pose a challenge to the traditional DOD acquisition process, to overcome these challenges, there has been a resurgence of prototyping and tailored DOD 5000 acquisition strategies within the Air Force. This indicates a shift in leadership's support for new software development practices not traditionally implemented in the DOD. One strategy to address the challenges associated with software acquisition is a potential new acquisi-

tion category for software-centric agile program management. Other options include the potential for an alternative appropriations account focused on software development with unique authorities to meet the needs of software development. Increased flexibility affords program managers the opportunity to explore unique alternatives to more efficiently and effectively, develop and deliver software. For example, the Protected Tactical Enterprise System software factory runs on a two-week delivery cycle, producing functioning, tested software. The software is developed in a contractor lab and new code is automatically tested and integrated into the codebase immediately when it is checked-in, at which point users are exposed to the updated software and can provide rapid feedback to development.

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31. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, the DOD is currently undertaking a number of initiatives, including Agile pilot programs and DevSecOps pathfinder efforts, to achieve more rapid acquisition of DOD software. What is the status of the Office of the Secretary of Defense's (OSD) and the Air Force's pilot efforts?

Lieutenant General David THOMPSON. Both the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)) and the Air Force are each pursuing an initiative for a new agile software development appropriation. USD(A&S) selected Space Command and Control (Space C2) as one of their pilot programs and the Space and Missile Systems Center offered the Space C2 [formerly JMS Inc 2] and Enterprise Ground Services (EGS) as pilot programs for the Air Force initiative. A new software appropriation could be used to obtain anything a software intensive program needs (e.g. manpower, equipment, services). Under this potential new appropriation, a program's existing appropriations for development, procurement, or operations and sustainment would be combined into the single software appropriation.

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32. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, to what extent has OSD or the Air Force considered potential challenges in the process steps in the DODI 5000.02 in meeting the Agile or DevSecOps goals of these programs?

Lieutenant General David THOMPSON. The Air Force and the DOD have spent considerable time addressing challenges with DODI 5000.02 and how it is conducive to Agile or DevSecOps. As a result, there are proposals regarding a software appropriation account and a new major agile software program designation being considered. These would help move the Department towards the culture, flexibility, and processes necessary for agile software to occur and away from the artificial constraints that DODI 5000.02 imposes. One potential mitigation of these challenges is the section 804 authorities granted to the DOD by Congress. The Air Force has leveraged section 804 authorities to help programs like the Protected Tactical Enter-

prise Service (PTES) streamline the traditional acquisition process to deliver prototype capabilities faster. This has led to lessons learned on what aspects of DODI 5000.02 do not mesh well with Agile and DevOps and those lessons are being fed into the DODI 5000.02 update process.

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33. Senator HEINRICH. Lieutenant General David Thompson and Lieutenant General John Thompson, how do we know programs claiming to be agile, truly are?

Lieutenant General David THOMPSON. SpRCO is taking full advantage of the authorities provided by Congress and Department of Defense. Based upon the first three assigned programs, SpRCO is rapidly progressing through Milestone A and contract award much faster than the typical DOD acquisition timelines. Typically, it takes most programs 2–3 years from requirements validation to contract award, whereas SpRCO is on track to complete this process within 8 months. Additionally, SpRCO is leveraging mature technology that is able to be transitioned into a full program at a more rapid pace. Finally, transition partners are identified for each of program at initiation to ensure SpRCO authorities are used through initial operational production, then transfers the programs to transition partners to execute full rate production and technical insertion. Every program is unique and there are numerous methods for implementing Agile, but there are some hallmarks of a truly agile program. Two key markers are rapid cycles of development, testing and delivery of functioning code (not necessarily into an ops environment); and end-users directly integrated with the developer. The Agile movement is a cultural change and will not happen overnight. However, some SMC programs, like the Protected Tactical Enterprise Service, Space Command and Control, and the Enterprise Ground Services, have already initiated finding ways to measure coherence to an agile construct.

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DOD SPACE ACQUISITION WORKFORCE

34. Senator HEINRICH. Secretary Rapuano, GAO issued a report on March 14, 2019, that examines what DOD knows about its space acquisition workforce and basically found that DOD does not know much. GAO gathered its own data and found that at the end of 2017, there were over 8,000 military, civilian, contractor, and Federally Funding Research and Development Center (FFRDC) personnel supporting space acquisition programs at over 50 locations across the United States. The report highlighted two very basic pieces of information that DOD doesn't know, which until they are addressed, will hinder DOD's efforts to stand-up a Space Force: DOD (1)

has not identified all of its space acquisition programs; and (2) does not know how many military, civilians, contractors, and FFRDC personnel support space acquisitions. GAO made recommendations that DOD identify its space acquisition programs and start collecting data on personnel supporting those programs. GAO indicated that the military departments had the most trouble identifying space programs in the user segment, such as radios or terminals that are needed by the warfighter to use a space-based capability. How will the department address this problem?

Secretary RAPUANO. As part of the analysis the Department conducted to develop the legislative proposal for the Space Force, the Department identified space missions and functions that would transfer into the Space Force. Each of the Military Services identified the personnel currently performing the space missions and functions required to develop, field, operate, and sustain space missions.

This data has served as the foundation for identifying which forces and functions would transfer into the Space Force and when they would transfer. These transfers would be very methodical and time-phased to avoid risk to mission execution.

35. Senator HEINRICH. Secretary Rapuano, what steps will DOD be taking to identify the number of acquisition personnel that are needed for Space Force?

Secretary RAPUANO. As part of the analysis the Department conducted to develop the legislative proposal for the Space Force, the Department identified space missions and functions that would transfer into the Space Force—including acquisition missions and functions. Using this data, the Department is continuing to refine our analysis of which forces and functions would transfer into the Space Force and when they would transfer.

36. Senator HEINRICH. Secretary Rapuano, how will DOD determine which acquisition personnel should be transitioned to Space Force to ensure that it has the most qualified personnel with space acquisition expertise?

Secretary RAPUANO. Space acquisition personnel would transfer into the Space Force with the transfer of their mission or function. The space acquisition billets that the Department would transfer into the Space Force from the existing Military Services have specific acquisition qualification requirements.

37. Senator HEINRICH. Secretary Rapuano, are there certain functions, such as cyber security, that DOD would like to increase its in-house capability to perform instead of relying heavily on contractors and FFRDCs for that support? If so, what actions do you plan to take to attract people for those positions?

Secretary RAPUANO. For any discipline, the Department uses a requirements determination process to identify the numbers and types of personnel needed to perform the missions, tasks, and functions. The Department has always experienced challenges attracting and retaining talent in highly technical and high-demand areas such as cyber, space, engineering, and artificial intelligence. To enhance civilian opportunities to serve in these roles, the Department is actively seeking to recruit talent through traditional and innovative methods, hiring directly for critical skills, and utilizing enhanced recruitment incentives and pay to meet market demands. For military personnel, the Department plans to maximize the use of special accession authority for officers such as lateral career entry processes.

SYNCHRONIZATION OF SATELLITES, GROUND CONTROL SYSTEMS, AND USER TERMINALS

38. Senator HEINRICH. Secretary Rapuano and Lieutenant General John Thompson, programs like the Global Positioning Satellites and their ground segment and user equipment, protected communications satellites and user terminals, and missile warning satellites and associated ground process system capabilities have experienced significant synchronization issues resulting in expensive satellite capabilities being underutilized. What efforts is DOD undertaking to minimize these alignment issues and avoid them in the future?

Secretary RAPUANO. Keeping the segments of a major space program aligned can be a significant challenge, particularly with multi-service or joint programs such as GPS. Section 1603 of the National Defense Authorization Act for Fiscal Year 2016 established a “Council on Oversight of the Department of Defense Positioning, Navigation, and Timing Enterprise,” which we are using to help identify, elevate, and mitigate alignment issues before they become major problems. In addition, we acknowledge Congress’s efforts to provide consistent program funding, which is essential to maintaining schedules and keeping segments synchronized.

Lieutenant General John THOMPSON. As part of the re-architecture of the Space and Missile Systems Center known as SMC 2.0, I recently made several key organizational changes to ensure synchronization across all aspects of the space enter-

prise. The SMC Portfolio Architect works across the SMC portfolio and in conjunction with the Air Force Space Command Enterprise Architect and other DOD space stakeholders. In concert with the SMC Portfolio Architect, I appointed senior military and civilian leaders to ensure the synchronization among all components of each space mission area. For example, for Positioning, Navigation, and Timing (PNT) under which GPS falls, we have a graduated Senior Materiel Leader (the highest level of certification for DOD acquisition professionals) who acts as the overall mission integrator for PNT. This Air Force colonel is backed up by a GS-15 Director Mission Integration, a GS-15 System of Systems Engineer, and another graduated Senior Materiel Leader serving as the Chief Architect. Together, this team of seasoned acquisition and operational experts track progress of space, ground, and control segments to avoid divergence of capabilities or delivery schedule. A similar construct exists for all other National Security Space mission areas such as Missile Warning, Satellite Communications, and Weather. The mission integrator will chair a mission configuration control board to approve any changes to all programs within the PNT mission area. Additionally, the Systems of Systems Engineer and the SMC Portfolio Architect will chair an enterprise configuration control board across missions to ensure no one mission change adversely affects another (e.g. launch mission changes driving unacceptable costs into the space segment, or vice versa). Lastly, the Chief Architect conducts modeling, simulation, and analysis to ensure mission needs are accurately captured and Program Executive Officers understand the requirements for the programs within their acquisition portfolio.

39. Senator HEINRICH. Secretary Rapuano and Lieutenant General John Thompson, as DOD considers making more space systems resilient, through approaches like disaggregation or using hosted payloads, what could be done to ensure all segments of the system (e.g., satellites, ground systems, and user terminals) are synchronized so the warfighter can take full advantage of the capabilities provided as they are fielded?

Secretary RAPUANO. In order to leverage innovative approaches like disaggregation or hosted payloads, we must relearn how to build, deploy, operate, and innovate rapidly, all at substantially lower cost. This requires a shift in mindset from how we have traditionally acquired space capabilities. A key component of DOD's space transformation is the Space Development Agency (SDA). The SDA's role is to define and monitor the Department's future threat-driven space architecture and to accelerate the development and fielding of new military space capabilities necessary to ensure our technological and military advantage in space for national defense. A feature of this architecture is a proliferated space transport layer, which leverages commercial networking standards and protocols. This will help ameliorate some of the synchronization issues we have today, which are a consequence of legacy, proprietary interfaces.

Lieutenant General John THOMPSON. Similar to how the Space and Missile Systems Center (SMC) will maintain schedule and performance alignment within mission areas by using senior, experienced leaders as mission area integrators, the Chief Architect will use modeling, simulation, and analysis to help Air Force Space Command refine and clearly articulate warfighter requirements that require materiel solutions. The SMC Chief Architect and the mission area integrators will remain actively engaged in the acquisition programs continually refining and assessing new technology or modernization initiatives to achieve the most effective mission performance at prudent costs. Resilience of satellites crosses multiple areas and the Chief Architect will use industry standards, like model-based systems engineering and digital twins, to trade performance and costs. Ultimately, the Chief Architect and the Systems of Systems Engineer will design and maintain standards (i.e. data standards, interface control documents, etc.) to ensure that SMC weapon systems are interoperable to the maximum extent practical. Additionally, continued investment in enterprise tools such as Enterprise Space Battle Management Command & Control (ESBMC2) and Enterprise Ground Services (EGS) will continue to prosecute the vision for flexibility in space to counter threats and leverage the advantage that space assets bring.

40. Senator HEINRICH. Secretary Rapuano and Lieutenant General John Thompson, to what extent will user equipment programs be integrated into the Space Force? If they are not, how do you plan to better synchronize them? Won't we continue to have disconnects?

Secretary RAPUANO. Most user equipment programs will remain within their respective Military Services because it is vital that these terminals be integrated with the weapon systems they support. The Department recognizes the need to synchronize across the Military Services more effectively, which is one of the main rea-

sons an Under Secretary of the Air Force for Space was included in the proposal. This individual would provide dedicated civilian supervision of the Space Force and look across the Department, not only to synchronize our user equipment programs, but also to provide advocacy for the Space budget at the highest levels and to oversee our space architecture development going forward.

Lieutenant General John THOMPSON. As Congress considers the Department's legislative proposal to stand up a Space Force, the Space and Missile Systems Center remains focused on delivering the premier space capabilities to the Joint and Allied Force. SMC will work with leadership within the Department, the Air Force, and if stood-up, the Space Force, to ensure user equipment programs, and all other segments of critical space capabilities, are integrated across the spectrum to ensure consistent and reliable warfighter support.

LAUNCH SCHEDULE

41. Senator HEINRICH. Lieutenant General John Thompson, the Air Force announced LSA awards to three companies in October 2018. The purpose of these awards was to: "to quickly transition from the use of non-allied space launch engines, implement sustainable competition for National Security Space (NSS) launch services, and maintain assured access to space." However, recent indications suggest that the program as structured may fail to achieve some or all of these goals. A key program objective was to have certified launch vehicles ready to send critical national security satellites to space by April 2022. However, within weeks of the LSA award announcement, all three winners disclosed significant schedule delays. What is the current schedule toward certification for each of the three LSA award winners?

Lieutenant General John THOMPSON. All three Launch Service Agreements participants are still on track to provide initial launch capability by April 2022. The selected offerors remain consistent with what was briefed to the Congressional committee staffs shortly after award. The Air Force updated its requirements dates based on actual changes to the projected National Security Space Launch manifest during the solicitation, and requested updated schedules that optimized development progress and risk based on these need dates.

42. Senator HEINRICH. Lieutenant General John Thompson, is the Air Force aware of further delays to the schedule announced in October 2018?

Lieutenant General John THOMPSON. All three Launch Service Agreements participants are still on track to provide initial launch capability by April 2022, per their original schedules. The Air Force is working closely with industry through development challenges that are a normal part of a complex rocket development program, as an expected part of the National Security Space Launch strategy.

43. Senator HEINRICH. Lieutenant General John Thompson, why didn't the Air Force know in October of 2018—just 5 months ago—when you made these awards that schedules were already slipping?

Lieutenant General John THOMPSON. Launch Service Agreements (LSA) schedule dates remain consistent with what was briefed to the Congressional committee staffs shortly after award. The Air Force updated the LSA Request for Proposal (RFP) to reflect initial launch capability need dates based on the actual launch manifest. This allowed our industry partners to optimize development planning and saved cost. Through the solicitation process, the Air Force worked closely with all LSA offerors to understand both technical and schedule risk developments.

44. Senator HEINRICH. Lieutenant General John Thompson, did you independently assess the schedule representations made to you by the bidders?

Lieutenant General John THOMPSON. Yes, as part of the source selection evaluation process, the Launch Service Agreement (LSA) Request for Proposal (RFP) requested Integrated Master Schedules from all bidders. The Air Force assessed each of these schedules, and assigned a schedule risk rating that was used as part of the award decision per the LSA RFP.

45. Senator HEINRICH. Lieutenant General John Thompson, will the Air Force award a block of the next roughly 10 years of missions this year to launch vehicles that have never flown?

Lieutenant General John THOMPSON. The Air Force is not awarding a 10 year block of missions. The Phase 2 competition will procure launch services for the five-year ordering period from fiscal year 2020 through fiscal year 2024, corresponding to launch services from fiscal year 2022 through fiscal year 2027. The Air Force is

investing in new launch vehicles with confidence they will meet the Initial Launch Capability (ILC) dates for the Phase 2 ordering period.

46. Senator HEINRICH. Lieutenant General John Thompson, if these new rockets are not ready, are you going to request access to more Russian rocket engines, or are you going to leverage existing, available, certified systems?

Lieutenant General John THOMPSON. The Air Force does not anticipate needing to request access to more Russian rocket engines than already prescribed in the fiscal year 2015 National Defense Authorization Act. The Air Force is confident the domestic launch systems in development will be able to meet National Security Space Launch requirements. To mitigate the risk of unforeseen development delays, the Air Force will permit Launch Service Procurement contract awardees to offer secondary launch vehicles (leveraging certified systems) for the first two years of the contract.

47. Senator HEINRICH. Lieutenant General John Thompson, why is it important that the both winners of LSP/Phase 2 be able to launch Category C missions?

Lieutenant General John THOMPSON. The Phase 2 strategy ensures space launch operations meet requirements for Assured Access to Space (AATS) codified in 10 U.S. Code 2273. The statute specifies the U.S. will sustain the availability of at least two space launch vehicles (or families of space launch vehicles) capable of delivering into space national security payloads. It is critical that two providers be able to meet all national security space launch requirements, which includes Category C missions, with the flexibility to respond to the evolving manifest requirements associated with mission planning. Finally, if the Air Force allows offerers' to be selective in the orbits they service, the DOD could have sub-optimal launch vehicles, an unwanted sole-source environment for specific mission sets, or worst case, no capability to meet the most stressing National Security Space (NSS) orbits. (Without DOD partnership no company's business case would lead them to pursue a launch system that supports the robust requirements needed for future NSS missions).

FAMILY OF BEYOND LINE OF SIGHT-TERMINALS (FAB-T)

48. Senator HEINRICH. Lieutenant General John Thompson, the FAB-T Force Element Terminals (FET) subprogram is intended to provide survivable and protected satellite communications capabilities for several aircraft, including the B-52 and RC-135 platforms. The Air Force has indicated that it plans to develop the FET subprogram using tailored acquisition approaches and fiscal year 2016 NDAA section 804 authorities. Has the Air Force made a final determination as to the number and type of platforms that will receive the FET?

Lieutenant General John THOMPSON. The Air Force intends to produce 76 Force Element Terminals for the B-52 and 17 for the RC-135. 479 Force Element Terminals for the KC-135 and KC-46 tankers remain as a development objective if a future requirement is identified.

49. Senator HEINRICH. Lieutenant General John Thompson, to what extent has the Air Force identified acquisition risks related to developing and fielding a terminal for multiple aircraft platforms, and what steps is the Air Force taking to address these risks?

Lieutenant General John THOMPSON. The Air Force has ongoing risk reduction contracts with the Force Element Terminal manufacturer to study system requirements, architecture, and platform integration. There are additional risk reduction contracts ongoing and planned with the B-52 and RC-135 platform prime contractors to study additional integration and installation requirements. These studies will burn down risk early in the development of the Force Element Terminal.

50. Senator HEINRICH. Lieutenant General John Thompson, what progress has the Air Force made toward its planned contract award for FET development in fiscal year 2019?

Lieutenant General John THOMPSON. The Force Element Terminal Acquisition Strategy was approved by the Milestone Decision Authority in February of 2019. The program remains on track to award a development contract in fiscal year 2019.

51. Senator HEINRICH. Lieutenant General John Thompson, how will the Air Force avoid the development problems that caused multi-year delays to the Command Post Terminals subprogram and ensure that this new subprogram meets the five-year timeline as a proposed section 804 acquisition?

Lieutenant General John THOMPSON. The Force Element Terminal subprogram leverages technology from existing AEHF terminal product lines, to include the Command Post Terminal, Very Important Person Special Airlift Mission (VIPSAM) Protected SATCOM (VPS), and Worldwide EHF Beyond Line-of-Sight Terminal (WEB-T) to meet the required five-year timeline. In addition, early risk reduction contracts will allow the program office to identify developmental challenges and burn down risk early in the development of the Force Element Terminal.

52. Senator HEINRICH. Lieutenant General John Thompson, FAB-T and the related PNVC system are expected to provide the President and senior leaders secure and survivable voice conferencing capabilities using the Advanced Extremely High Frequency (AEHF) space system. However, AEHF already has four of a planned six satellites on orbit and the earliest AEHF satellites will be nearing the end of their projected service life by the time FAB-T and the Presidential and National Voice Conferencing (PNVC) system are fully operational. How will the Air Force ensure that systems like FAB-T and PNVC are compatible with the space system(s) that replaces the Advanced Extremely High Frequency (AEHF) system?

Lieutenant General John THOMPSON. Evolved Strategic SATCOM (ESS), the planned replacement for AEHF, includes a requirement for backwards compatibility with existing AEHF and NC3 architecture and interoperability with XDR user terminals. In addition, the FAB-T program office regularly participates in the MILSATCOM Control Board and associated technical working groups to ensure that satellite and terminal development are properly synchronized.

OVERHEAD PERSISTENT INFRARED SATELLITES

53. Senator HEINRICH. Lieutenant General John Thompson, section 804 authorities give the services permission to waive the burdensome requirements process for systems that need to be fielded in 3 to 5 years. The Air Force designated the follow-on to the Space Based Infrared System (SBIRS) missile warning constellation—known as Next-Generation Overhead Persistent Infrared, or Next-Gen OPIR—as the “pacesetter” program that will guide future efforts. To what extent is the Air Force confident the program can succeed in launching the first Next-Gen OPIR satellite in 2023, 2 years ahead of a schedule it presented less than a year ago?

Lieutenant General John THOMPSON. The Air Force accepted that challenge, knowing that there were two prerequisites which would start the clock for the program manager to deliver success to launch the first Next Gen Geosynchronous (GEO) satellite by calendar year 2023: (1) Getting on contract and (2) Securing the required funding. A focused effort by the team at SMC, and the Air Force’s embrace of the use of section 804 authorities allowed the program manager to get on contract with both the Next Gen GEO (Lockheed Martin Space) and Next Gen Polar (Northrop Grumman Aerospace Systems) satellite prime contractors within 3 months, and to complete payload selection within 6 months. While SMC and Lockheed Martin (Next Gen GEO) moved out at a pace to meet a calendar year 2023 launch, we were unable to secure the funding necessary to sustain this speed. The schedule acceleration was underpinned by a need to simultaneously accelerate the required funding, allowing the program to move quickly to address the programs largest risks, payload development and early systems engineering. The Air Force prepared to accelerate \$744 million in funding forward into fiscal year 2018 and fiscal year 2019 in two above threshold reprogramming (ATR) requests to Congress. OSD submitted an ATR to reprogram \$344 million in fiscal year 2018 funds, however, while Congress supported the full \$344 million requirement it denied \$232 million in sources, resulting in a shortfall in early funding and an associated re-plan of the program to deliver in fiscal year 2025. The fiscal year 2020 President’s Budget Request assumes the processing and approval of an fiscal year 2019 ATR to secure \$632 million to put the program on solid footing to deliver by fiscal year 2025, our Joint Requirements Oversight Council-validated need date. The Air Force took this strategy (vice including the additional funds in the fiscal year 2020 President’s Budget, because delaying funding delays the program. SMC is keeping the program’s focus on competitively prototyping the program’s largest risk area, the main mission payload, while posturing the program to “pull to the left” if early funding becomes available.

54. Senator HEINRICH. Lieutenant General John Thompson, what are the primary reasons that the planned date for the full system to become operational in 2029 have not changed given the acceleration in schedule?

Lieutenant General John THOMPSON. The Air Force chose to accelerate the Next Gen OPIR Geosynchronous satellite program while holding the Next Generation Polar program satellites steady. Given the program strategy to maintain large reuse

in payload design between the GEO and Polar satellites, accelerating the payload design efforts through competitive prototyping burns down early program risk for both efforts. The current Next Gen OPIR Block 0 program baseline for initial launch capability (ILC) are GEO-1 (fiscal year 2025); GEO-2 (fiscal year 2027); Polar-1 (fiscal year 2027); GEO-3 (fiscal year 2028); and Polar-2 (fiscal year 2029). After the launch of each Next Gen OPIR satellite into its intended GEO or Polar orbit, it can take approximately 12 or more months to complete ground system and on-orbit satellite checkout activities; as well as, sensor-tuning activities before the satellites are ready to transition to operations.

55. Senator HEINRICH. Lieutenant General John Thompson, to what extent is the decision to speed up the Next-Gen OPIR schedule and build in advanced sensors and resiliency features requiring a major shift in cost estimates and how is this affecting the program?

Lieutenant General John THOMPSON. The schedule acceleration was underpinned by a need to simultaneously accelerate the required funding, allowing the program to move quickly to address the programs largest risks, payload development and early systems engineering. The Air Force prepared to accelerate \$744 million in funding forward into fiscal year 2018 and fiscal year 2019 in two above threshold reprogramming (ATR) requests to Congress. The Department submitted an ATR to reprogram \$344 million in fiscal year 2018 funds, however, while Congress supported the full \$344 million requirement it denied \$232 million in sources, resulting in a shortfall in early funding and an associated re-plan of the program to deliver in fiscal year 2025. The fiscal year 2020 President's Budget Request assumes the processing and approval of an fiscal year 2019 ATR to secure \$632 million to put the program on solid footing to deliver by fiscal year 2025, our Joint Requirements Oversight Council-validated need date. The Air Force took this strategy (vice including the additional funds in the fiscal year 2020 President's Budget, because delaying funding delays the program. SMC is keeping the program's focus on competitively prototyping the program's largest risk area, the main mission payload, while posturing the program to "pull to the left" if early funding becomes available.

56. Senator HEINRICH. Lieutenant General John Thompson, what due diligence did the Air Force perform to estimate the potential cost of the program?

Lieutenant General John THOMPSON. The Air Force executing due diligence by completing a program office estimate and three (3) independent cost estimates at the Center, Air Force, and Office of the Secretary of Defense levels. The Air Force developed a program office estimate using a parametric cost model and acquiring information from multiple sources including historical data from similar programs; and estimates were independently validated by the financial management function at the Space and Missile Systems Center. Additionally, the Air Force Cost Analysis Agency (AFCAA) independently developed a Non-Advocacy Cost Assessment of the program. Lastly, the Office of the Secretary of Defense's Cost Assessment & Program Evaluation (CAPE) office is conducting a separate Independent Cost Estimate which will support Air Force and OSD budget planning.

57. Senator HEINRICH. Lieutenant General John Thompson, to what extent will having sole-sourced contracts allow single suppliers to dominate the market, thereby limiting the government's ability to find an alternative contractor should unforeseen issues with a current vendor arise?

Lieutenant General John THOMPSON. While the Air Force is executing the Next Gen OPIR Block 0 program using two sole-source contracts, it has taken direct action to foster and enable a competitive environment. The Next Gen OPIR Geosynchronous satellites were awarded sole source to the incumbent contractor after the government determined through extensive market research that they were the only provider that was postured to meet the aggressive delivery date of fiscal year 2025. In order to foster competition and increase the industrial base capabilities to support an open competition for the subsequent Block 1 program, the Air Force awarded the Next Gen OPIR Polar satellite contract to a separate prime contractor. In order to mitigate the program's highest risks in the main mission payload, the Air Force required the satellite prime contractors to execute a payload competition and carry up to two payload vendors to provide for alternate paths. The prime contractors are also utilizing this "alternate source" strategy on multiple other components as needed to mitigate program risk.

58. Senator HEINRICH. Lieutenant General John Thompson, to what extent is the Air Force monitoring sub-tier suppliers for this program?

Lieutenant General John THOMPSON. The Air Force has created strong working relationships with the prime contractors and subcontractors by conducting shoulder-to-shoulder working groups that meet several times a week throughout all levels of the program's planning and execution activities. For example, the Air Force required the Next Gen GEO (Lockheed Martin Space) and Next Gen Polar (Northrop Grumman Aerospace Systems) satellite prime contractors to conduct subcontractor competitions for the mission payload (MPL) with Government insight and oversight. Both Next Gen OPIR prime contractors are currently carrying two MPL subcontractors until a Government-approved down-select decision, maintaining a competitive environment among MPL suppliers while leveraging this critical path risk mitigation to reduce the highest risk on the program schedule. Beyond the MPL, the Government is also monitoring subcontractor performance, in concert with the prime contractors, at key suppliers guided by program risk assessments.

59. Senator HEINRICH. Lieutenant General John Thompson, SBIRS GEO satellites 5 and 6 were to be derivatives of GEO satellite 4, with limited design changes to capitalize on the use of previously procured engineering and parts. Yet, technical challenges and manufacturing issues have arisen that have caused schedule delays. Please explain why the Air Force is confident in the Next Gen OPIR acquisition cycle time when a lower risk, more understood.

Lieutenant General John THOMPSON. SBIRS GEO-5/6 satellites are in production as technology refreshed equivalents of SBIRS GEO-3/4 satellites and are intended as replenishments for SBIRS GEO-1/2 satellites. SBIRS GEO-5/6 satellites are being built on Lockheed Martin's modernized LM 2100 satellite bus through the technical refresh contract change in 2015 and is on track to meet the September 2020 contractual delivery date to enable the current planned initial launch capability in January 2021 and January 2022, respectively. Though the SBIRS GEO-5/6 program has experienced some manufacturing challenges, this is not unexpected with the integration of a first article, tech refreshed satellite. Lockheed Martin Space has worked closely with the Air Force to resolve and close all issues to date. As a result, the Air Force is confident the acquisition cycle is achievable because Next Gen OPIR GEO-1/2/3 satellites will leverage the LM 2100 common satellite bus that is used across multiple Lockheed Martin programs and mission areas. The LM 2100 has recently been enhanced to add capabilities that benefit multiple mission areas to include OPIR. Bus enhancements include elimination of obsolescence and insertion of modern electronics in multiple subsystems, as well as increased resiliency capabilities that are all applicable to the Next Gen OPIR mission. While SBIRS provided "leading edge" capabilities with new technologies, Next Gen OPIR uses mature technologies based on decades of Air Force and Industry lessons learned: (1) Next Gen OPIR intends to use a single, simplified onboard sensor—SBIRS has both a scanner and starrer; (2) By taking advantage of advancements in technology, Next Gen OPIR is able to save payload weight and power—allows reallocation of the Size, Weight, and Power savings to resilience capabilities; (3) Requirements are simplified to focus on strategically survivable missile warning; (4) The acquisition is streamlined; and (5) The program office is using 2016 National Defense Authorization Act section 804 authorities, allowing rapid delivery of capabilities to keep missile warning ahead of adversary efforts. To reduce schedule and technical program risks, Lockheed Martin has two mission payload subcontractors (Raytheon & the Northrop Grumman-Ball Aerospace Team) designing, developing, and prototyping missile warning sensors in a competitive environment to maximize the use of parallel design, development, and test processes. The two suppliers were selected in September 2018 just 45 days after Next Gen OPIR's start, further embracing the program's rapid acquisition requirements. The recent successful completion of the Next Gen OPIR GEO System Requirements Review and mission payload System Design Reviews demonstrated a solid understanding of the mission, requirements, current design, risks and plans for work moving forward, enabling the Next Gen OPIR GEO program to proceed with preliminary design activities. The program remains on track to achieve a GEO space vehicle delivery by fiscal year 2025.

QUESTIONS SUBMITTED BY SENATOR ELIZABETH WARREN

MILITARY SPACE PROGRAMS

60. Senator WARREN. Secretary Rapuano, Lieutenant General David Thompson, and Lieutenant General John Thompson, the fiscal year 2020 budget request includes nearly \$50 million to pursue the development of non-kinetic and kinetic options for space-based missile defense interception. In 2016, former Missile Defense Agency Director Adm. James Syring told the House Armed Services Committee the

following: “I have serious concerns about the technical feasibility of interceptors in space, and I have serious concerns about the long-term affordability of a program like that.” Do you agree with Adm. Syring? If not, why not? Please provide an unclassified explanation.

Secretary RAPUANO. The 2019 Missile Defense Review requested that the Missile Defense Agency study the development and fielding of a space-based missile intercept layer capable of boost-phase defense. This report is scheduled to be completed between July and the end of 2019, and will identify the technologies, schedule, cost, and other requirements for a space-based defensive layer for boost-phase defense.

As with all programs, affordability will help shape space-based missile defenses. Affordability begins by setting appropriate objectives for space-based missile defense and then assessing the capabilities and limitations of potential architectures. The purpose of the study is to better understand more fully the feasibility drivers in today’s environment so that the leadership has the best possible information with which to make the most informed decisions.

Lieutenant General David THOMPSON. I agree that it will be challenging, but believe technology is advancing in ways that space-based interceptors are becoming viable. Space-based interceptors will always be technically challenging due to closing velocities. However, we’ve demonstrated solutions to closure speeds problems by successfully rendezvousing in Low Earth Orbit. The steps to rendezvous and dock in orbit are similar to the steps needed to intercept ballistic missile upper stages and high altitude hypersonic threats. Since 2016, U.S. industry has made significant advances in autonomous rendezvous and proximity operations (RPO). Work is being done on tipping and queueing of interceptors as well as decoy detection. Advances in Overhead Persistent Infrared sensor focal planes, onboard processing, and inter-satellite links show great promise in reducing or eliminating the uncertainty of space-based interceptors. The Air Force, especially the Space and Missile Systems Center, remains tightly coupled with the Missile Defense Agency on their space-based kill assessment, defense against hypersonic weapons, and space sensor layer efforts.

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61. Senator WARREN. Secretary Rapuano, Lieutenant General David Thompson, and Lieutenant General John Thompson, former Missile Defense Agency Director Adm. James Syring observed in 2016 that the “basic feasibility” of an operational space-based interceptor layer “has not yet been shown in the relevant environment of space and on the compressed engagement timelines required. Essential space-based interceptor technologies have been worked only sporadically over the years and consequently are not feasible to procure, deploy, or operate in the near- to mid-term.” Do you agree or disagree? Please provide an unclassified explanation.

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Lieutenant General David THOMPSON. I agree that no end-to-end interceptor concept has been demonstrated in space. However, the technologies required for space-based interception of incoming threats are similar to what is required for autono-

mous rendezvous and docking two objects in space: detection, tracking, orbital phasing, and rendezvous and proximity operations (RPO). U.S. industry has demonstrated great advances in autonomous RPO, as seen when commercial companies' rockets make flawless approaches to the International Space Station. While cooperative RPO is done at lower speeds, the basic feasibility of RPO and interception are the same. The Missile Defense Agency's work on the space-based kill assessment has been valuable to assess the technological readiness for the US to field space-based interceptors. Additional work will need to be done, to include responsible on-orbit demonstrations to exercise the kill chain of detecting, tracking, targeting, and discrimination of threats while mitigating debris and danger to other space objects.

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62. Senator WARREN. Secretary Rapuano, Lieutenant General David Thompson, and Lieutenant General John Thompson, if Russia or China were to move to establish missile defense interceptors in space, how would you advise the Secretary of Defense to respond? Please provide an unclassified explanation.

Secretary RAPUANO. Russia and China have substantial missile defense programs and other military capabilities intended to threaten space. The defensive actions the United States is taking to improve space-based missile defense sensor systems and to explore space-based interceptor concepts are fully consistent with our obligations under relevant international law, including the United Nations Charter and the Outer Space Treaty.

Lieutenant General David THOMPSON. Similar to the discussions surrounding ballistic missile defense systems, a space-based interceptor system would appear to make the world a safer place since it seems to negate the first-strike advantage. However, a system that threatens assured retaliation might invoke an arms race in supra-maneuverable weapons or encourage countries to increase their arsenal sizes in an attempt to overwhelm the adversary's magazine depth or shot capacity. Space situational awareness (SSA) and Space Object Surveillance and Identification (SOSI) systems become supremely important to find/fix the orbital interceptors, assess their performance limitations, and offer U.S. decision makers courses of action across the spectrum of military operations.

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63. Senator WARREN. Secretary Rapuano, Lieutenant General David Thompson, and Lieutenant General John Thompson, what historical evidence is available to demonstrate that space-based missile defense has been affordable and effective for the United States? Please provide an unclassified explanation.

Secretary RAPUANO. The conceptual benefits of engaging missile threats from space, particularly for boost phase defense, have long been recognized, as have the critical technical and operational issues that would have to be resolved on the way to a militarily useful and affordable capability.

Given the significant advantages of space-based missile defenses, the 2019 Missile Defense Review tasked the Missile Defense Agency to study the development and fielding of a space-based missile intercept layer capable of boost-phase defense. This report is scheduled to be completed between July and the end of 2019, and will iden-

tify the technologies, schedule, cost, and other requirements for a space-based defensive layer for boost-phase defense.

Lieutenant General David THOMPSON. Air Force Space Command plays a key role in the Department's missile warning architecture to include multi-domain command and control efforts aimed at enhancing interoperability. However, space-based missile defense falls under the purview of the Missile Defense Agency and as such I would defer to MDA leadership for funding and operational details. There are no historical examples of space-based missile defense. However, recent years have seen clear demonstrations of the various aspects of space-based missile defense, such as increased performance of space-based infrared sensors, advances in onboard data processing, autonomous rendezvous and proximity operations, and research into decoy discernment. On-orbit demonstrations would have to be conducted responsibly to connect these various functions while minimizing debris.

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QUESTIONS SUBMITTED BY SENATOR JOSEPH MANCHIN

ACQUISITION TIMELINES

64. Senator MANCHIN. Lieutenant General John Thompson, in the testimony provided you highlight a 65 percent savings on acquisition timelines based on the implementation of the SMC 2.0 initiative. Ms. Chaplain in her testimony though highlighted some significant delays such as a 3.5 year delay in the AEHF satellite program's first launch and a 4 year delay in the Global Positioning System III (GPS III) program. Are these delays symptomatic of problems not addressed by the SMC 2.0 enterprise or is this a sign of the new processes attempting to catch up to and correct old problems?

Lieutenant General John THOMPSON. Over the last 4 years, the Space and Missile Systems Center (SMC) has taken a multi-faceted approach to reduce the pre-contract award timelines and has seen a 65 percent reduction. SMC 2.0 continues to reduce this timeline by delegating acquisition authority to the lowest level possible and reduces/streamlines the documentation development and review timelines. To address the program execution timelines, we are using 804 authorities to critically think about the operational requirement and develop an acquisition strategy to burn down the developmental risk. Although the Technology Maturation and Risk Reduction (TMRR) phase of DODI 5000.02 was meant to "prototype" and mature technology, the cost of space programs limited lengthy technical reviews with multiple contractors. As a result, programs were not performing true prototyping, but rather they matured the technology at the piece part level with limited vendor(s), restricting the program's vendor options in the Engineering, Manufacturing and Development (EMD) phase. By emphasizing capability delivery with constrained costs and shortened time horizons, our negotiation leverage shifts away from industry partners and back to SMC. Rather than locking SMC into decades-long contracts, we can award short term contracts and/or agreements with less requirement specificity, forcing industry to prove what capability can be delivered the fastest. Programs can then select the contractor(s) with the greatest potential with real data and not a concept or paper design. This will drive our programs to uncover critical component issues, hardware/software integrations risks, and/or software development risks earlier.

AGENCY RESPONSIBILITIES

65. Senator MANCHIN. Lieutenant General David Thompson, in February Secretary of the Air Force Heather Wilson wrote a memo to Under Secretary of Defense for Research and Engineering, Michael Griffin, in which she detailed why she believed the SDA was replicating duties already directed by Congress to the Air Force and that the agency lacked a "uniquely identifiable mission". She also highlighted that the Air Force had already stood up its Space RCO to complement its existing

Rapid RCO with a space focus. Given the growing number of space focused research and acquisition agencies to include SDA, Space RCO, SMC and DARPA, has the Office of the Secretary of Defense and the Department of the Air Force clearly outlined responsibilities and deconflicted lines of effort to maximize growth while minimizing waste?

Lieutenant General David THOMPSON. Leaders across the Department have been focused on the goal of achieving more rapid and agile delivery of space capabilities to the warfighter. The Space Development Agency, the Space Rapid Capabilities Office, the Defense Advance Research Project Agency, the Defense Innovation Unit, the Space and Missile Systems Center, and various other interagency partners all represent distinct and important lines of effort toward that goal. The Department's initial vision of SDA's role is to leverage industry investment and commercial capabilities for the next generation space architecture. Further, Department and Service acquisition organizations continue to improve the rapid delivery of warfighter capabilities while minimizing duplication of effort and eliminating non-value-added processes and procedures.

ACQUISITION STRATEGY FOR SPACE LAUNCH VEHICLES

66. Senator MANCHIN. Ms. Chaplain, generally fully open, head-to-head competition provides benefit in quality and price of products delivered. Has GAO conducted any sort of cost assessment since the Space Vehicle Launch competition was opened up in 2015 to assess the value of the program to date?

Ms. CHAPLAIN. We agree competition is the cornerstone of a sound acquisition process and a critical tool for achieving the best return on investment for taxpayers. However, we have not assessed the cost or value of the National Security Space Launch (formerly known as Evolved Expendable Launch Vehicle) program since the Air Force amended its acquisition strategy to allow for competitive launch service procurements. This would be another topic worthy of a future review given the changing nature of the launch market.

ASSURED ACCESS TO SPACE

67. Senator MANCHIN. Lieutenant General David Thompson, Lieutenant General John Thompson and Ms. Chaplain, the assured access to space policy is critical to ensure we are always able to provide the ability to reach and operate from space. I've become aware that the LSA companies' products share significant commonality across many systems, to include engines. Is our Defense Industrial Base adequately diversified under these agreements in order to provide continual access to space if a critical failure of any similar or common component is discovered?

Lieutenant General David THOMPSON. The Air Force selected the best portfolio of providers to ensure assured access to space and provide effective competition for Phase 2 Procurement. While the portfolio does include some commonality between launch systems, this does not inherently drive a higher risk, and can often reduce risk by demonstrating higher reliability across multiple applications. The Air Force has a strong history of effectively managing common components across the U.S. industrial base, as evidenced by the Atlas and the Delta Evolved Expendable Launch Vehicles use of the common Aerojet Rocketdyne RL-10 engine.

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Ms. CHAPLAIN. We have not reviewed each LSA companies' launch system development efforts and plans, but we are aware of instances of commonality among the systems. Some commonality is also present between the Delta IV and Atlas V launch families, and issues with common components have resulted in or raised risk of launch delays for both families until the issues were resolved. Ultimately, it is the Air Force's responsibility to assess the sufficiency of its space launch industrial base and any potential impacts on assured access to space.