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STATEMENT OF

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Committee on Armed Services

Introduction

Chairman Udall, Ranking Member Sessions, and Members of the Subcommittee, I am pleased to join General Shelton, Lieutenant General Mann, Dr. Zangardi, and Ms. Chaplain to testify on Department of Defense (DoD) space programs and policies. I first testified in front of Congress on these topics one year ago, and I welcome the opportunity to continue that discussion today.

As I stated last year, space remains vital to our national security. It underpins DoD capabilities worldwide at every level of engagement, from humanitarian assistance to the highest levels of combat. It enables U.S. operations to be executed with precision on a global basis with reduced resources, fewer deployed troops, lower casualties, and decreased collateral damage. Space empowers both our forces, and those of our allies, to win faster and to bring more of our warfighters home safely. It is a key to U.S. power projection, providing a strong deterrent to our potential adversaries and a source of confidence to our friends.

But the evolving strategic environment increasingly challenges U.S. space advantages. Space is no longer the sole province of world powers – it is a frontier that is now open to all. In the last several decades, space has become more competitive, congested, and contested. I am confident that with the right policies, the United States is well-positioned to remain ahead in the competitive environment. I am equally confident that we are on course to deal with congestion. But what worries me the most is the contested environment we now face. Over the last 15 years, our adversaries have watched us closely and have recognized that if they are to challenge the United States, they must challenge us in space.

The United States has successfully addressed such challenges before in air, sea, and land domains, and now we must likewise respond in space. We do so against the backdrop of a decreasing budget that challenges both the ability and speed with which we can act, but that in no way diminishes the importance of successfully sustaining our crucial advantages in space.

Our strategic approach remains consistent with what we outlined in the 2011 National Security Space Strategy and reaffirmed in DoD Directive 3100.10, the DoD Space Policy, released in late 2012. In my testimony today, I will outline the five key elements of this strategic approach and describe specific steps we are taking to implement our approach.

Promoting the Responsible, Peaceful, and Safe Use of Space

As still the world's leading space power, the United States is uniquely positioned to define and promote the responsible, peaceful, and safe use of space. We need to do this to ensure that we can continue to reap the military benefits that space provides and, more importantly, the civil, scientific, and economic opportunities it presents. Space is woven into the fabric of modern economies and the United States, beyond all others, has led the way in using that to our national advantage. We are taking steps to make sure that access to and use of space is not threatened by irresponsible actions. The Department of Defense is working closely with the Department of State to establish an International Code of Conduct and other "rules of the road" for the safe and sustainable use of space. Those rules include common sense standards for debris limitation, launch notification, on-orbit monitoring, and collision avoidance. The United States already follows these practices and, by encouraging their adoption by others, could help ensure that space remains sustainable for the future

I know there are some who question the wisdom of these multilateral activities. They are worried that in establishing international norms of behavior we would limit our response options. Let me assure you, we do not intend to allow that to happen. We have worked side-by-side with the Joint Staff, Combatant Commands, Military Services, Defense Agencies, and Intelligence Community to make sure that any agreement we develop enhances security and does not threaten current or future U.S. capabilities.

I am not so naïve as to believe that a simple set of rules will solve all of the major issues we face – they will not; nor would I expect that they will inhibit those who would try to threaten our use of space. But common sense rules that can be embraced by a majority of space-faring nations will help stem the rise of uncontrollable debris, add demonstratively to spaceflight safety, and clearly differentiate those who use space responsibly from those who do not.

Our efforts here go beyond mere words – they are backed by actions. As I have discussed before, a key aspect of improving spaceflight safety, and assuring we can monitor the space environment more closely, is our space situational awareness (SSA) capabilities. We have been working on this for some time, and I am happy to report that we have made some real progress over the last year. That progress comes in two forms – new sensors and information sharing agreements.

On the sensor front, we have remained on a constant path for the last several years to reposition sensors where they can do the most good and to invest in new sensors where needed. Last year we reported that we had entered into an agreement with Australia to relocate and repurpose a launch tracking radar, the C-Band radar, from Antigua to western Australia to aid in our ability to monitor activities at low altitude in the southern hemisphere. That work is now underway. We complemented that effort with a second agreement signed with Australia this past

November to relocate the DARPA-developed Space Surveillance Telescope to western Australia to give us an unmatched ability to track deep space objects in that critical region of the world. Additionally, after years of focused effort, and a sequestration-imposed six-month delay, we will soon award the contract for the first Space Fence site. The Space Fence will provide an unprecedented ability to track an order-of-magnitude greater number of objects in low earth orbit, supporting long-term spaceflight safety.

The Department has also made great strides in more transparently sharing SSA information with other space operators. Over the past year, U.S. Strategic Command (USSTRATCOM) has continued to pursue SSA sharing agreements with commercial companies and foreign governments, consistent with existing legislative authority. This year, USSTRATCOM signed five agreements with other governments – Australia, Japan, Italy, Canada, and France – and increased to forty-one our agreements with commercial satellite operators. Many more agreements are in varying stages of negotiation. We are committed to providing SSA services to enhance spaceflight safety for all.

While the purpose of these agreements is to allow us to share more advanced space flight safety products with other space-faring nations, they really serve to lay the groundwork for the next stage of effort – two-way data sharing. The space environment is too big and too complex for a single nation to bear the entire cost of monitoring it. Cost-effective SSA requires cooperation among space actors. The increasingly congested space environment means that an unparalleled level of information sharing is needed to promote safe and responsible operations in space and to reduce the likelihood of mishaps, misperceptions, and mistrust. We are currently engaged in detailed technical discussions with several nations that have space situational awareness capabilities to explore opportunities for two-way information exchange. This type of sharing will increase SSA information available to the United States while limiting unnecessary duplication of SSA capabilities. In short, we save money and improve safety for us and our allies.

Improving DoD Space Capabilities

Improved SSA is but one facet of the next pillar of our strategy – improving our own space capabilities. This element boils down to a single refrain – make DoD space systems and architectures more resilient. Yes, we need to continue to improve how space systems operate, the services they provide, and the capabilities they create; yes, we need to make space systems less expensive; but above all others, we have to focus on making those capabilities more resilient. The most capable and cost-effective space capability in the world is of little use if it is not there when the warfighter needs it. If we are to overcome the challenges posed by others, resilience is job one.

We have been talking about resilience for some time, but often I am unsure if we have clearly defined what we mean. In fact, I am sure we have confused several audiences. Before I describe specific investments in resilient space architectures, allow me to explain the concept.

Resilience, in fact, is not an end in and of itself; rather we seek to assure the mission benefit that our capabilities provide – omnipresent positioning from the Global Positioning System (GPS), global surveillance from overhead intelligence, surveillance, and reconnaissance (ISR), and worldwide information availability from Satellite Communications (SATCOM). As we see it, that assurance can be achieved through a combination of (1) strengthened or resilient space architectures, (2) the ability to replenish lost or degraded capabilities, and (3) defensive operations to provide warning of and interruption to an adversary's attack. Making architectures more resilient is a combination of adequate protection, increased proliferation, service diversity, appropriate distribution, well-reasoned disaggregation, and operational ambiguity – all to create a service that can stand up to an adversary's attack. These are the same force structure ideas we use in every other field of warfighting to help our systems survive in a hostile environment.

With these concepts in hand, we have begun to consider resilience in a variety of architectural and programmatic discussions. For the first time ever, for example, our protected SATCOM analysis of alternatives is focusing on resilience. The same will be true when we look at overhead persistent infrared monitoring later this year. From an investment standpoint, we have identified extremely cost-effective enhancements in automated anti-jamming for our Wideband Global SATCOM system (WGS) to increase protection in a jammed environment. We are committed to assuring that GPS can face the rigors of a hostile battlefield environment by continuing our investment in our military (or "M-code") user equipment program. And the Department continues to use Space Modernization Initiative (SMI) investments to improve affordability and capability of our current Space Based Infrared System (SBIRS) and Advanced Extremely-High Frequency (AEHF) architectures. SMI funds are also being used to invest in evolutionary follow-ons to those architectures that disaggregate strategic and tactical elements and look at ways to distribute and proliferate the resulting pieces. Every aspect of these decisions is driven by our focus on improving space system resilience.

Partnering with Like-Minded Nations, International Organizations, and Commercial Firms

Resilience, however, will not be achieved through U.S. investment alone. The reality of the budget is such that we cannot just hope to "buy our way out" of these challenges. They are too complex, and they are too long term. Instead we have taken a more expansive approach:

joining with other like-minded space-faring nations and commercial partners to create a coalition approach to space, just as we have done in other warfighting domains.

Space is no longer limited to just a few nations. It is a major force structure component for each of our allies, and that is force structure we can all share. Whether we are talking about the dozens of radar and electro-optical imaging satellites that the United States and our allies already have on orbit, the rapidly multiplying navigation constellations whose satellites will soon number over 100, or the ever-growing array of weather and SATCOM capabilities at the world's disposal, we have begun to recognize that the United States neither can, nor does it need to, go it alone in space. This is a fundamental shift in how we approach this problem. Just as in other fields of combat where we combine with allied land, sea, and air forces, so too can we combine our space forces with equally effective results and for very little increased investment.

For example, by 2020 we anticipate that at least six nations or regional intergovernmental organizations will have fielded independent space navigation systems – our GPS network, the European Union's Galileo, Japan's Quasi Zenith Satellite System (QZSS), the Indian Regional Navigation Space System (IRNSS), China's Compass system, and Russia's GLONASS. Those constellations will include nearly 140 satellites, with a dizzying number of new signals and services. While it may be possible for an adversary to deny GPS signals through jamming, physical antisatellite attacks, or a cyber-attack on a ground control network, it is much more difficult to eliminate multiple services at the same time. Assuring U.S. warfighters have access to the bulk of these systems is a very powerful way to make sure no warfighter will ever have to face battle without the incredible benefit of space-enabled positioning, navigation, and timing (PNT). To that end, we have begun negotiations with like-minded PNT owner/operators to ensure the United States has that access. We must likewise ensure our equipment is capable of receiving these different signals – just as is already happening in commercial applications.

The same is true for other space services and is already bearing fruit in our plan for future space weather capabilities. We closely examined what we could get from others – international partners, U.S. civil agencies, the commercial sector, and even non-space services – and we defined a new, minimal, DoD owned- and operated-system that is an order-of-magnitude less expensive than the previously planned system it replaces. Together this "system of systems" meets U.S. warfighting needs in a way that stymies an adversary's ability to threaten the resulting whole. A combination of diversity, distribution, disaggregation, and proliferation can increase resilience while reducing needed investment.

This approach is particularly well-suited to areas in which the commercial world plays a major role, such as remote sensing. In this area, we are aligning several of our policy elements to take advantage of and hasten the diversity- and proliferation-driven resilience I have been discussing. Building on over a decade of experience with traditional commercial providers, we are reexamining commercial remote sensing licensing policy, while leveraging new authorities to relax export controls for systems that are widely available commercially. Our aim is to posture U.S. industry – both traditional commercial providers and entrepreneurial start-ups – to compete successfully in a burgeoning global marketplace.

Deterring Aggression

The fourth strategic element is to prevent and deter aggression against our space systems. In fact, all of the policy elements I have covered thus far – promoting responsible use, improving our own capabilities, and partnering with allies and commercial space providers – are also aimed squarely at this fourth strategy element. Those efforts are complemented by a focus on SSA to provide timely and accurate indications and warning prior to an attack and attribution during and after an attack, with a focus on command and control systems that support our ability to respond appropriately.

Let me discuss two efforts aimed at those objectives. First is our Joint Space Operations Center (JSpOC) Mission Systems (JMS). That program delivered its first operational increment early last year, and we are on track to complete increment two in fiscal year 2017. That will be followed by additional increments that support characterizing attacks and coordinating operational responses.

The second is the Geosynchronous Space Situational Awareness Program (GSSAP) recently announced by Gen Shelton. This previously classified program will deliver two satellites later this year for launch into near geosynchronous orbit (GEO). From that unique vantage point they will survey objects in the GEO belt and allow us both to track known objects and debris and to monitor potential threats that may be aimed at this critically important region. In short, threats can no longer hide in deep space. Our decision to declassify this program was simple. We need to monitor what happens 22,000 miles above the Earth, and we want to make sure that everyone knows we can do so. We believe that such efforts add immeasurably to both the safety of space flight and the stability that derives from the ability to attribute actions – to the benefit of all space-faring nations and all who rely on space-based services.

Taken together, all of these elements combine to enhance stability and deterrence – seeking to reduce the likelihood of attack, to provide the necessary indications and warning to take evasive actions prior to an attack, to deny benefits to the adversary if such attacks are undertaken, to attribute the source of the attack, and to make it impractical for an adversary to isolate the United States from the community of space-faring nations that will be affected.

<u>Defeating Attacks and Preparing to Operate in a Degraded Environment</u>

Even with all these efforts in place, however, attacks may occur. Our last strategic element is to assure we can defeat attacks and prepare to withstand them should they occur. Much of our effort in this area is coordinated through our Space Security Defense Program (SSDP). SSDP was established last year as an outgrowth of the Space Protection Program initiated in 2008 by Air Force Space Command and the National Reconnaissance Office. SSDP is developing methods to protect and defend our space systems by finding ways to counter the ever growing list of threats they will face.

Several of the initiatives I have already mentioned today, such as the WGS automatic anti-jamming capability, are derived from work of SSDP. We have requested increased funding for SSDP this year to allow them to examine non-material solutions, such as changes to tactics and procedures, that can be implemented today. While our long-term intent is to move to more resilient and more defendable space architectures, we have over a decade before those systems will even begin to deploy, and we need to protect ourselves and our on-orbit systems now.

<u>Other Matters</u>

Let me conclude by moving from our overall strategy to address specific matters in which I know there is continuing interest. First, last year your colleagues in the House Armed Services Committee challenged me to explain why the United States was leasing communication links from a Chinese provider to support U.S. Africa Command (USAFRICOM). I agreed that while the initial lease was driven by operational need, it was not an appropriate long-term solution. I pledged that we would address the issue as quickly as possible. I am happy to report that we have. Working with us, USAFRICOM has made significant progress over the last year in moving DoD SATCOM leases from the Chinese Apstar system to other commercial satellite providers in the region. We have already transitioned over 75% of the Apstar bandwidth to other satellites, and our intent is to be completely transitioned by May of this year.

Second, we are developing a better strategy for making long-term commitments to commercial SATCOM providers to reduce cost, increase capability, and add resilience. Later this year, Air Force Space Command will purchase a commercial transponder, one that is already in space, for use by USAFRICOM. This is not a lease – instead it is government ownership of an on-orbit asset that will be managed and operated by the commercial provider at a small fraction of the cost that it would take to lease this capability on an annual basis. Not only will this transponder help to accelerate the move off of Apstar, it will provide needed experience with this new method of acquiring commercial SATCOM, potentially ushering in a revolutionary way to do so worldwide.

Third, we recently welcomed the President's new National Space Transportation Policy, released November 21, 2013. This policy will help ensure the United States stays on the cutting edge by maintaining space transportation capabilities that are innovative, reliable, efficient, competitive, and perhaps most importantly, affordable. This policy supports DoD's ongoing efforts to provide stability to the industrial base that currently provides launch vehicles to the national security community by mandating that all programmatic decisions are made in a manner that considers the health of the U.S. space transportation industrial base. The policy also calls for a level playing field for competition that can spur innovation, improve capabilities, and reduce costs, without increasing risk. The President's budget request already bears evidence that this strategy is working: the EELV request has been reduced significantly. Those benefits will become even greater in the future as we fully qualify new entrant launch providers, an effort that is already well underway.

Fourth, we continue to make progress in building coalition space operations. Led by USSTRATCOM, the Department is working with close allies on cooperation, not only in the systems we fly, but in the operations we perform. This initiative paves the way for far closer operational collaboration with allies than we have ever had, with the aim of eventually broadening participation to include additional space-faring countries.

Finally**,** just as the United States develops its space capabilities and leverages them to support military operations, so too do other countries. We are increasingly seeing rival nations begin to integrate space into their own operations in the same way as the United States and our allies have done for years. This is not unexpected. But it does mean that the benefits we ourselves derive from space will begin to be available to those that we may someday have to face in combat. We recognize that this is the reality of the future and we are beginning to prepare to face a more capable adversary. We appreciate the increased interest from the Congress in this area and look forward to working with you over the coming years to assure our strategies and plans in this area are thoroughly deliberated.

Conclusion

Mr. Chairman, thank you for the opportunity to provide these updates on the Department's space policies and programs. My colleagues and I look forward to working closely with Congress, our interagency partners, our allies, and U.S. industry to continue implementing this new approach to space.

RECORD VERSION

STATEMENT BY

LIEUTENANT GENERAL DAVID L. MANN, USA

COMMANDING GENERAL,
U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND
AND
ARMY FORCES STRATEGIC COMMAND

BEFORE THE

COMMITTEE ON ARMED SERVICES
STRATEGIC FORCES SUBCOMMITTEE
UNITED STATES SENATE

ON SPACE PROGRAMS

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Lieutenant General David L. Mann, USA
Commanding General
U.S. Army Space and Missile Defense Command
and
Army Forces Strategic Command

Introduction

Mr. Chairman, Ranking Member Sessions, and distinguished Members of the Subcommittee, thank you for your continued support of our Soldiers, Civilians, and Families. This marks my first appearance before the Strategic Forces Subcommittee of the Senate Armed Services Committee, a body that has been a strong supporter of the Army and the key capabilities that space affords our Warfighters. Your past and future support is vital as we pursue Joint efforts to provide critical space capabilities for our Nation, our fighting forces, and our allies. Thank you for your continued support.

In my current assignment, I have three distinct responsibilities. First, as the Commander of the U.S. Army Space and Missile Defense Command, I have Title 10 responsibilities to organize, man, train, and equip space and missile defense forces for the Army. Second, as the Commander, Army Forces Strategic Command, I am the Army Service Component Commander (ASCC) to the U.S. Strategic Command (USSTRATCOM). I am responsible for planning, integrating, and coordinating Army space and missile defense forces and capabilities in support of USSTRATCOM missions. Third, as the Commander of USSTRATCOM's Joint Functional Component Command for Integrated Missile Defense (JFCC IMD), I am responsible for synchronizing missile defense plans, conducting ballistic missile defense operations support, and also serve as the Warfighter's advocate for missile defense capabilities.

Today, I am honored to appear with General Shelton to provide this subcommittee insight on the critical space-based capabilities that our respective commands continuously provide the Warfighter.

As the Army's proponent for space, USASMDC/ARSTRAT coordinates with the other members of the Army space enterprise, to include the Army intelligence, signal, and geospatial communities. We are engaged across the broader Army community to ensure space capabilities are maximized and integrated across our entire force and that potential vulnerabilities to our systems are, to the greatest extent possible, mitigated. We also collaborate with USSTRATCOM, its Joint Functional Component Command for Space (JFCC Space), and other members of the Joint community to provide trained and ready space forces, as well as space-based and space-enabled ground-based capabilities to the Warfighter. Additionally, we work closely with acquisition developers in the other Services to ensure the enhancement of systems that provide the best capabilities for ground forces.

Providing Army Space Capabilities—Today, Tomorrow, and the Day-After-Tomorrow

My focus today is to impress upon the Subcommittee the need to ensure our space capabilities are maintained, if not further enhanced, during the present environment of increasing threats and declining resources.

The Workforce—Our Greatest Asset

At USASMDC/ARSTRAT, as is the case within all the Army, our people are our most enduring strength. The Soldiers, Civilians, and Contractors at USASMDC/ARSTRAT support the Army and Joint Warfighter each and every day, both those stationed on the homeland and those deployed overseas. Within our command, we strive to maintain a cadre of space professionals to support our Army.

In step with the Army, our USASMDC/ARSTRAT leadership team embraces the imperatives of Sexual Harassment / Assault Response and Prevention (SHARP). As stated by the Chief of Staff of the Army, sexual harassment and sexual assault violate everything the U.S. Army stands for including our Army Values and Warrior Ethos. At USASMDC/ARSTRAT, I will continually assess the effectiveness of our SHARP efforts to ensure we are meeting the needs of our Soldiers, Civilians, and family members. Our workforce deserves nothing less.

Reliance on Space-Based Capabilities

Our Army provides a globally responsive and regionally engaged force that supports the Joint Team with critical enablers and, as directed, responds to crises at home and abroad. The Army is dependent on space capabilities to execute Unified Land Operations in support of the nation's objectives. Army space forces contribute to the Joint Force and the Army's ability to be adaptive, versatile, and agile to meet tomorrow's security challenges. Simply put, space capabilities are critical elements of the Army's ability to see, shoot, move, and communicate.

The Army is the largest user of space-enabled capabilities within the DoD. Our ability to achieve operational adaptability and land dominance depends on the benefits derived from key assets in space. Integrating space capabilities enables commanders, down to the lowest echelon, to conduct Unified Land Operations through decisive action and operational adaptability.

> ***"The Army's warfighting functions, weapons and battle systems are vitally dependent on space."***
>
> **--Army Strategic Planning Guidance 2013**

There are currently six Army warfighting functions that contribute to operational adaptability: mission command, movement and maneuver, intelligence, protection, fires, and sustainment. Space-based capabilities leveraged and employed across the National space enterprise enable each of these warfighting functions. Virtually every Army operation relies on space capabilities to enhance the effectiveness of our force.

When combined with other capabilities, space systems allow Joint forces to see the battlefield with clarity, navigate with accuracy, strike with precision, communicate with certainty, and operate with assurance. Dependence on space as a force multiplier will continue to grow for the Army of 2020 and beyond, especially in an era of tight fiscal resources, a smaller force structure, and possibly, a further reduced forward presence. The bottom line is the Army depends on space capabilities in everything we do. Retaining our global space superiority is a military imperative.

Space in Support of Army Warfighting Functions

There are five space force enhancement mission areas: (1) satellite communications (SATCOM); (2) position, navigation, and timing; (3) intelligence, surveillance, and reconnaissance; (4) missile warning; and (5) environmental monitoring. Commanders and Soldiers leverage these space force enhancement capabilities to conduct warfighting functions. They are critical enablers to our ability to plan, communicate, navigate, and maintain battlefield situational awareness; target the enemy; provide missile warning; and protect and sustain our forces. Joint and Army forces require assured access to space capabilities and, when required, have the ability to deny our adversaries the same space-based capabilities.

Joint interdependence is achieved through the deliberate reliance on the capabilities of one or more Service elements to maximize effectiveness while minimizing vulnerabilities. As the DoD Executive Agent for Space, the Secretary of the Air Force is responsible for leading the development, production, support, and execution of military space operations. USSTRATCOM is the combatant command headquarters responsible for planning and advocating for space capabilities for the Warfighter. The Army continues to utilize national, Joint, and commercial systems for additional capabilities while pursuing cross-domain solutions that support Unified Land Operations. The Army must continue to influence Joint requirements and new solutions that provide compatible space capabilities in support of our warfighting functions. Finally, we must actively engage in focused experimentation, smart developmental test and evaluation, and timely military utility demonstrations to take advantage of dynamic technological advances in space.

> ***"Modern Armed Forces Cannot Conduct High-Tempo, Effective Operations Without…Assured Access to Cyberspace and Space."***
>
> ***--Defense Strategic Guidance January 2012***

Today's Operations —Provide Trained and Ready Space Forces and Capabilities

While the Army is the largest DoD user of space, we are also a provider of space-based capabilities. Each day, USASMDC/ARSTRAT provides trained and ready space forces and capabilities to combatant commanders and the Warfighter. Within our 1st Space Brigade, approximately 1,000 Soldiers and Civilians—forward-deployed, forward-stationed, or serving at home—provide space capabilities that are essential in all phases of operations. The Brigade, a multi-component organization comprised of

Active, Army Reserve, and associated National Guard Soldiers, provides flexible, reliable, and tailored support to combatant commanders and Warfighters by conducting continuous global space support, space control, and space force enhancement operations. The Brigade's three battalions provide satellite communications, space operations, theater missile warning, and forward-deployable space support teams.

Army space professional personnel policy is the responsibility of USASMDC/ARSTRAT. We serve as the Army's proponent and developer of training for space professionals and provide training assistance for Space-Enabler indentified positions. Our Army Space Personnel Development Office (ASPDO) is the focal point for all Functional Area (FA) 40 Space Operations Officers matters and executes the personnel development and life-cycle management functions on their behalf. Additionally, ASPDO develops policies, procedures, and metrics for the Army Space Cadre. The Army's Space Cadre, utilizing FA 40s as its foundation, is comprised of over 3,000 Soldiers and Civilians. The Space Cadre and Space Enablers consist of Soldiers and Civilians from multiple branches, career fields, disciplines, and functional areas.

> ***"Access to these capabilities is achieved through the Warfighting Functions by Soldiers and a Space Cadre…"***
>
> ***--Army Space Operations White Paper April 2012***

Today, there are approximately 400 multi-component FA 40s serving in Joint and Army organizations across all echelons of command—tactical, operational, and strategic. These Space Operations Officers, along with members of the Army's Space Cadre, directly influence the execution of strategic operations in support of operational and tactical level ground maneuver forces. Their principal duties include planning, developing, acquiring, and integrating space force capabilities. Over recent years, the maturity of the career field and the capabilities these officers provide to the Army and its Joint partners has led to an increased demand for FA 40 personnel. As the Army continues to reduce its overall end strength, FA 40 billets have fared well in the support of our corps and divisions. We have actually realized a slight increase in billets due to the requirements of the Special Forces community. During the past year, USASMDC/ARSTRAT space professionals have supported over a dozen major exercises, several mission rehearsal exercises for units deploying in support of Operation Enduring Freedom, and other named operations.

An overview of some of the critical space capabilities provided by Army space professionals is highlighted below.

Army Space Support Teams: The Army deploys specialized Army Space Support Teams to support Army corps and divisions, other Services, Joint task forces, and multinational forces. The teams, which maintain a continuous presence in the Afghanistan theater, provide space-based products and services to commanders and Warfighters. The teams are on-the-ground space experts, pulling key commercial imagery, forecasting the impact of space weather, and providing responsive space support to their units. During 2013, USASMDC/ARSTRAT deployed four Army Space Support Teams and Commercial Imagery Teams to U.S. Central Command's area of operations. Since this era of persistent conflict began, we have deployed teams on 86 occasions. These teams bring tailored products and capabilities that meet critical theater commander needs.

> ***The Army "requires access to space capabilities to exercise effective mission command and support combatant commanders."***
>
> ***-- Army Capstone Concept December 2012***

Satellite Communications: Our mission in satellite communications (SATCOM) is to ensure reliable and resilient access to tactical Warfighter networks and the DoD Information Network primarily through the successful execution of satellite payload operations and the management of regional satellite communication centers. USASMDC/ARSTRAT conducts payload and transmission control for all DoD-owned wideband SATCOM bandwidth, including communications carried over the Defense Satellite Communications System (DSCS) and Wideband Global SATCOM System (WGS) constellations.

Additionally, we serve as the Consolidated SATCOM System Expert (C-SSE) for the DoD narrowband and wideband SATCOM constellations, which include the DSCS, the WGS, the Mobile User Objective System (MUOS), the Ultra High Frequency

SATCOM (UHF), and the Fleet Satellite Communications System. As the SATCOM System Expert for MUOS, the Army is responsible for DoD's use of our next generation tactical system, which will transform tactical SATCOM from radios into secure cellular networked communication tools. During 2013, our Wideband C-SSE experts conducted detailed testing on the recently activated WGS-5 and WGS-6 satellites that are now providing increased Wideband SATCOM resources to Combatant Commanders. In 2013, we supported the early activation of the MUOS-1 legacy payload and will soon directly support the testing and activation of enhanced capabilities on the MUOS-2. The Army also has a significant role and assigned responsibilities in DoD's expanding use of military satellite communications through a number of growing programs and initiatives, and is the operational lead for multiple international partnerships.

USASMDC/ARSTRAT also mans and operates the Wideband Satellite Communications Operations Centers (WSOCs) and the Regional Satellite Communications Support Centers (RSSCs). The satellite communications control missions of the DSCS and the WGS are performed by the 1st Space Brigade's 53rd Signal Battalion and Department of the Army Civilians utilizing the capabilities of the globally located WSOCs and RSSCs. Support to the Joint community, agencies, and our allies continue to grow exponentially as use of military SATCOM increases. SATCOM is the Army's top space priority. We are actively transforming our concept of operations and upgrading our capabilities to defend vital mission command links and provide assured access to SATCOM. For example, we recently replaced aging antennas and terminal equipment at the Wahiawa, Hawaii WSOC. The new WSOC at Fort Meade, Maryland will be completed this year, and we broke ground for the construction of a new WSOC facility in Germany. Modernization and equipment replacement are required so that the centers remain compatible with the fleet of new and expanding WGS assets being deployed by the Air Force.

Friendly Force Tracking: Friendly force tracking (FFT) systems support situational awareness enroute to and throughout areas of operation. Joint and Army forces require precise position, navigation, and timing information to enable confident, decisive maneuver by both ground and air assets. The DoD's Friendly Force Tracking Mission Management Center, operated by USASMDC/ARSTRAT from Peterson Air Force Base, Colorado, receives more than one million location tracks a day to provide a common operating picture to command posts and operations centers. This capability, performed on behalf of USSTRATCOM, is an essential worldwide enabler to both military and other government agencies.

> ***"Future forces require the ability to conduct integrated FFT operations that include joint forces and a wide array of unified action partners."***
> ***--Army Space Operations White Paper April 2012***

Ballistic Missile Early Warning: Early warning is a key component of indications and warning for missile defense. Army forces need assured, accurate, and timely missile warning launch location, in-flight position, and predicted impact area data. The 1st Space Brigade's Joint Tactical Ground Stations (JTAGS) Detachments, operated by Army personnel, monitor adversary missile launch activity and other events of interest and then share this information with members of the air and missile defense and operational communities. Our JTAGS Detachments are forward-stationed across the globe, providing 24/7/365 dedicated and assured missile warning to theater level commanders.

Geospatial Intelligence (GEOINT) Support: USASMDC/ARSTRAT provides geospatial intelligence in direct support of the combatant commands as an operational element of the Army's National-To-Theater Program and as a member of the National System for Geospatial Intelligence. The Army's space and intelligence experts exploit a variety of commercial, civil, and DoD imagery data derived from space and airborne sources. Additionally, they aid in the exploration of emerging spectral system technologies and in transitioning new capabilities to the Warfighter. During 2013, our GEOINT professionals created over 17,000 geospatial intelligence reports which provided essential support to the geographical and functional combatant commands. Late last year, our GEOINT Team was presented the 2013 Military Achievement Award by the U.S. Geospatial Intelligence Foundation for its work in developing a process to speed the exploitation of large volumes of hyper-spectral imagery data from DoD's experimental Tactical Satellite-3 platforms.

Operations Reach-back Support and Services: Our Operations Center, located in Colorado Springs, Colorado, continues to provide daily reach-back support for our space experts deployed throughout the operational force and enables the Army to reduce our forward-deployed footprint. This center maintains constant situational awareness of deployed elements, continuously responds to requests for information, and provides the essential reach-back system of connectivity with technical subject matter experts.

As Land Force Structure is Reduced, Strategic Enablers Such as Space and Cyber Become More Important

Strategic Space Surveillance: The Army also operates facilities and assets that are of utmost importance to protecting the Nation's use of space. The Ronald Reagan Ballistic Missile Test Site (RTS), located on the U.S. Army Garrison - Kwajalein Atoll (USAG-KA) in the Marshall Islands, is a national asset that provides unique radars and sensors that contribute to USSTRATCOM's space situational awareness mission, enabling protection of the Nation's manned and unmanned space assets. This strategic site also serves as a critical asset for ballistic missile testing and is ideally located to provide equatorial launch benefits.

Addressing Tomorrow's Requirements—Building Future Space Forces

Over the past two decades, Army operations have transitioned from being "supported" by space capabilities to being truly "enabled" by them – space capabilities are an integral part of military operations. Military and civilian space technology has dramatically improved access, processing, and dissemination of data collected by space-based capabilities. To ensure our continued access to space-based capabilities, we must continue active participation in defining space-related requirements. These identified needs equip us to develop and mature Joint and Army force structure and concepts of operations in sync with the deployment of capabilities, thereby enabling our forces to conduct tomorrow's full range of military operations. Assured access to space is our focus— ensuring the requisite capabilities and effects are delivered to the tactical Warfighter on time, every time demands that our space capabilities and architectures become more resilient against attacks and disruption. We must ensure the Army is prepared to conduct operations in a space-degraded environment.

In our second core task of building space forces for tomorrow, we use our capability development function to meet future space requirements. We continue to use both established and emerging processes to document our space-based needs and pursue validation of Joint, Army, and coalition requirements. This regimented approach helps ensure limited resources are applied where Warfighter operational utility is most effectively served. This approach enhances our pursuit and development of necessary capabilities across Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF) domains to address threats and vulnerabilities while sustaining land force operations. In addition to conducting and evaluating experiments, war games, studies, and analysis, our Battle Lab develops and validates concepts leading to space related DOTMLPF alternatives and solutions.

Preparing Today's Warfighter for the Challenges of Tomorrow

In 2011, the Secretary and Chief of Staff of the Army approved the Army's Strategic Space Plan. This document, shaped by national level guidance such as the National Space Policy and the National Security Space Strategy, outlines the Army's space enterprise path for strategic planning, programming, and resourcing.

The essence of our space strategy and the guiding vision of the Army space enterprise are to ensure Army forces conducting Unified Land Operations have access to resilient and relevant space-enabled capabilities. To achieve this, our space strategy rests on three tenets that link Army strategic planning and programming for space to the guidance in national and DoD space policy and strategy. The three essential tenets are:

- To enable the Army's enduring mission by providing requisite space-enabled capabilities to support current operations, as well as future transformation efforts;

- To leverage existing DoD, national, commercial, and international space-based capabilities; and
- To employ cross-domain solutions to create a resilient architecture to address threats and vulnerabilities, and assure access to critical capabilities needed to sustain land force operations.

The initial implementation tasks of this strategy are complete. This past November, the Army completed a Space Capabilities Based Assessment to identify critical space gaps and potential solutions. These solutions are currently being evaluated and prioritized to ensure the most critical and affordable solutions are pursued. The Army also implemented a Space Training Strategy last year. This strategy seeks to improve the Army's understanding and utilization of space capabilities, to improve operations in contested operational environments, and to create an integrated and seamless continuum of career-long space education and training.

The Day-After-Tomorrow—Continued Space Technology Materiel Development

Our final core task entails our materiel development function—pursuing essential capabilities for the day-after-tomorrow. Our goal is to expand technological capabilities to ensure space and space-based products provide Warfighters, especially those who are remotely located, with dominant battlefield advantages. While we are very much aware that today's, and likely tomorrow's, fiscal realities will limit technology modernization efforts, we strongly believe that we must continue to conduct research, development, and demonstrations of capabilities that return maximum advances in our combat effectiveness. We cannot afford to mortgage future combat readiness by continuing to defer research today. As such, we continue to prioritize, leverage, and invest in promising space research and development technologies.

> ***Space-Based Products—Providing Greater Capabilities to Future Warfighters***

In conjunction with both DoD and non-DoD agencies, we continue to advance three responsive space Joint Capability Technology Demonstration (JCTD) Program efforts that have the potential to provide enhanced space capabilities to ground commanders and Warfighters. A summarized update of these three initiatives follows.

SMDC Nanosatellite Program-3 (SNaP-3): Future constellations of relatively low cost nanosatellites deployed in mission-specific, low earth orbits can provide a cost effective, beyond-line-of-sight data communications capability. This capability is targeted for users who, without it, have no dedicated access to satellite communications. These satellites are also very useful in exfiltrating data from unattended ground sensors that have been placed in remote locations to track enemy troop movement, thereby reducing the friendly force footprint. SNaP-3, an OSD-approved JCTD, seeks to utilize small satellites to provide dedicated coverage to a wide range of under-served users in remote areas. The Army is building and will launch three SNaP-3 nanosatellites to address this communications shortfall. We are hopeful that, in the near future, this initiative will transition to a program of record.

Kestrel Eye Visible Imagery Nanosatellite*:* Kestrel Eye is an endeavor to manufacture and fly three electro-optical near-nanosatellite-class imagery satellites that can be more responsive in support to ground Warfighters. Weighing about 30 pounds and capable of producing 1.5 meter resolution imagery, data from each Kestrel Eye satellite will be down-linked directly to the same tasking Warfighter via a data relay system, also accessible by other theater Warfighters, without any continental United States relay pass-through or data filtering. The intent of this program is to demonstrate a small, tactical space-based imagery nanosatellite that could be employed in large numbers to provide a cost effective, persistent capability for ground forces. Each satellite would have an operational life of greater than two years in low earth orbit. The initial Kestrel Eye launch is scheduled for 2015.

Soldier-Warfighter Operationally Responsive Deployer for Space (SWORDS)*:* SWORDS, an OSD-approved JCTD, is an initiative to develop a very low-cost launch vehicle that can respond to a combatant commander's launch request within 24 hours. This launch system is designed to take advantage of low-cost, proven technologies and materials to provide an affordable launch for small weight payloads to low earth orbit with a goal of about one million dollars per launch vehicle. SWORDS employs a very simple design, using commercial off-the-shelf hardware from outside the aerospace industry. It incorporates a benign bi-propellant liquid propulsion system, and uses simple and low cost launch support and launch site hardware. NASA is providing reimbursable support for development of the SWORDS launch vehicle.

Conclusion

The Army is the largest user of space and space-based capabilities. USASMDC/ARSTRAT is actively engaged in organizing, manning, equipping, and training space forces for the Army. We also work with other organizations to continue to develop and enhance technology to provide our Warfighters with the best battlefield capabilities. We will continue to rely on and advocate for space products and services provided by the DoD, other government agencies, our allies and coalition partners, and commercial entities in order to see, shoot, move, and communicate. In adapting to the budget realities, space capabilities will become even more critical to enabling adaptive Army and Joint Forces.

Space—The Ultimate High Ground

While continued technological advances are critical, the most critical space asset we possess are the dedicated Soldiers, Sailors, Airmen, Marines, and Civilians who develop, field, and operate space technology and deliver its capabilities to the Warfighter. The men and women of USASMDC/ARSTRAT will continue to focus on providing trained and ready space forces and capability enhancements to these Warfighters, the Army, the Joint community, and to the Nation.

I appreciate having the opportunity to speak on these important matters and look forward to addressing any questions you may have. Secure the High Ground!

United States Government Accountability Office

Testimony

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SPACE ACQUISITIONS

Acquisition Management Continues to Improve but Challenges Persist for Current and Future Programs

Statement of Cristina T. Chaplain, Director,
Acquisition and Sourcing Management

GAO Highlights

Highlights of GAO-14-382T, a testimony before the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate

March 12, 2014

SPACE ACQUISITIONS

Acquisition Management Continues to Improve but Challenges Persist for Current and Future Programs

Why GAO Did This Study

Each year, DOD spends billions of dollars to acquire space-based capabilities that support military and other government operations. The majority of DOD's space programs were beset by significant cost and schedule growth problems during their development. Most programs are now in production, however, and acquisition problems are not as widespread and significant as they were several years ago. In prior years, GAO has identified a number of actions DOD is taking to improve management and oversight of space program acquisitions. Facing constrained budgets and concerns about the resiliency of its satellites, DOD is considering potential changes to how it acquires space systems.

This testimony focuses on (1) the current status and cost of major DOD space systems acquisitions, (2) recent actions taken to further improve space systems acquisitions, and (3) potential impacts of the direction DOD is taking on upcoming changes to the acquisition of DOD space systems. This testimony is based on previously issued GAO products, ongoing GAO work on disaggregated architectures, interviews with DOD officials, and an analysis of DOD funding estimates from fiscal years 2013 through 2018.

What GAO Recommends

GAO is not making recommendations in this testimony. However, in previous reports, GAO has generally recommended that DOD adopt best practices for developing space systems. DOD has agreed and is in the process of implementing such practices.

View GAO-14-382T. For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

Most of the Department of Defense's (DOD) major satellite acquisition programs are in later stages of acquisition, with the initial satellites having been designed, produced, and launched into orbit while additional satellites of the same design are being produced. A few other major space programs, however, have recently experienced setbacks. For example: the Missile Defense Agency's Precision Tracking Space System, which was intended to be a satellite system to track ballistic missiles, has been cancelled due to technical, programmatic and affordability concerns; the Air Force's Space Fence program, which is developing a ground-based radar to track Earth-orbiting objects, continues to experience delays in entering development; and the first launch of the new Global Positioning System satellites has been delayed by 21 months.

Congress and DOD continue to take steps they believe will improve oversight and management of space systems acquisitions. In the past year, for example, DOD has updated its major acquisition policy with the goal of improving efficiency and productivity in defense spending. Among other things, the policy change adds a requirement for independent development testing for DOD acquisition programs, which officials believe will provide an independent voice on programs' development. However, DOD still faces significant oversight and management challenges, including (1) leadership of a space community that is comprised of a wide variety of users and stakeholders with diverse interests and (2) alignment of the delivery of satellites with corresponding ground systems and user terminals. For instance, in some cases, gaps in delivery can add up to years, meaning that a satellite is launched but not effectively used for years until ground systems become available. One reason DOD has been unable to align the delivery of space system components is because budgeting authority for the components is spread across the military services.

While most DOD major space system acquisitions have overcome development challenges and are currently being produced and launched, past problems involving large, complicated systems, coupled with the recent fiscal climate of reduced funds, has led DOD to consider efforts that could signal significant changes to the way it acquires and conducts space activities. DOD is considering moving away from its current approach in satellite development—building small numbers of large satellites over a decade or more that meet the needs of many missions and users—toward a more disaggregated architecture involving less complex, smaller, and more numerous satellites. GAO has found that DOD does not yet have sufficient information to make decisions on whether to disaggregate, but it is in the process of gathering that information. In addition, in response to predictions of dramatic increases to the price of launching its satellites, coupled with restrained budgets, DOD has made changes to the way it procures launch vehicles, and is moving forward with plans to allow competition for launch services—a significant shift from past ways of doing business. According to the Air Force, other recent steps in launch acquisitions, including gaining significant insight into launch services cost drivers, have enabled it to achieve significant savings.

Chairman Udall, Ranking Member Sessions, and Members of the Subcommittee:

I am pleased to be here today to discuss the Department of Defense's (DOD) space systems acquisitions. DOD spends billions of dollars each year to develop, produce and launch space systems. These systems provide the government with critical intelligence information, communication methods, and navigation information, which are vital to many military and other government programs. Because these systems can be highly complex, they require large investments of both money and time to develop, produce and launch. Given the expensive nature of space systems in today's constrained government budget environment, it is essential that DOD manage the acquisition of these systems carefully and continue to address problems that have plagued space systems acquisitions in the past decade.

In the past, DOD has seen program after program experience significant cost increases coupled with schedule delays. However, in recent years these problems have largely been overcome for the programs currently in production, and additional satellites of the same design are now being launched. With the worst of their acquisition problems behind them, DOD is beginning to look at potential new directions for the national security space community, including options for meeting program requirements through the disaggregation[1] of large space missions into multiple smaller satellites as a means to increase satellite resiliency and reduce acquisition costs and development time.[2] In addition, DOD has been introducing significant changes to the way it acquires space launch

[1] The Air Force defines space disaggregation as "[t]he dispersion of space-based missions, functions or sensors across multiple systems spanning one or more orbital plane, platform, host or domain." Programs may consider disaggregation in the future because it allows for options within a system's architecture to drive down cost, increase resiliency and distribute capability. Air Force Space Command, *Resiliency and Disaggregated Space Architectures,* White Paper (Aug. 21, 2013).

[2] DOD Space Policy defines resilience as the ability of an architecture to support the functions necessary for mission success with higher probability, shorter periods of reduced capability, and across a wider range of scenarios, conditions, and threats, in spite of hostile action or adverse conditions. The policy further states that resilience may leverage cross-domain or alternative government, commercial, or international capabilities. See Department of Defense Directive 3100.10, *Space Policy* (Oct. 18, 2012). However, Office of the Secretary of Defense and Air Force officials we spoke with stated DOD is in the process of refining the definition of resilience and determining a methodology for measuring it.

services, by transitioning to a new acquisition approach with a longer-term commitment, and by taking steps to introduce competition to its Evolved Expendable Launch Vehicle program, a major change from the last eight years of that program. These potential changes may provide benefits to DOD, but there are challenges to their implementation.

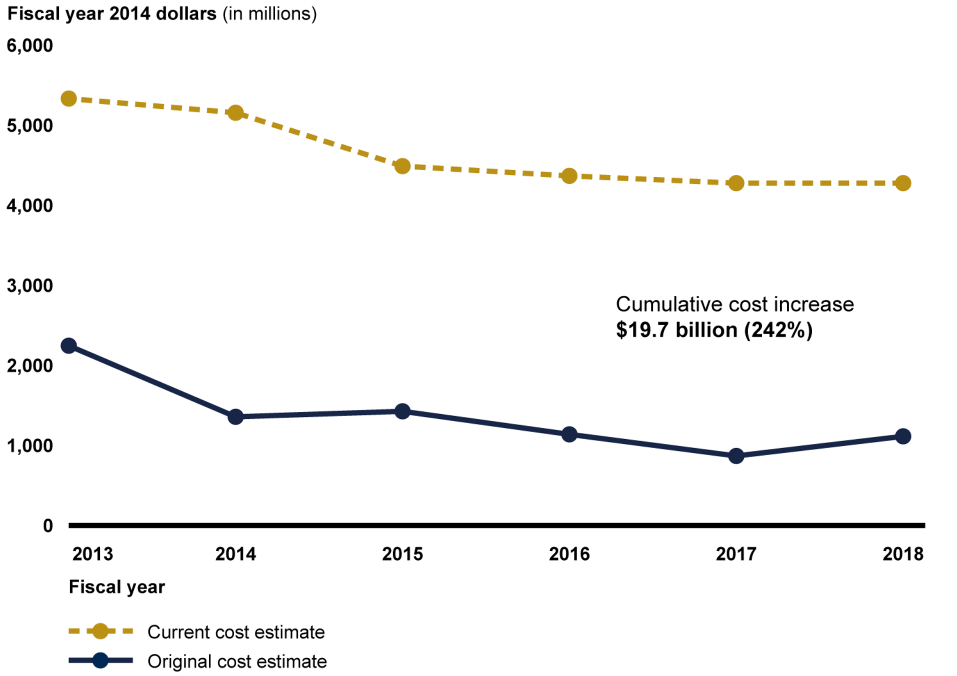
My testimony today will focus on (1) the current status and cost of major DOD space systems acquisitions, (2) recent actions taken to further improve space systems acquisitions, and (3) potential impacts of the direction DOD is taking on upcoming changes to the acquisition of DOD space systems. This testimony is based on GAO reports issued over the past 5 years on space programs and weapon system acquisition best practices, and on DOD reports. In addition, it is based on ongoing work conducted to address a mandate in the Senate Report accompanying the National Defense Authorization Act for Fiscal Year 2014 for GAO to review the potential benefits and limitations of disaggregating future space systems.[3] It is also based on work performed in support of our annual weapon system assessments, as well as space-related work in support of our reports on duplication, overlap, and fragmentation across the federal government. Finally, this statement is based on updates on cost increases and investment trends and improvement actions taken since last year. To conduct these updates, we analyzed DOD funding estimates for selected major space systems acquisition programs from fiscal years 2013 through 2018. More information on our scope and methodology is available in our related GAO products. The work that supports this statement was performed 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. DOD provided technical comments which were incorporated as appropriate.

[3] S. Rep. No. 113-44, at 165 (2013). The Senate Report mandated GAO to assess the potential benefits and drawbacks of disaggregating key military space systems and examine whether disaggregation and payload hosting (an arrangement where DOD instruments are placed on commercial or other agency satellites) offers benefits to cost and survivability of a constellation (a group of similar satellites synchronized to orbit the Earth in an optimal way).

Background

Over the last decade, DOD has been managing many challenging space systems acquisitions. A long-standing problem for the department is that program costs have tended to increase significantly from original cost estimates. In recent years, DOD has overcome many of the problems that had been hampering program development, and has begun to launch many of these satellites. However, the large cost growth of these systems continues to affect the department. Figure 1 compares the original cost estimates with current cost estimates for some of the department's major space acquisition programs.

Figure 1: Comparison of Original Cost Estimates and Current Cost Estimates for Selected Major Space Acquisition Programs for Fiscal Years 2013 through 2018.



Source: GAO analysis of DOD Selected Acquisition Report cost data.

Note: Includes Advanced Extremely High Frequency (AEHF), Evolved Expendable Launch Vehicle (EELV), Global Broadcast System (GBS), Global Positioning System (GPS) II and III, Mobile User Objective System (MUOS), GPS Operational Control System (GPS OCX), Space Based Infrared System (SBIRS), and Wideband Global SATCOM (WGS). This chart does not include planned new space acquisition efforts—such as Joint Space Operations Center Mission System (JMS), Space Based Space Surveillance Follow-on (SBSS), the Defense Weather Satellite Follow-on (WSF), or Space Fence—for which total cost data were unavailable.

The gap between the estimates in figure 1 represents money that the department was not planning to spend on these programs, and did not have available to invest in other efforts. The gap in estimates is fairly stable between fiscal years 2014-2018, a result of the fact that most programs are mature and in a steady production phase. This figure does not include programs that are still in the early stages of planning and development.

In past reports, we have identified a number of causes of acquisition problems. For example, in past years, DOD has tended to start more weapon programs than is affordable, creating a competition for funding that focuses on advocacy at the expense of realism and sound management. DOD has also tended to start its space programs before it has the assurance that the capabilities it is pursuing can be achieved within available resources and time constraints. There is no way to accurately estimate how long it would take to design, develop, and build a satellite system when key technologies planned for that system are still in relatively early stages of discovery and invention. Finally, programs have historically attempted to satisfy all requirements in a single step, regardless of the design challenges or the maturity of the technologies necessary to achieve the full capability. DOD's preference to make larger, complex satellites that perform a multitude of missions has stretched technology challenges beyond current capabilities in some cases.

Our work has recommended numerous actions that can be taken to address the problems we identified. Generally, we have recommended that DOD separate technology discovery from acquisition, follow an incremental path toward meeting user needs, match resources and requirements at program start, and use quantifiable data and demonstrable knowledge to make decisions to move to next phases. We have also identified practices related to cost estimating, program manager tenure, quality assurance, technology transition, and an array of other aspects of acquisition program management that could benefit space programs. DOD has generally concurred with our recommendations, and has undertaken a number of actions to establish a better foundation for acquisition success. For example, we reported in the past that, among other actions, DOD created a new office within the Undersecretary of Defense for Acquisition, Technology and Logistics to focus attention on oversight for space programs and it eliminated offices considered to perform duplicative oversight functions. We have also reported in the past that the Air Force took actions to strengthen cost estimating and to reinstitute stricter standards for quality.[4]

The Current Status and Cost of Space Systems Acquisitions

Most of DOD's major satellite programs are in mature phases of acquisition, and some of the significant problems of past years, such as cost and schedule growth, are not currently as prevalent. Table 1 describes the status of the space programs we have been tracking in detail.

Table 1: Status and Cost of Selected Space Systems Acquisitions

Advanced Extremely High Frequency (AEHF) (satellite communications)	Original total program cost: $6.7 billion Current total program cost: $14.6 billion Original quantity: 5 Current quantity: 6 Schedule: First launch occurred in August 2010, 6 years later than initially planned, and the second launch occurred May 2012. The third launch occurred in September 2013. The fourth satellite, currently in production, is scheduled to be launched in 2017. AEHF satellites will replenish the existing Milstar system with higher-capacity, survivable, jam-resistant, worldwide, secure communication capabilities for strategic and tactical warfighters.
Global Positioning System (GPS) III (positioning, navigation, and timing)	Original total program cost: $4.1 billion Current total program cost: $4.4 billion Quantity: 8 Schedule: The program recently experienced a 21-month delay due to a satellite anomaly, and the first satellite is now expected to be ready for launch in January 2016. GPS III is to replenish a constellation of multiple generations of GPS satellites that provide global position, navigation and timing capability to both military and civil users worldwide.

[4] GAO, *Space Acquisitions: DOD Is Overcoming Long-Standing Problems, but Faces Challenges to Ensuring Its Investments Are Optimized.* GAO-13-508T. (Washington, D.C.: April 24, 2013) and *Space Acquisitions: DOD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements.* GAO-12-563T. (Washington, D.C.: March 21, 2012).

Mobile User Objective System (MUOS) (satellite communications)	Original total program cost: $7.1 billion Current total program cost: $7.4 billion Quantity: 6 Schedule: MUOS has launched two satellites. The third scheduled launch has been delayed 6 months to January 2015, as described in more detail below. MUOS is expected to provide a worldwide, multiservice population of mobile and fixed-site terminal users with increased narrowband communications capacity and improved availability for small terminal users.
Space Based Infrared System (SBIRS) (missile warning, infrared intelligence, surveillance, and reconnaissance)	Original total program cost: $4.8 billion Current total program cost: $18.9 billion Original quantity: 5 Current quantity: 6 Schedule: The first SBIRS satellite launched in May 2011—roughly 9 years later than estimated at program start. The second satellite launched in March 2013. The third satellite is expected for delivery in late 2015. The program plans to fully meet operational requirements in 2019 once it has established the full on-orbit constellation of highly elliptical orbit sensors, four geostationary orbit satellites, completion of its first two software blocks, and delivery of its mobile ground assets. The production contract for the fifth and sixth satellites is expected to be awarded in early 2014. SBIRS is being developed to replace the Defense Support Program and perform a range of missile warning, missile defense, technical intelligence, and battle space awareness missions. SBIRS is to consist of four GEO satellites, two sensors on host satellites in highly elliptical orbit, two replenishment satellites and sensors, and fixed and mobile ground stations.
Next Generation Operation Control System (GPS OCX) (command and control system for GPS III satellites)	Original total program cost: $3.5 billion Current total program cost: $3.5 billion Original quantity: 1 Current quantity: 1 Schedule: The first GPS OCX deliverable is scheduled to be complete in November 2014. The second deliverable, which is to provide command and control for GPS III satellites, is scheduled to be complete in October 2016, 9 months after the first GPS III satellite is available for launch. GPS OCX is to replace the current ground control system for current and new GPS III satellites.

Wideband Global SATCOM (WGS) (satellite communications)	Original program cost: $1.3 billion Current total program cost: $4.2 billion Original quantity: 3 Current quantity: 10 (two funded by international partners) Schedule: The first satellite was launched in October 2007, over 3 years later than estimated at program start. Currently, six satellites are on orbit. The seventh and eight satellites are in full production and scheduled for launch in 2016 and 2017. WGS provides essential communications services to U.S. warfighters, allies, and coalition partners during all levels of conflict short of nuclear war.

Source: GAO analysis of DOD information.

Note: Dollar figures are reported in fiscal year 2014 dollars.

While many programs have overcome past problems, some of the major space programs have encountered significant challenges in the last year and some delays in development and production. For example:

- The Air Force's Space Fence program office is developing a large ground-based radar that is expected to improve on the performance of and replace the Air Force Space Surveillance System, which became operational in 1961 and was recently shut down. The Space Fence radar will emit radio frequencies upward to space, from ground-based radar sites, to detect and track more and smaller Earth-orbiting objects than is currently possible, and provide valuable space situational awareness data to military and civilian users. The Air Force had originally planned to award a contract for Space Fence systems development in July 2012, but due to internal program reviews and budget re-prioritizations, this date has been delayed to May 2014. In addition, the number of radar sites planned has been reduced from two to one, though DOD plans to have an option under the system development contract to build a second site if needed.
- In April 2013, DOD proposed canceling the Missile Defense Agency's Precision Tracking Space System (PTSS) because of concerns with the program's high-risk acquisition strategy and long-term affordability. PTSS was intended to be a satellite system equipped with infrared sensors that would track ballistic missiles through their emitted heat. The planned satellite system would consist of a constellation of nine satellites in orbit around the earth's equator. We reported in July 2013 that the decision to propose canceling the PTSS program was based on an evaluation of the acquisition, technical, and

operational risks of the PTSS program. Specifically, DOD's evaluation assessed the PTSS cost, schedule, technical design, and acquisition strategy to identify whether risks could challenge the program's ability to acquire, field, and sustain the system within planned cost and schedule constraints. The evaluation also determined that the PTSS program had significant technical, programmatic, and affordability risks. The program officially ceased operations in October 2013.

- The Air Force has nearly completed its analysis of alternatives to determine the direction for space based environmental monitoring, which will be a follow-on program for the Defense Meteorological Satellite Program (DMSP). Through this analysis, the Air Force analyzed various options that included, but were not limited to, a traditional procurement of a weather satellite similar to the existing DMSP satellites, or a disaggregated approach using small satellites and hosted payload opportunities. According to the Air Force, the study was completed in the fall of 2013 and is awaiting final approval.
- The MUOS program plans to launch a third satellite in January 2015, which represents a delay of 6 months due to a production issue on the third satellite. Specifically, the third satellite failed system- and subsequent unit-level testing after rework last year and the program determined the root cause to be a manufacturing deficiency on a component critical for the operation of the satellite's ultra-high-frequency legacy communications payload. The program is replacing the component. According to the MUOS program office, the program is on track to meet the launch schedule of subsequent satellites, which is important because most of the communications satellites that MUOS is replacing are past their design lives. Synchronizing deliveries of MUOS satellites with compatible Army Handheld, Manpack, Small Form Fit (HMS) terminals remains a challenge. Currently over 90 percent of the first satellite's on-orbit capabilities are being underutilized because of terminal program delays. Consequently, military forces are relying on legacy communication terminals and are not able to take advantage of the superior capabilities offered by the MUOS satellites. Operational testing and initial fielding of MUOS-capable HMS terminals is planned for fiscal year 2014, with a production decision expected in September 2015.

Recent Actions DOD Believes Will Improve Space System Acquisition Processes, and Continuing Barriers to Program Oversight and Management

We have reported in the past that DOD and Congress are taking steps to reform and improve the defense acquisition system, and in the past year additional actions have been taken towards these goals.[5]

DOD Continues to Take Actions it Believes Will Improve Acquisition Oversight

In November 2013, DOD published an update to its instruction 5000.02, which provides acquisition guidance for DOD programs.[6] With this update, DOD hoped to create an acquisition policy environment that will achieve greater efficiency and productivity in defense spending. Air Force officials noted that, for satellite programs, there are two major changes that they believe will improve the acquisition process. First, the instruction was changed to formally allow satellite programs to combine two major program milestones, B and C, which mark the beginning of the development and production phases, respectively.[7] According to the Air Force, satellite programs have typically seen a great deal of overlap in the development and production phases, mainly because they are buying small quantities of items. They are often not able to produce a prototype to be fully tested because of the high costs of each article, so the first satellite in a production is often used both for testing and operations. Air Force officials believe that this change to the acquisition guidance will allow for streamlining of satellite development and production processes, and provide more efficient oversight without sacrificing program requirements. GAO has not assessed the potential effects of this change. In the past, we have reported that committing a program to production

[5] GAO-13-508T. GAO-12-563T.

[6] Interim Department of Defense Instruction 5000.02, Operation of the Defense Acquisition System para. 5.d.(10)(b) (Nov. 25, 2013).

[7] In defense acquisitions, milestone B provides authorization for a program to enter into the system development phase, and commits the required investment resources to the program. Milestone C is the point at which a program enters the production and deployment phase.

without a substantive development phase may increase program cost and schedule risks, and we plan to look at the impacts of this change as it begins to be implemented.

A second change made this year, according to Air Force officials, is the requirement that DOD programs, including space programs, undergo independent development testing. While development testing for DOD programs is not new to this policy revision, now the testing organization will be an independent organization outside the program office. For space programs, this organization will be under the Program Executive Officer for Space, and will report their findings directly to that office, providing what the Air Force believes will be an independent voice on a program's development status. The Air Force is confident that these changes will provide benefits to program oversight, although because these are recent changes, we have not yet assessed their potential for process improvements.

In addition, DOD is adopting new practices to reduce fragmentation of its satellite ground control systems, which adds oversight to a major development decision. Last year we reported that DOD's satellite ground control systems were potentially fragmented, and that standalone systems were being developed for new satellite programs without a formal analysis of whether or not the satellite control needs could be met with existing systems.[8] In the National Defense Authorization Act for Fiscal Year 2014, Congress placed more oversight onto this process by requiring a cost-benefit analysis for all new or follow-on satellite systems using a dedicated ground control system instead of a shared ground control system.[9] This new requirement should improve oversight into these systems' development, and may reduce some unnecessary duplication of satellite control systems. According to Air Force officials, the first program to go through this process was the Enhanced Polar System, and all future satellite programs will include this cost-benefit analysis in their ground system planning. In addition, the Act directed

[8] GAO, *Satellite Control: Long-Term Planning and Adoption of Commercial Practices Could Improve DOD's Operations,* GAO-13-315 (Washington, D.C.: April 18, 2013).

[9] Pub. L. No. 113-66, § 822(a) (2013) (codified as amended at10 U.S.C. § 2366b(a)).

DOD to develop a DOD-wide long-term plan for satellite ground control systems.[10]

Additionally, the Defense Space Council continues with its architecture reviews in key space mission areas. According to Air Force officials, the Council is the principal DOD forum for discussing space issues, and brings together senior-level leaders to discuss these issues. These architecture reviews are to inform DOD's programming, budgeting, and prioritization for the space mission area. The Council has five reviews underway or completed in areas such as overhead persistent infrared, satellite communications, space situational awareness, and national security space launches. They are also initiating a study of how DOD can assess the resilience of its space systems. DOD also recently held a forum on resiliency that included participation from senior leaders from several groups within DOD and the Intelligence Community to create a work plan towards resolution of critical gaps in resiliency.

Many of the reforms that are being initiated may not be fully proven for some years, because they apply mainly to programs in early acquisition stages, and most DOD space systems are currently either in the production phase or late in the development phase. We have not assessed the impact of actions taken this year, but we have observed that the totality of improvements made in recent years has contributed to better foundations for program execution.

DOD Continues to Face Barriers to Program Oversight and Management

While DOD has taken steps to address acquisition problems of the past, significant issues above the program level will still present challenges to even the best run programs. One key oversight issue is fragmented leadership of the space community. We have reported in the past that fragmented leadership and lack of a single authority in overseeing the acquisition of space programs have created challenges for optimally acquiring, developing, and deploying new space systems.[11] Past studies and reviews have found that responsibilities for acquiring space systems

[10] Pub. L. No. 113-66, § 822(b) (2013).

[11] GAO, *2012 Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue*, GAO-12-342SP (Washington, D.C.: Feb. 28, 2012); and *Space Acquisitions: DOD Poised to Enhance Space Capabilities but, Persistent Challenges Remain in Developing Space Systems*, GAO-10-447T (Washington, D.C.: Mar. 10, 2010).

are diffused across various DOD organizations, even though many of the larger programs, such as the Global Positioning System and those to acquire imagery and environmental satellites, are integral to the execution of multiple agencies' missions. This fragmentation is problematic because the lack of coordination has led to delays in fielding systems, and also because no one person or organization is held accountable for balancing governmentwide needs against wants, resolving conflicts and ensuring coordination among the many organizations involved with space systems acquisitions, and ensuring that resources are directed where they are most needed. Though changes to organizations and the creation of the Defense Space Council have helped to improve oversight, our work continues to find that DOD would benefit from increased coordination and a single authority overseeing these programs.

A program management challenge that GAO has identified, which stems from a lack of oversight, is that DOD has not optimally aligned the development of its satellites with associated components, including ground control system and user terminal acquisitions. Satellites require ground control systems to receive and process information from the satellites, and user terminals to deliver that satellite's information to users. All three elements are important for utilizing space-based data, but development of satellites often outpaces the ground control systems and the user terminals. Delays in these ground control systems and user terminals lead to underutilized on-orbit satellite resources, and thus delays in getting the new capabilities to the warfighters or other end-users. In addition, there are limits to satellites' operational life spans once launched. When satellites are launched before their associated ground and user segments are ready, they use up time in their operational lives without their capabilities being utilized. Synchronization of space system components will be an important issue for DOD in considering disaggregating space architectures, as the potential for larger numbers and novel configurations of satellites and ground systems will likely require the components to be synchronized to allow them to work together in the most effective way possible. As mentioned earlier, DOD is taking steps in response to improvements mandated by the Congress. But it will likely be difficult to better synchronize delivery of satellite components without more focused leadership at a level above the acquisitions' program offices. For example, budget authority for user terminals, ground systems, and satellites is spread throughout the military services, and no one is in charge of synchronizing all of the system components, making it difficult to optimally line up programs' deliveries.

DOD Is Considering and Adopting Significant Changes to Space Systems Acquisitions

Fiscal pressures, past development problems, and concerns about the resiliency of satellites have spurred DOD to consider significant changes in the way it acquires and launches national security satellites.

Potential Changes to Acquiring New DOD Space Systems

Significant fiscal constraints, coupled with growing threats to DOD space systems—including adversary attacks such as anti-satellite weapons and communications jamming, and environmental hazards such as orbital debris—have called into question whether the complex and expensive satellites DOD is fielding and operating are affordable and will meet future needs. For example, a single launch failure, on-orbit anomaly, or adversary attack on a large multi-mission satellite could result in the loss of billions of dollars of investment and a significant loss of capability. Additionally, some satellites, which have taken more than a decade to develop, contain technologies that are already considered obsolete by the time they are launched.[12]

To address these challenges, DOD is considering alternative approaches to provide space-based capabilities, particularly for missile warning, protected satellite communications, and environmental monitoring. According to DOD, the primary considerations for studying these approaches and making decisions on the best way forward relate to finding the right balance of affordability, resiliency, and capability. These decisions, to be made over the next 2 to 3 years, have the potential for making sweeping changes to DOD's space architectures of the future. For example, DOD could decide to build more disaggregated architectures, including dispersing sensors onto separate platforms; 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.

Our past work has indicated that some of the approaches being considered have the potential to reduce acquisition cost and time on a

[12]GAO, *Briefing on Commercial and Department of Defense Space System Requirements and Acquisition Practices,* GAO-10-135R (Washington, D.C.: Jan. 14, 2010).

single program. For instance, we have found that DOD's initial preference to make fewer large and complex satellites that perform a multitude of missions has stretched technology challenges beyond existing capabilities, and in some cases vastly increased the complexities of related software.[13] In addition, developing extensive new designs and custom-made spacecraft and payloads to meet the needs of multiple users limits DOD's ability to provide capabilities sooner and contributes to higher costs.[14] Last year, we reported that one potential new approach, hosted payload arrangements in which government instruments are placed on commercial satellites, may provide opportunities for government agencies to save money, especially in terms of launch and operation costs, and gain access to space.[15]

As new approaches, such as disaggregation, are considered, the existing management environment could pose barriers to success, including fragmented leadership for space programs, the culture of the DOD space community, fragmentation in satellite control stations, and disconnects between the delivery of satellites and their corresponding user terminals. For instance, disaggregation may well require substantial changes to acquisition processes and requirements setting. But without a central authority to implement these changes, there is likely to be resistance to adopting new ways of doing business, particularly since responsibilities for space acquisitions stretch across the military services and other government agencies. Moreover, under a disaggregated approach, DOD may need to effectively network and integrate a larger collection of satellites—some of which may even belong to commercial providers. We have reported that ground systems generally only receive and process data from the satellites for which they were developed. They generally do not control and operate more than one type of satellite or share their data with other ground systems. To date, however, DOD has had difficulty adopting modern practices and technologies for controlling satellites as well as difficulty in coordinating the delivery of satellites with the user terminals that must be installed on thousands of ships, planes, and

[13] GAO, *Space Acquisitions: DOD Needs to Take More Action to Address Unrealistic Initial Cost Estimates of Space Systems*, GAO-07-96 (Washington, D.C.: Nov. 17, 2006).

[14] GAO-10-135R.

[15] GAO, *2013 Annual Report: Actions Needed to Reduce Fragmentation, Overlap, and Duplication and Achieve Other Financial Benefits,* GAO-13-279SP (Washington, D.C.: April 9, 2013).

ground-based assets. These are conditions that are difficult to change without strong leadership to break down organizational stove-pipes and to introduce technologies or techniques that could enable DOD to better integrate and fuse data from a wider, potentially more disparate, collection of satellites.

In light of suggestions that disaggregation could potentially reduce cost and increase survivability, the Senate Committee on Armed Services mandated that we assess the potential benefits and limitations of disaggregating key military space systems, including potential impacts on total costs.[16] To date, we have found that the potential effects of disaggregation are conceptual and not yet quantified. DOD has taken initial steps to assess alternative approaches, but it does not yet have the knowledge it needs to quantify benefits and limitations and determine a course of action. DOD officials we spoke with acknowledge the department has not yet established sufficient knowledge on which to base a decision. While DOD has conducted some studies that assessed alternative approaches to the current programs of record, some within the department do not consider these studies to be conclusive because they were either not conducted with sufficient analytical rigor or did not consider the capabilities, risks, and trades in a holistic manner. For example, according to the Office of the Secretary of Defense's Office of Cost Assessment and Program Evaluation, a recent Air Force study that assessed future satellite communications architectures contained insufficient data to support the conclusion that one architectural approach was more resilient than others, and the cost estimates it contained did not consider important factors, such as ground control and terminal costs, in calculating the implications of changing architectures.

To build consensus in the department, and to conduct a more rigorous analysis of options, DOD is currently in the process of conducting additional studies that will consider future architectures. Included in these studies are Analyses of Alternatives for future missile warning, protected satellite communications, and space based environmental monitoring

[16] S. Rep. No. 113-44, at 165 (2013).

capabilities.[17] Among the range of alternatives these analyses are considering are approaches that keep the current system, evolve the current system, and disaggregate the current system into more numerous, but smaller and less complex, satellites. DOD has nearly finished the space-based environmental monitoring study and expects to finish the other two in either this fiscal year or next.

Moreover, as DOD continues to build knowledge about different acquisition approaches, it will be essential to develop an understanding of key factors for decisions on future approaches that could impact the costs, schedules, and performance of providing mission capabilities. Some considerations for moving to a new or evolved architecture may include the following:

- Common definitions of key terms, such as resiliency and disaggregation, across all stakeholders, and a common measurement of these terms in order to compare architectural alternatives.
- The true costs of moving to a new architecture, including transition costs for funding overlapping operations and compatibility between new and legacy systems and non-recurring engineering costs for new-start programs, among others.
- Potential technical and logistical challenges. For example, with hosted payloads, our past work has found that ensuring compatibility between sensors and host satellites may be difficult because of variable interfaces on different companies' satellites.[18] In addition, scheduling and funding hosted payload arrangements may be difficult because the timeline for developing sensors may be much longer than that of commercial satellites.

[17] An Analysis of Alternatives (AOA) is a review in the DOD acquisition process that compares the operational effectiveness, suitability, and lifecycle cost of solutions to satisfy documented capability needs. Factors considered in the AOA include effectiveness, cost, schedule, concepts of operations, and overall risk of each alternative. A GAO report in 2009 found in many cases the AOAs did not effectively consider a broad range of alternatives and that DOD sponsors sometimes identify a preferred solution before an AOA is conducted. GAO, *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System* Options, GAO-09-665 (Washington, D.C.: Sept. 24, 2009). These AOAs are to investigate follow-on programs for SBIRS, AEHF and the Defense Meteorological Satellite Program. In addition to missile warning, SBIRS supports missile defense, battlespace awareness, and technical intelligence missions.

[18] GAO-13-279SP.

- Impacts to supporting capabilities, such as ground control and operations and launch availability, and long-standing challenges we have identified regarding how these have been managed.[19]
- Readiness of the acquisition workforce and industrial base to support a new architecture.

Given that DOD is in the early stages of assessing alternatives, our ongoing work is continuing to identify potential benefits and limitations of disaggregation and examine the extent to which these issues are being factored into DOD's ongoing studies. We look forward to reporting on the results of this analysis this summer.

Recent and Upcoming Changes to the Evolved Expendable Launch Vehicle Program

DOD has made some changes to the way it buys launch services from its sole-source provider, and plans to allow other companies to compete with that provider for launch services in the near future. DOD's Evolved Expendable Launch Vehicle (EELV) program is the primary provider of launch vehicles for U.S. military and intelligence satellites. Since 2006, the United Launch Alliance (ULA) has been the sole-source launch provider for this program, with a record of 50 successful consecutive government missions. From 2006 through 2013, DOD had two types of contracts with ULA through which ULA provided launch services for national security space launches.[20] DOD utilized this dual-contract structure to achieve flexibility in launch schedules and to avoid additional costs associated with frequent launch delays.

In the last few years, though the dual contract structure met DOD's needs for unprecedented mission success and flexible launch capability, predicted costs continued to rise for launch services. In response to these cost predictions, DOD revised its acquisition strategy to allow for a "block buy" of launch vehicles, where DOD would commit to multiple years of launch purchases from ULA, with the goal of stabilizing production and

[19] GAO-13-315. GAO, *Evolved Expendable Launch Vehicle: DOD Needs to Ensure New Acquisition Strategy Is Based on Sufficient Information*. GAO-11-641. (Washington, D.C.: September 15, 2011) and *Space Acquisitions: Uncertainties in the Evolved Expendable Launch Vehicle Program Pose Management and Oversight Challenges*. GAO-08-1039. (Washington, D.C.: September 26, 2008).

[20] Under this two-contract structure, DOD bought launch capability on one series of contracts, and launch hardware on another series of contracts. Launch capability included things like overhead on launch pads, engineering support, and labor to conduct launches.

decreasing prices. In addition, and partially in response to GAO recommendations, DOD gathered large amounts of information on ULA's cost drivers to allow DOD to negotiate significantly lower prices under the contracting structure.[21] In December 2013, DOD signed a contract modification with ULA to purchase 35 launch vehicle booster cores over a 5-year period, 2013-2017, and the associated capability to launch them. According to the Air Force, this contracting strategy saved $4.4 billion over the predicted program cost in the fiscal year 2012 budget. We recently reported on some of the changes included in this new contract from the prior contracts.[22]

In addition to this change in the way DOD buys launch vehicles, DOD is also in the process of introducing a method for other launch services companies to compete with ULA for EELV launches. Since 2006, when ULA began as a joint venture between then-competitors Boeing and Lockheed Martin, the EELV program has been managed as a sole source procurement, because there were no other domestic launch companies that could meet the program's requirements. With the recent development of new domestic launch vehicles that can meet at least some EELV mission requirements, DOD plans to make available for competition up to 14 launches in fiscal years 2015-2017. Any launch company that has been certified by DOD to launch national security space payloads will be able to compete with ULA to launch these missions. DOD is currently finalizing their plan for this competition, including what requirements will be placed on the contractors and how they will compare proposals from the contractors.

Based on our discussions with DOD officials, they plan to use a best value approach for this competition, in which price is not the only consideration. DOD will likely consider several factors when comparing proposals for launch services for the 14 booster core competition between ULA and new entrants, including price, mission risk, and satellite vehicle integration risks. DOD could require competitive proposals to be structured in several ways. If DOD requires proposals to contain both fixed-price and cost reimbursement features for launch services and capability, respectively, similar to the way it currently contracts with ULA,

[21] GAO-11-641.

[22] GAO, *The Air Force's Evolved Expendable Launch Vehicle Competitive Procurement*, GAO-14-377R (Washington, D.C.: March 4, 2014).

there could be benefits to DOD and ULA, but potential burdens to new entrants. For example, DOD is familiar with this approach and has experience negotiating under these terms, and ULA is familiar with DOD's requirements given ULA's role as the EELV's sole launch provider. But use of a cost type contract may negate efficient contractor business practices and cost savings due to government data requirements under this type of approach, and it may give ULA a price advantage because DOD already funds launch capability for ULA. Alternatively, if DOD implements a fixed-price commercial approach to launch proposals with fewer data reporting requirements, DOD could lose insight into contractor cost or pricing, but may receive lower prices from new entrants due to these fewer data reporting requirements. DOD could also require a combination of elements from each of these approaches, or develop new contract requirements for this competition. We examined some of the benefits and challenges of the first two approaches, either of which can facilitate competitive launch contract awards, in a recent report.[23] DOD expects to issue a draft request for proposal for the first of the competitive missions, where the method for evaluating and comparing proposals will be explained, in the spring of 2014.

The planned competition for launch services may have helped DOD negotiate the lower prices it achieved in its December 2013 contract modification, and DOD could see further savings if a robust domestic launch market materializes. DOD noted in its 2014 President's Budget submission for EELV that after the current contract with ULA has ended, it plans to have a full and open competition for national security space launches. Cost savings on launches, as long as they do not come with a reduction in mission successes, would greatly benefit DOD, and allow the department to put funding previously needed for launches into programs in the development phases to ensure they are adequately resourced.

In conclusion, DOD has made significant progress in solving past space systems acquisition problems, and is seeing systems begin to launch after years of development struggles. However, systemic problems remain that need to be addressed as DOD considers changes to the way it acquires new systems. This is particularly important if DOD decides to pursue new approaches that could require changes in longstanding processes, practices, and organizational structures. Even if DOD decides

[23] GAO-14-377R.

not to pursue new approaches, these problems must still be tackled. In addition, challenging budget situations will continue to require tradeoffs and prioritization decisions across programs, though limited funds may also provide the impetus for rethinking architectures. We look forward to working with Congress and DOD in identifying the most effective and efficient ways to sustain and develop space capabilities in this challenging environment.

Chairman Udall, Ranking Member Sessions, this completes my prepared statement. I would be happy to respond to any questions you and Members of the Subcommittee may have at this time.

Contacts and Acknowledgements

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DEPARTMENT OF THE AIR FORCE

PRESENTATION TO THE
SUBCOMMITTEE ON STRATEGIC FORCES
SENATE ARMED SERVICES COMMITTEE
UNITED STATES SENATE

SUBJECT: Fiscal Year 2015 National Defense Authorization Budget Request for National Security Space Activities

STATEMENT OF: General William L. Shelton
Commander, Air Force Space Command

March 12, 2014

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Introduction

Chairman Udall, Senator Sessions and distinguished Members of the Subcommittee, it is an honor to appear before you once again as the Commander of Air Force Space Command (AFSPC). As the Air Force space and cyberspace lead, I am responsible for organizing, training and equipping more than 40,000 military and civilian employees to provide Air Force space and cyberspace capabilities for the Combatant Commands and for the Nation. My team works hard to deliver these capabilities around the world, every hour, every day.

Space and cyberspace capabilities are foundational to the Joint Force Commander's ability to deter aggression and to execute global operations across the entire range of military operations, from humanitarian and disaster relief through major combat operations. Our military satellites and computer networks are technological marvels, providing mission-critical global access, persistence, and awareness. These systems not only provide essential, game-changing capabilities for our joint forces, they are increasingly vital assets for the global community and world economy.

Specifically in space, our sustained mission success integrating these capabilities into our military operations has encouraged potential adversaries to further develop counterspace technologies and attempt to exploit our systems and information. Therefore, I believe we are at a strategic crossroad in space. With the threats to our space systems increasing and defense budget uncertainty, the status quo is no longer a viable option. This "new normal" in space requires us to address protection of mission-critical systems, challenge traditional acquisition practices, and analyze new operational constructs.

The grand challenge before us is to assure essential space services will be available at the time and place of our choosing, while simultaneously lowering the cost of executing these missions. Finally, the budget situation of the last year certainly reminded us that our ability to provide these services now and into the future is fragile.

Mandate for Change: Future Space Capabilities at a Strategic Crossroad

The space environment has fundamentally changed since our fledgling efforts in the late-1950s and early 1960s. Our space systems were designed to operate in a relatively benign environment, and the detente between the United States and the Soviet Union kept the peace--even in space. There were few space-faring nations, and even fewer with indigenous launch capability. Today, there are more than 170 nations with some form of financial interest in a variety of satellites, and 11 nations that can independently launch satellites into space. The rapid expansion in space traffic over the past 50+ years occurred largely without conflict, but that era is coming to an end.

The joint force dependence on space assets yields a corresponding vulnerability we know others seek to exploit. Counterspace developments by potential adversaries are varied and include everything from jamming to kinetic kill anti-satellite weapons. Global Positioning System (GPS) jammers are widely available, complicating our employment of GPS navigation and timing signals in weapons and platforms. Satellite communications jammers are also available, which may challenge over-the-horizon communications when needed most. Also, some nations have developed and successfully demonstrated anti-satellite weapon capabilities which could threaten our satellites in times of conflict. Unfortunately, all projections indicate these threatening capabilities will become more robust and proliferated, and they will be operational on a shorter than predicted timeline.

In addition to adversarial counterspace programs, the growing debris problem is also a concern to spacecraft operators in all space sectors: military, civil and commercial. While we are routinely tracking some 23,000 objects at the Joint Space Operations Center (JSpOC), our sensors are unable to detect and reliably track objects smaller than 10 centimeters. And our models project more than 500,000 man-made objects greater in size than one centimeter in orbit today--many of these small objects represent a potentially catastrophic risk to fragile-by-design spacecraft.

We are also addressing the President's direction to support the National Broadband Plan by finding balance between assured access, spectrum sharing and reallocation/repurposing. Use of radio spectrum for ground-space communications must be protected from both a regulatory perspective and from targeted adversary action.

With the rapidly expanding adversary threats to our spacecraft, the growing debris population and decreasing budgets, we must adapt our satellite constellation architectures to become more resilient, while simultaneously making them more affordable. Just as combat aircraft necessarily evolved with the threat, we can no longer expect satellites built for a permissive environment to operate effectively in an increasingly contested space domain.

Due to the cost of launching satellites, our design philosophy has been to maximize the functionality on a given satellite, which translates to increased weight, size and corresponding cost. As a result, we build just enough satellites, just in time, to sustain our constellations. This philosophy worked well over the years, but in the new normal of space, we are vulnerable to the cheap shot or to premature failure. For example, loss of a single satellite in our missile warning or our protected communications constellations would potentially leave large gaps in a vital capability. We must consider different architecture options that will provide adequate and resilient capability at an affordable cost. Our die is cast through the mid-2020s with the outstanding satellites we are buying and successfully placing on orbit to support national security objectives and joint operations. Because of lengthy acquisition timelines, to affect these architectures in the post-2025 timeframe, we need to complete ongoing studies soon to determine the most efficient approach for the future.

Confronting Budget Challenges

Based on available funding, we made difficult decisions in the Command to survive Fiscal Year (FY) 13. The Budget Control Act of 2011 resulted in significant FY13 cuts to the Operations and Maintenance (O&M) budget at Air Force Space Command, which in turn compelled irreversible changes and significant risk to space operations going into FY14. The welcome relief and flexibility provided by the FY14 Appropriations Act is sustained in the FY15 President's Budget—our space operations budget requires this level of support to maintain our current operational posture and manage risk in changing operating conditions.

Impact of Sequestration

Despite our cost reduction efforts, last year's sequestration cuts required drastic actions at AFSPC. We cut $304.8 million from our O&M budget for FY14 alone to comply with the Budget Control Act. Achieving that magnitude of reductions required continued civilian workforce pay freezes, a 25 percent reduction of contractor services within my headquarters (on top of a 50 percent reduction the year before), inactivation of some operational capabilities, and most notably $100 million of additional risk in Weapon System Sustainment funding. This means that in FY15, vital sustainment activities are delayed or deferred, which could translate into system outages of increased duration or severity. Additionally, AFSPC uses a significant portion of our O&M budget to fund mission-essential contractor operators for our space and cyberspace missions--there is no flexibility here. Our search for savings over the last several years of declining budgets virtually eliminated any margin in O&M; therefore, the cuts began to erode these contracts which are essential to perform and sustain our mission.

While the Bipartisan Budget Act of 2013 alleviates a portion of the cuts we were facing in FY14 and FY15, we remain concerned that continued sequestration-induced budget cuts in FY16 and beyond, as well as overall funding instability, could undermine our space capability for years to come.

Challenging Legacy Space Architectures and Traditional Acquisition Practices

This past year, we continued success in our acquisition programs to provide greater mission assurance and cost savings. As we transition from development to production, we have captured success through lean processing, smart testing and appropriate oversight and reporting. The Space and Missile Systems Center (SMC) made tremendous strides implementing "should-cost" initiatives that resulted in real program savings of more than $1.4 billion across the Future Years Defense Program. The result of these actions can be seen in streamlined assembly, testing and delivery of a number of programs to include Advanced Extremely High Frequency (AEHF), Space-Based Infrared System (SBIRS), Wideband Global Satellite Communications (WGS) and GPS III.

Space Modernization Initiative (SMI)

In 2011, AFSPC adopted the Efficient Space Procurement (ESP) concept to reduce procurement risk and lower overall cost by transitioning from buying satellites one-at-a-time to buying satellites in blocks using fixed price contracts. This approach allowed us to take advantage of economic order quantities and the efficiencies inherent in a stable production line. We then used a portion of these savings to invest back into mission areas under SMI. The overall SMI strategy is to invest in program efforts that create increased trade space for future decisions. Study contracts under SMI are helping us better plan for a challenging future by exploring affordable technology alternatives and architectures in missile warning, communications, global positioning, navigation and timing mission areas.

SMI-funded studies position AFSPC to take advantage of opportunities such as greater commercial satellite availability, a competitive medium launch market and faster commercial production cycles. SMI also postures the Air Force to rapidly address emerging kinetic and non-kinetic threats. These investments are critical to our ability to define future options to increase resiliency in this dynamic operational space environment.

Resilient Architectures

As we work toward increased resiliency and affordability, we are examining a range of options, one of which is disaggregation. Disaggregation concepts call for the dispersion of space-based missions, functions or sensors across multiple systems or platforms. By separating payloads on different satellites we will complicate a potential adversary's targeting calculus, decrease size and system complexity, and enable use of smaller boosters--with the goal of simultaneously driving down cost.

In addition, we are evaluating constructs to host payloads on other platforms where feasible, and take better advantage of available commercial services. The trailblazing Commercial Hosted Infrared Payload program, a government infrared payload on a commercial satellite, was a technical success by any measure, and we learned significant lessons on the overall hosted payload concept.

Over the past several months, we've met with more than 65 space companies to seek their ideas on alternative architectures. From those meetings, we collected many concepts that will inform our Analyses of Alternatives (AoA) for the future of protected military satellite communications and overhead persistent infrared systems. In addition, the Missile Defense Agency (MDA) is supporting our AoA studies with threat definition, technical evaluations and cost analysis support. AFSPC and MDA are collaborating on future space sensor architecture studies and sensor performance assessments across a broad set of joint mission areas. Finally, Federally Funded Research and Development Centers, as well as others, will complete studies this year on disaggregation and its secondary impacts on the launch industry and space architectures.

Better Buying Power

As previously mentioned, our use of the ESP approach and the Department of Defense's (DoD) Better Buying Power concepts resulted in significant positive results. SMC, under the sterling leadership of Lieutenant General Ellen Pawlikowski, awarded a block buy contract for the AEHF space vehicles 5 and 6, obtaining $1.625 billion in savings from the original independent cost estimate. Also, we anticipate the award of a contract for two more SBIRS satellites later this year, taking advantage of lessons learned on AEHF 5 and 6. Despite parts obsolescence challenges that required initial nonrecurring engineering and advance procurement efforts, we will realize significant savings using a firm, fixed-price contract.

Space Capabilities for the Joint Warfighter

Space Situational Awareness (SSA)

SSA underpins everything we do in space. Gaining and maintaining awareness in space requires data from global sensors and the integration and exploitation of that data to support operational command and control (C2). The JSpOC Mission System (JMS) is integral to improving SSA and C2. JMS Increment 1 was approved for full deployment and operationally accepted last year. This increment delivered the net-centric framework and the initial capability advances toward better operator understanding and monitoring of the space environment. JMS Increment 2 will build on that foundation by fielding groundbreaking capabilities to include greatly improved capability to detect and characterize orbital hazards and adversary threats. Increment 2 will also enable the JSpOC to transition from the legacy Space Defense Operations Center system to expanded computational capacity and improved automation, thereby improving our ability to handle space events and allowing us to retire increasingly difficult to sustain hardware. Furthermore, it will allow integration of data from our network of space surveillance sensors, previously unavailable intelligence community data, and data from other commercial, allied and governmental sensors. The JMS program clearly represents game-changing capability for the Nation's space situational awareness.

Enhancements to the Space Surveillance Network are necessary to close sensing gaps and take full advantage of the JMS high performance computing environment. And international cooperative efforts are part of that effort. As an example, in November, 2013, Secretary Hagel and Australian Defense Minister Johnston signed a Memorandum of Understanding finalizing arrangements to move the Defense Advanced Research Projects Agency's Space Surveillance Telescope from its original site in New Mexico to a site in Western Australia. The high capacity and extremely accurate capabilities of this telescope will significantly enhance SSA in deep space. The telescope will be relocated and operational in 2016 to monitor geosynchronous orbits over the Pacific region. Similarly, we have reached an agreement to place a C-Band Radar in Australia to help with southern hemisphere SSA coverage.

Another big step forward is the new S-Band Radar, commonly known as the Space Fence. We will build this critical SSA sensor on Kwajalein Atoll, and remotely operate from Huntsville, AL. This radar will track much smaller objects and cover almost all orbital inclinations with a capacity to track many thousands of objects daily. Budget uncertainty contributed to a one year delay, but the contract should be awarded this Spring, with an initial operational capability date in FY19.

Our ground-based radars provide outstanding deep space tracking and space object identification capabilities, but they are not well-suited to search operations. Our ground-based optical systems are outstanding deep space search and tracking assets, but they can only perform their mission at night, and they must have clear skies to conduct imaging operations.

Based on the success of a sensor flown on a missile defense experimental satellite, in 2010 we developed and launched the Space-Based Space Surveillance (SBSS) satellite, with a 7-year design life, into low-earth orbit to augment both search and tracking of man-made objects. The follow-on program is being developed; however, it will not be launched until 2021 based on available funding. The result is a potential 4-year gap in this crucial space-based coverage, which will limit our ability to maintain timely custody of threats to our satellites in geosynchronous orbits. We have extended our network to include allied contributions to mitigate the potential loss of data. For example, the Canadian Sapphire satellite, launched in 2013, is a contributing sensor to our space surveillance efforts, but unfortunately, this satellite has a 5-year design life and is expected to be decommissioned about the same time as SBSS. We are working hard to extend the life of SBSS and other potential contributors to mitigate this potential coverage gap.

A future contributor to extend and enhance coverage is the Geosynchronous Space Situational Awareness Program (GSSAP). This system will collect SSA data allowing for more accurate tracking and characterization of man-made orbiting objects in a near-geosynchronous orbit. Data from GSSAP will contribute to timely and accurate orbital predictions, enhance our knowledge of the geosynchronous environment and further enable space flight safety to include satellite collision avoidance. GSSAP is expected to launch in 2014.

Assured Access to Space

It is essential that we sustain a reliable capability to launch national security satellites into space. To that end, we continued our unprecedented string of successful launches in 2013. Alongside our industry partner, United Launch Alliance, we executed an all-time high of 11 launches of the Evolved Expendable Launch Vehicle (EELV).

The commercial space launch industry made substantial progress last year with successful launches by Orbital Sciences and SpaceX. Our launch acquisition strategy aims to take advantage of the competition made possible by these new entrants once they are fully certified under the approved new entrant certification protocol. We have been very successful placing new satellites in orbit by placing a premium on mission assurance. As we move forward in an era of competition for launch services, we must remain focused on mission assurance to ensure national security payloads are safely and reliably delivered to space.

Our launch and range infrastructure has served the space enterprise well over the years, but the infrastructure overall is old and it requires considerable sustainment and modernization efforts. And due to the previously mentioned O&M budget shortfalls, we took action to right-size our infrastructure on both coasts and at our down-range sites. Our National Security Space Essential Range will not compromise public safety or mission assurance, but we will continue to balance sustainability and modernization to overcome obsolescence, as well as implementing better contract mechanisms to control costs.

Military Satellite Communications

2013 was a successful year for AFSPC military satellite communications as well. The Air Force launched the third AEHF satellite in September 2013, delivering increased capacity for survivable, secure, protected and jam-resistant satellite communication for strategic and tactical warfighters as well as our most senior national leadership and international partners. The Air Force also successfully launched the fifth and sixth WGS satellites within 76 days of each other. These satellites significantly increase high-capacity satellite communication to joint forces around the world.

The WGS program exemplifies the opportunities to leverage commercial satellite technologies to reduce the cost of providing space systems. However, we need to go further. At SMC, our program managers collaborated with industry to explore other possibilities. Through the use of broad area announcement solicitations, SMC awarded contracts to 17 vendors to examine concepts for secure satellite communications at a lower cost.

Position, Navigation and Timing (PNT)

By the end of 2013, we completed production of all 12 GPS IIF satellites. The fourth GPS IIF satellite was launched in 2013, and we plan to launch three satellites in 2014, three more satellites in 2015 and the final two GPS IIF satellites in 2016.

As has been widely reported, the navigation payload delivery for GPS III is delayed beyond the contracted date. Although we don't believe this will result in any impact to our ability to provide gold standard PNT services to the world, we are concerned about the impact to the overall GPS III program. We are working remedies with the prime contractor for this delay.

We also expect the Next-Generation GPS Control Segment Block 1 to transition to operations in 2016. In November, we tested the system's ability to command GPS Blocks II and III satellites using space system simulators, including control of the major PNT signals. This demonstration is a major step forward to prepare for the GPS III era of more secure and robust GPS signals to the warfighter.

Space-Based Infrared System

The SBIRS GEO-2 satellite was launched, delivered for operational trial period and operationally accepted in 2013. To date, the data provided by both SBIRS GEO-1 and GEO-2 satellites is outstanding, providing enhanced missile warning and battlespace awareness over critical portions of the world. SBIRS GEO-3 is planned to launch in 2016.

Terrestrial Environmental Monitoring

Defense Meteorological Satellite Program (DMSP) satellite number 19 will launch in April 2014 and we expect the satellite will remain operational well into the 2020s. We are concerned about potential gaps in meteorological coverage when current DoD, civilian, partner and allied meteorological satellites reach their end-of-life in the 2015-2025 timeframe. The Space-Based Environmental Monitoring AoA was conducted to study follow-on options, such as international partnerships, hosted payloads or a new satellite, for continued meteorological support to warfighters in the most cost-effective manner. The results from the AoA are currently being reviewed by the Joint Requirements Oversight Council.

Conclusion

The men and women of AFSPC remain committed to providing unsurpassed support to our warfighters and allies. Every day they bring innovation, excellence, and uncompromising focus to the Nation's space missions that are conducted 24/7 across the globe.

Our Nation's advantage in space is no longer a given. The ever-evolving space environment is increasingly contested as current and potential adversary capabilities grow in number and sophistication. Providing budget stability and flexibility in this very dynamic strategic environment is necessary to maintain and bolster the viability of all space capabilities.

I remain committed to a course of action that acknowledges and responds to uncertainty in this new normal. The status quo is not a viable alternative in response to the new normal. We are reaching out to our talented Airmen, industry partners, allies and Congress to make the changes necessary to provide required capability that is affordable and resilient.

I thank you for your support and look forward to working with Congress and this committee to keep you abreast of our efforts to provide resilient, capable and affordable space capabilities for the joint force and the Nation.

United States Government Accountability Office

Testimony

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SPACE ACQUISITIONS

Acquisition Management Continues to Improve but Challenges Persist for Current and Future Programs

Statement of Cristina T. Chaplain, Director, Acquisition and Sourcing Management

GAO Highlights

Highlights of GAO-14-382T, a testimony before the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate

March 12, 2014

SPACE ACQUISITIONS

Acquisition Management Continues to Improve but Challenges Persist for Current and Future Programs

Why GAO Did This Study

Each year, DOD spends billions of dollars to acquire space-based capabilities that support military and other government operations. The majority of DOD's space programs were beset by significant cost and schedule growth problems during their development. Most programs are now in production, however, and acquisition problems are not as widespread and significant as they were several years ago. In prior years, GAO has identified a number of actions DOD is taking to improve management and oversight of space program acquisitions. Facing constrained budgets and concerns about the resiliency of its satellites, DOD is considering potential changes to how it acquires space systems.

This testimony focuses on (1) the current status and cost of major DOD space systems acquisitions, (2) recent actions taken to further improve space systems acquisitions, and (3) potential impacts of the direction DOD is taking on upcoming changes to the acquisition of DOD space systems. This testimony is based on previously issued GAO products, ongoing GAO work on disaggregated architectures, interviews with DOD officials, and an analysis of DOD funding estimates from fiscal years 2013 through 2018.

What GAO Recommends

GAO is not making recommendations in this testimony. However, in previous reports, GAO has generally recommended that DOD adopt best practices for developing space systems. DOD has agreed and is in the process of implementing such practices.

View GAO-14-382T. For more information, contact Cristina Chaplain at (202) 512-4841 or chaplainc@gao.gov.

What GAO Found

Most of the Department of Defense's (DOD) major satellite acquisition programs are in later stages of acquisition, with the initial satellites having been designed, produced, and launched into orbit while additional satellites of the same design are being produced. A few other major space programs, however, have recently experienced setbacks. For example: the Missile Defense Agency's Precision Tracking Space System, which was intended to be a satellite system to track ballistic missiles, has been cancelled due to technical, programmatic and affordability concerns; the Air Force's Space Fence program, which is developing a ground-based radar to track Earth-orbiting objects, continues to experience delays in entering development; and the first launch of the new Global Positioning System satellites has been delayed by 21 months.

Congress and DOD continue to take steps they believe will improve oversight and management of space systems acquisitions. In the past year, for example, DOD has updated its major acquisition policy with the goal of improving efficiency and productivity in defense spending. Among other things, the policy change adds a requirement for independent development testing for DOD acquisition programs, which officials believe will provide an independent voice on programs' development. However, DOD still faces significant oversight and management challenges, including (1) leadership of a space community that is comprised of a wide variety of users and stakeholders with diverse interests and (2) alignment of the delivery of satellites with corresponding ground systems and user terminals. For instance, in some cases, gaps in delivery can add up to years, meaning that a satellite is launched but not effectively used for years until ground systems become available. One reason DOD has been unable to align the delivery of space system components is because budgeting authority for the components is spread across the military services.

While most DOD major space system acquisitions have overcome development challenges and are currently being produced and launched, past problems involving large, complicated systems, coupled with the recent fiscal climate of reduced funds, has led DOD to consider efforts that could signal significant changes to the way it acquires and conducts space activities. DOD is considering moving away from its current approach in satellite development—building small numbers of large satellites over a decade or more that meet the needs of many missions and users—toward a more disaggregated architecture involving less complex, smaller, and more numerous satellites. GAO has found that DOD does not yet have sufficient information to make decisions on whether to disaggregate, but it is in the process of gathering that information. In addition, in response to predictions of dramatic increases to the price of launching its satellites, coupled with restrained budgets, DOD has made changes to the way it procures launch vehicles, and is moving forward with plans to allow competition for launch services—a significant shift from past ways of doing business. According to the Air Force, other recent steps in launch acquisitions, including gaining significant insight into launch services cost drivers, have enabled it to achieve significant savings.

Chairman Udall, Ranking Member Sessions, and Members of the Subcommittee:

I am pleased to be here today to discuss the Department of Defense's (DOD) space systems acquisitions. DOD spends billions of dollars each year to develop, produce and launch space systems. These systems provide the government with critical intelligence information, communication methods, and navigation information, which are vital to many military and other government programs. Because these systems can be highly complex, they require large investments of both money and time to develop, produce and launch. Given the expensive nature of space systems in today's constrained government budget environment, it is essential that DOD manage the acquisition of these systems carefully and continue to address problems that have plagued space systems acquisitions in the past decade.

In the past, DOD has seen program after program experience significant cost increases coupled with schedule delays. However, in recent years these problems have largely been overcome for the programs currently in production, and additional satellites of the same design are now being launched. With the worst of their acquisition problems behind them, DOD is beginning to look at potential new directions for the national security space community, including options for meeting program requirements through the disaggregation[1] of large space missions into multiple smaller satellites as a means to increase satellite resiliency and reduce acquisition costs and development time.[2] In addition, DOD has been introducing significant changes to the way it acquires space launch

[1] The Air Force defines space disaggregation as "[t]he dispersion of space-based missions, functions or sensors across multiple systems spanning one or more orbital plane, platform, host or domain." Programs may consider disaggregation in the future because it allows for options within a system's architecture to drive down cost, increase resiliency and distribute capability. Air Force Space Command, *Resiliency and Disaggregated Space Architectures,* White Paper (Aug. 21, 2013).

[2] DOD Space Policy defines resilience as the ability of an architecture to support the functions necessary for mission success with higher probability, shorter periods of reduced capability, and across a wider range of scenarios, conditions, and threats, in spite of hostile action or adverse conditions. The policy further states that resilience may leverage cross-domain or alternative government, commercial, or international capabilities. See Department of Defense Directive 3100.10, *Space Policy* (Oct. 18, 2012). However, Office of the Secretary of Defense and Air Force officials we spoke with stated DOD is in the process of refining the definition of resilience and determining a methodology for measuring it.

services, by transitioning to a new acquisition approach with a longer-term commitment, and by taking steps to introduce competition to its Evolved Expendable Launch Vehicle program, a major change from the last eight years of that program. These potential changes may provide benefits to DOD, but there are challenges to their implementation.

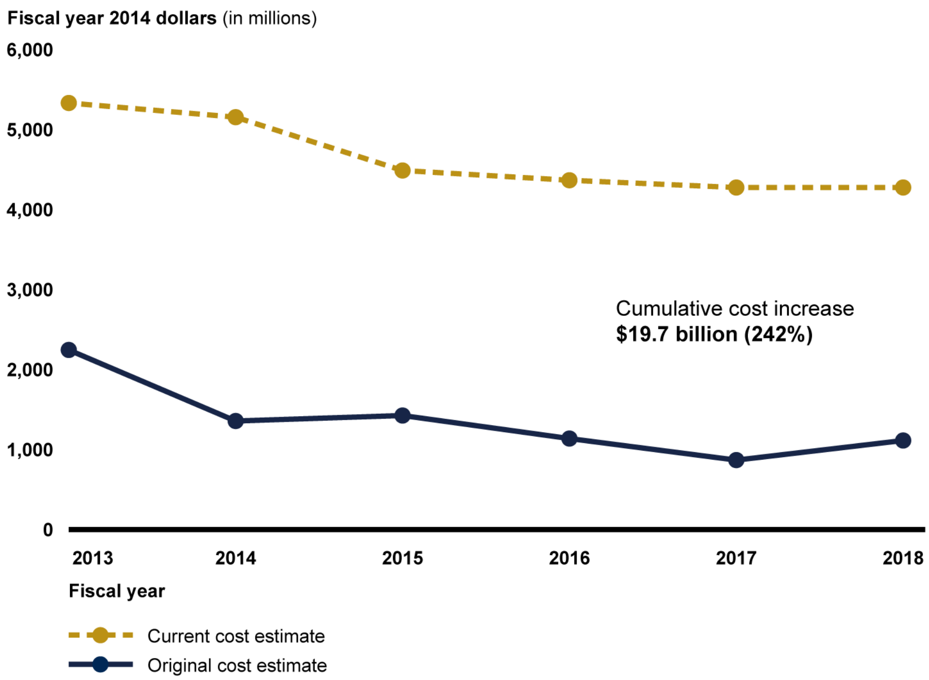
My testimony today will focus on (1) the current status and cost of major DOD space systems acquisitions, (2) recent actions taken to further improve space systems acquisitions, and (3) potential impacts of the direction DOD is taking on upcoming changes to the acquisition of DOD space systems. This testimony is based on GAO reports issued over the past 5 years on space programs and weapon system acquisition best practices, and on DOD reports. In addition, it is based on ongoing work conducted to address a mandate in the Senate Report accompanying the National Defense Authorization Act for Fiscal Year 2014 for GAO to review the potential benefits and limitations of disaggregating future space systems.[3] It is also based on work performed in support of our annual weapon system assessments, as well as space-related work in support of our reports on duplication, overlap, and fragmentation across the federal government. Finally, this statement is based on updates on cost increases and investment trends and improvement actions taken since last year. To conduct these updates, we analyzed DOD funding estimates for selected major space systems acquisition programs from fiscal years 2013 through 2018. More information on our scope and methodology is available in our related GAO products. The work that supports this statement was performed 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. DOD provided technical comments which were incorporated as appropriate.

[3] S. Rep. No. 113-44, at 165 (2013). The Senate Report mandated GAO to assess the potential benefits and drawbacks of disaggregating key military space systems and examine whether disaggregation and payload hosting (an arrangement where DOD instruments are placed on commercial or other agency satellites) offers benefits to cost and survivability of a constellation (a group of similar satellites synchronized to orbit the Earth in an optimal way).

Background

Over the last decade, DOD has been managing many challenging space systems acquisitions. A long-standing problem for the department is that program costs have tended to increase significantly from original cost estimates. In recent years, DOD has overcome many of the problems that had been hampering program development, and has begun to launch many of these satellites. However, the large cost growth of these systems continues to affect the department. Figure 1 compares the original cost estimates with current cost estimates for some of the department's major space acquisition programs.

Figure 1: Comparison of Original Cost Estimates and Current Cost Estimates for Selected Major Space Acquisition Programs for Fiscal Years 2013 through 2018.



Source: GAO analysis of DOD Selected Acquisition Report cost data.

Note: Includes Advanced Extremely High Frequency (AEHF), Evolved Expendable Launch Vehicle (EELV), Global Broadcast System (GBS), Global Positioning System (GPS) II and III, Mobile User Objective System (MUOS), GPS Operational Control System (GPS OCX), Space Based Infrared System (SBIRS), and Wideband Global SATCOM (WGS). This chart does not include planned new space acquisition efforts—such as Joint Space Operations Center Mission System (JMS), Space Based Space Surveillance Follow-on (SBSS), the Defense Weather Satellite Follow-on (WSF), or Space Fence—for which total cost data were unavailable.

The gap between the estimates in figure 1 represents money that the department was not planning to spend on these programs, and did not have available to invest in other efforts. The gap in estimates is fairly stable between fiscal years 2014-2018, a result of the fact that most programs are mature and in a steady production phase. This figure does not include programs that are still in the early stages of planning and development.

In past reports, we have identified a number of causes of acquisition problems. For example, in past years, DOD has tended to start more weapon programs than is affordable, creating a competition for funding that focuses on advocacy at the expense of realism and sound management. DOD has also tended to start its space programs before it has the assurance that the capabilities it is pursuing can be achieved within available resources and time constraints. There is no way to accurately estimate how long it would take to design, develop, and build a satellite system when key technologies planned for that system are still in relatively early stages of discovery and invention. Finally, programs have historically attempted to satisfy all requirements in a single step, regardless of the design challenges or the maturity of the technologies necessary to achieve the full capability. DOD's preference to make larger, complex satellites that perform a multitude of missions has stretched technology challenges beyond current capabilities in some cases.

Our work has recommended numerous actions that can be taken to address the problems we identified. Generally, we have recommended that DOD separate technology discovery from acquisition, follow an incremental path toward meeting user needs, match resources and requirements at program start, and use quantifiable data and demonstrable knowledge to make decisions to move to next phases. We have also identified practices related to cost estimating, program manager tenure, quality assurance, technology transition, and an array of other aspects of acquisition program management that could benefit space programs. DOD has generally concurred with our recommendations, and has undertaken a number of actions to establish a better foundation for acquisition success. For example, we reported in the past that, among other actions, DOD created a new office within the Undersecretary of Defense for Acquisition, Technology and Logistics to focus attention on oversight for space programs and it eliminated offices considered to perform duplicative oversight functions. We have also reported in the past that the Air Force took actions to strengthen cost estimating and to reinstitute stricter standards for quality. [4]

The Current Status and Cost of Space Systems Acquisitions

Most of DOD's major satellite programs are in mature phases of acquisition, and some of the significant problems of past years, such as cost and schedule growth, are not currently as prevalent. Table 1 describes the status of the space programs we have been tracking in detail.

Table 1: Status and Cost of Selected Space Systems Acquisitions

Advanced Extremely High Frequency (AEHF) (satellite communications)	Original total program cost: $6.7 billion Current total program cost: $14.6 billion Original quantity: 5 Current quantity: 6 Schedule: First launch occurred in August 2010, 6 years later than initially planned, and the second launch occurred May 2012. The third launch occurred in September 2013. The fourth satellite, currently in production, is scheduled to be launched in 2017. AEHF satellites will replenish the existing Milstar system with higher-capacity, survivable, jam-resistant, worldwide, secure communication capabilities for strategic and tactical warfighters.
Global Positioning System (GPS) III (positioning, navigation, and timing)	Original total program cost: $4.1 billion Current total program cost: $4.4 billion Quantity: 8 Schedule: The program recently experienced a 21-month delay due to a satellite anomaly, and the first satellite is now expected to be ready for launch in January 2016. GPS III is to replenish a constellation of multiple generations of GPS satellites that provide global position, navigation and timing capability to both military and civil users worldwide.

[4] GAO, *Space Acquisitions: DOD Is Overcoming Long-Standing Problems, but Faces Challenges to Ensuring Its Investments Are Optimized.* GAO-13-508T. (Washington, D.C.: April 24, 2013) and *Space Acquisitions: DOD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements.* GAO-12-563T. (Washington, D.C.: March 21, 2012).

Mobile User Objective System (MUOS) (satellite communications)	Original total program cost: $7.1 billion Current total program cost: $7.4 billion Quantity: 6 Schedule: MUOS has launched two satellites. The third scheduled launch has been delayed 6 months to January 2015, as described in more detail below. MUOS is expected to provide a worldwide, multiservice population of mobile and fixed-site terminal users with increased narrowband communications capacity and improved availability for small terminal users.
Space Based Infrared System (SBIRS) (missile warning, infrared intelligence, surveillance, and reconnaissance)	Original total program cost: $4.8 billion Current total program cost: $18.9 billion Original quantity: 5 Current quantity: 6 Schedule: The first SBIRS satellite launched in May 2011—roughly 9 years later than estimated at program start. The second satellite launched in March 2013. The third satellite is expected for delivery in late 2015. The program plans to fully meet operational requirements in 2019 once it has established the full on-orbit constellation of highly elliptical orbit sensors, four geostationary orbit satellites, completion of its first two software blocks, and delivery of its mobile ground assets. The production contract for the fifth and sixth satellites is expected to be awarded in early 2014. SBIRS is being developed to replace the Defense Support Program and perform a range of missile warning, missile defense, technical intelligence, and battle space awareness missions. SBIRS is to consist of four GEO satellites, two sensors on host satellites in highly elliptical orbit, two replenishment satellites and sensors, and fixed and mobile ground stations.
Next Generation Operation Control System (GPS OCX) (command and control system for GPS III satellites)	Original total program cost: $3.5 billion Current total program cost: $3.5 billion Original quantity: 1 Current quantity: 1 Schedule: The first GPS OCX deliverable is scheduled to be complete in November 2014. The second deliverable, which is to provide command and control for GPS III satellites, is scheduled to be complete in October 2016, 9 months after the first GPS III satellite is available for launch. GPS OCX is to replace the current ground control system for current and new GPS III satellites.

Wideband Global SATCOM (WGS) (satellite communications)	Original program cost: $1.3 billion Current total program cost: $4.2 billion Original quantity: 3 Current quantity: 10 (two funded by international partners) Schedule: The first satellite was launched in October 2007, over 3 years later than estimated at program start. Currently, six satellites are on orbit. The seventh and eight satellites are in full production and scheduled for launch in 2016 and 2017. WGS provides essential communications services to U.S. warfighters, allies, and coalition partners during all levels of conflict short of nuclear war.

Source: GAO analysis of DOD information.

Note: Dollar figures are reported in fiscal year 2014 dollars.

While many programs have overcome past problems, some of the major space programs have encountered significant challenges in the last year and some delays in development and production. For example:

- The Air Force's Space Fence program office is developing a large ground-based radar that is expected to improve on the performance of and replace the Air Force Space Surveillance System, which became operational in 1961 and was recently shut down. The Space Fence radar will emit radio frequencies upward to space, from ground-based radar sites, to detect and track more and smaller Earth-orbiting objects than is currently possible, and provide valuable space situational awareness data to military and civilian users. The Air Force had originally planned to award a contract for Space Fence systems development in July 2012, but due to internal program reviews and budget re-prioritizations, this date has been delayed to May 2014. In addition, the number of radar sites planned has been reduced from two to one, though DOD plans to have an option under the system development contract to build a second site if needed.
- In April 2013, DOD proposed canceling the Missile Defense Agency's Precision Tracking Space System (PTSS) because of concerns with the program's high-risk acquisition strategy and long-term affordability. PTSS was intended to be a satellite system equipped with infrared sensors that would track ballistic missiles through their emitted heat. The planned satellite system would consist of a constellation of nine satellites in orbit around the earth's equator. We reported in July 2013 that the decision to propose canceling the PTSS program was based on an evaluation of the acquisition, technical, and

operational risks of the PTSS program. Specifically, DOD's evaluation assessed the PTSS cost, schedule, technical design, and acquisition strategy to identify whether risks could challenge the program's ability to acquire, field, and sustain the system within planned cost and schedule constraints. The evaluation also determined that the PTSS program had significant technical, programmatic, and affordability risks. The program officially ceased operations in October 2013.

- The Air Force has nearly completed its analysis of alternatives to determine the direction for space based environmental monitoring, which will be a follow-on program for the Defense Meteorological Satellite Program (DMSP). Through this analysis, the Air Force analyzed various options that included, but were not limited to, a traditional procurement of a weather satellite similar to the existing DMSP satellites, or a disaggregated approach using small satellites and hosted payload opportunities. According to the Air Force, the study was completed in the fall of 2013 and is awaiting final approval.
- The MUOS program plans to launch a third satellite in January 2015, which represents a delay of 6 months due to a production issue on the third satellite. Specifically, the third satellite failed system- and subsequent unit-level testing after rework last year and the program determined the root cause to be a manufacturing deficiency on a component critical for the operation of the satellite's ultra-high-frequency legacy communications payload. The program is replacing the component. According to the MUOS program office, the program is on track to meet the launch schedule of subsequent satellites, which is important because most of the communications satellites that MUOS is replacing are past their design lives. Synchronizing deliveries of MUOS satellites with compatible Army Handheld, Manpack, Small Form Fit (HMS) terminals remains a challenge. Currently over 90 percent of the first satellite's on-orbit capabilities are being underutilized because of terminal program delays. Consequently, military forces are relying on legacy communication terminals and are not able to take advantage of the superior capabilities offered by the MUOS satellites. Operational testing and initial fielding of MUOS-capable HMS terminals is planned for fiscal year 2014, with a production decision expected in September 2015.

Recent Actions DOD Believes Will Improve Space System Acquisition Processes, and Continuing Barriers to Program Oversight and Management

We have reported in the past that DOD and Congress are taking steps to reform and improve the defense acquisition system, and in the past year additional actions have been taken towards these goals.[5]

DOD Continues to Take Actions it Believes Will Improve Acquisition Oversight

In November 2013, DOD published an update to its instruction 5000.02, which provides acquisition guidance for DOD programs.[6] With this update, DOD hoped to create an acquisition policy environment that will achieve greater efficiency and productivity in defense spending. Air Force officials noted that, for satellite programs, there are two major changes that they believe will improve the acquisition process. First, the instruction was changed to formally allow satellite programs to combine two major program milestones, B and C, which mark the beginning of the development and production phases, respectively.[7] According to the Air Force, satellite programs have typically seen a great deal of overlap in the development and production phases, mainly because they are buying small quantities of items. They are often not able to produce a prototype to be fully tested because of the high costs of each article, so the first satellite in a production is often used both for testing and operations. Air Force officials believe that this change to the acquisition guidance will allow for streamlining of satellite development and production processes, and provide more efficient oversight without sacrificing program requirements. GAO has not assessed the potential effects of this change. In the past, we have reported that committing a program to production

[5] GAO-13-508T. GAO-12-563T.

[6] Interim Department of Defense Instruction 5000.02, Operation of the Defense Acquisition System para. 5.d.(10)(b) (Nov. 25, 2013).

[7] In defense acquisitions, milestone B provides authorization for a program to enter into the system development phase, and commits the required investment resources to the program. Milestone C is the point at which a program enters the production and deployment phase.

without a substantive development phase may increase program cost and schedule risks, and we plan to look at the impacts of this change as it begins to be implemented.

A second change made this year, according to Air Force officials, is the requirement that DOD programs, including space programs, undergo independent development testing. While development testing for DOD programs is not new to this policy revision, now the testing organization will be an independent organization outside the program office. For space programs, this organization will be under the Program Executive Officer for Space, and will report their findings directly to that office, providing what the Air Force believes will be an independent voice on a program's development status. The Air Force is confident that these changes will provide benefits to program oversight, although because these are recent changes, we have not yet assessed their potential for process improvements.

In addition, DOD is adopting new practices to reduce fragmentation of its satellite ground control systems, which adds oversight to a major development decision. Last year we reported that DOD's satellite ground control systems were potentially fragmented, and that standalone systems were being developed for new satellite programs without a formal analysis of whether or not the satellite control needs could be met with existing systems.[8] In the National Defense Authorization Act for Fiscal Year 2014, Congress placed more oversight onto this process by requiring a cost-benefit analysis for all new or follow-on satellite systems using a dedicated ground control system instead of a shared ground control system.[9] This new requirement should improve oversight into these systems' development, and may reduce some unnecessary duplication of satellite control systems. According to Air Force officials, the first program to go through this process was the Enhanced Polar System, and all future satellite programs will include this cost-benefit analysis in their ground system planning. In addition, the Act directed

[8] GAO, *Satellite Control: Long-Term Planning and Adoption of Commercial Practices Could Improve DOD's Operations,* GAO-13-315 (Washington, D.C.: April 18, 2013).

[9] Pub. L. No. 113-66, § 822(a) (2013) (codified as amended at10 U.S.C. § 2366b(a)).

DOD to develop a DOD-wide long-term plan for satellite ground control systems.[10]

Additionally, the Defense Space Council continues with its architecture reviews in key space mission areas. According to Air Force officials, the Council is the principal DOD forum for discussing space issues, and brings together senior-level leaders to discuss these issues. These architecture reviews are to inform DOD's programming, budgeting, and prioritization for the space mission area. The Council has five reviews underway or completed in areas such as overhead persistent infrared, satellite communications, space situational awareness, and national security space launches. They are also initiating a study of how DOD can assess the resilience of its space systems. DOD also recently held a forum on resiliency that included participation from senior leaders from several groups within DOD and the Intelligence Community to create a work plan towards resolution of critical gaps in resiliency.

Many of the reforms that are being initiated may not be fully proven for some years, because they apply mainly to programs in early acquisition stages, and most DOD space systems are currently either in the production phase or late in the development phase. We have not assessed the impact of actions taken this year, but we have observed that the totality of improvements made in recent years has contributed to better foundations for program execution.

DOD Continues to Face Barriers to Program Oversight and Management

While DOD has taken steps to address acquisition problems of the past, significant issues above the program level will still present challenges to even the best run programs. One key oversight issue is fragmented leadership of the space community. We have reported in the past that fragmented leadership and lack of a single authority in overseeing the acquisition of space programs have created challenges for optimally acquiring, developing, and deploying new space systems.[11] Past studies and reviews have found that responsibilities for acquiring space systems

[10] Pub. L. No. 113-66, § 822(b) (2013).

[11] GAO, *2012 Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue*, GAO-12-342SP (Washington, D.C.: Feb. 28, 2012); and *Space Acquisitions: DOD Poised to Enhance Space Capabilities but, Persistent Challenges Remain in Developing Space Systems*, GAO-10-447T (Washington, D.C.: Mar. 10, 2010).

are diffused across various DOD organizations, even though many of the larger programs, such as the Global Positioning System and those to acquire imagery and environmental satellites, are integral to the execution of multiple agencies' missions. This fragmentation is problematic because the lack of coordination has led to delays in fielding systems, and also because no one person or organization is held accountable for balancing governmentwide needs against wants, resolving conflicts and ensuring coordination among the many organizations involved with space systems acquisitions, and ensuring that resources are directed where they are most needed. Though changes to organizations and the creation of the Defense Space Council have helped to improve oversight, our work continues to find that DOD would benefit from increased coordination and a single authority overseeing these programs.

A program management challenge that GAO has identified, which stems from a lack of oversight, is that DOD has not optimally aligned the development of its satellites with associated components, including ground control system and user terminal acquisitions. Satellites require ground control systems to receive and process information from the satellites, and user terminals to deliver that satellite's information to users. All three elements are important for utilizing space-based data, but development of satellites often outpaces the ground control systems and the user terminals. Delays in these ground control systems and user terminals lead to underutilized on-orbit satellite resources, and thus delays in getting the new capabilities to the warfighters or other end-users. In addition, there are limits to satellites' operational life spans once launched. When satellites are launched before their associated ground and user segments are ready, they use up time in their operational lives without their capabilities being utilized. Synchronization of space system components will be an important issue for DOD in considering disaggregating space architectures, as the potential for larger numbers and novel configurations of satellites and ground systems will likely require the components to be synchronized to allow them to work together in the most effective way possible. As mentioned earlier, DOD is taking steps in response to improvements mandated by the Congress. But it will likely be difficult to better synchronize delivery of satellite components without more focused leadership at a level above the acquisitions' program offices. For example, budget authority for user terminals, ground systems, and satellites is spread throughout the military services, and no one is in charge of synchronizing all of the system components, making it difficult to optimally line up programs' deliveries.

DOD Is Considering and Adopting Significant Changes to Space Systems Acquisitions

Fiscal pressures, past development problems, and concerns about the resiliency of satellites have spurred DOD to consider significant changes in the way it acquires and launches national security satellites.

Potential Changes to Acquiring New DOD Space Systems

Significant fiscal constraints, coupled with growing threats to DOD space systems—including adversary attacks such as anti-satellite weapons and communications jamming, and environmental hazards such as orbital debris—have called into question whether the complex and expensive satellites DOD is fielding and operating are affordable and will meet future needs. For example, a single launch failure, on-orbit anomaly, or adversary attack on a large multi-mission satellite could result in the loss of billions of dollars of investment and a significant loss of capability. Additionally, some satellites, which have taken more than a decade to develop, contain technologies that are already considered obsolete by the time they are launched.[12]

To address these challenges, DOD is considering alternative approaches to provide space-based capabilities, particularly for missile warning, protected satellite communications, and environmental monitoring. According to DOD, the primary considerations for studying these approaches and making decisions on the best way forward relate to finding the right balance of affordability, resiliency, and capability. These decisions, to be made over the next 2 to 3 years, have the potential for making sweeping changes to DOD's space architectures of the future. For example, DOD could decide to build more disaggregated architectures, including dispersing sensors onto separate platforms; 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.

Our past work has indicated that some of the approaches being considered have the potential to reduce acquisition cost and time on a

[12] GAO, *Briefing on Commercial and Department of Defense Space System Requirements and Acquisition Practices,* GAO-10-135R (Washington, D.C.: Jan. 14, 2010).

single program. For instance, we have found that DOD's initial preference to make fewer large and complex satellites that perform a multitude of missions has stretched technology challenges beyond existing capabilities, and in some cases vastly increased the complexities of related software.[13] In addition, developing extensive new designs and custom-made spacecraft and payloads to meet the needs of multiple users limits DOD's ability to provide capabilities sooner and contributes to higher costs.[14] Last year, we reported that one potential new approach, hosted payload arrangements in which government instruments are placed on commercial satellites, may provide opportunities for government agencies to save money, especially in terms of launch and operation costs, and gain access to space.[15]

As new approaches, such as disaggregation, are considered, the existing management environment could pose barriers to success, including fragmented leadership for space programs, the culture of the DOD space community, fragmentation in satellite control stations, and disconnects between the delivery of satellites and their corresponding user terminals. For instance, disaggregation may well require substantial changes to acquisition processes and requirements setting. But without a central authority to implement these changes, there is likely to be resistance to adopting new ways of doing business, particularly since responsibilities for space acquisitions stretch across the military services and other government agencies. Moreover, under a disaggregated approach, DOD may need to effectively network and integrate a larger collection of satellites—some of which may even belong to commercial providers. We have reported that ground systems generally only receive and process data from the satellites for which they were developed. They generally do not control and operate more than one type of satellite or share their data with other ground systems. To date, however, DOD has had difficulty adopting modern practices and technologies for controlling satellites as well as difficulty in coordinating the delivery of satellites with the user terminals that must be installed on thousands of ships, planes, and

[13] GAO, *Space Acquisitions: DOD Needs to Take More Action to Address Unrealistic Initial Cost Estimates of Space Systems*, GAO-07-96 (Washington, D.C.: Nov. 17, 2006).

[14] GAO-10-135R.

[15] GAO, *2013 Annual Report: Actions Needed to Reduce Fragmentation, Overlap, and Duplication and Achieve Other Financial Benefits,* GAO-13-279SP (Washington, D.C.: April 9, 2013).

ground-based assets. These are conditions that are difficult to change without strong leadership to break down organizational stove-pipes and to introduce technologies or techniques that could enable DOD to better integrate and fuse data from a wider, potentially more disparate, collection of satellites.

In light of suggestions that disaggregation could potentially reduce cost and increase survivability, the Senate Committee on Armed Services mandated that we assess the potential benefits and limitations of disaggregating key military space systems, including potential impacts on total costs.[16] To date, we have found that the potential effects of disaggregation are conceptual and not yet quantified. DOD has taken initial steps to assess alternative approaches, but it does not yet have the knowledge it needs to quantify benefits and limitations and determine a course of action. DOD officials we spoke with acknowledge the department has not yet established sufficient knowledge on which to base a decision. While DOD has conducted some studies that assessed alternative approaches to the current programs of record, some within the department do not consider these studies to be conclusive because they were either not conducted with sufficient analytical rigor or did not consider the capabilities, risks, and trades in a holistic manner. For example, according to the Office of the Secretary of Defense's Office of Cost Assessment and Program Evaluation, a recent Air Force study that assessed future satellite communications architectures contained insufficient data to support the conclusion that one architectural approach was more resilient than others, and the cost estimates it contained did not consider important factors, such as ground control and terminal costs, in calculating the implications of changing architectures.

To build consensus in the department, and to conduct a more rigorous analysis of options, DOD is currently in the process of conducting additional studies that will consider future architectures. Included in these studies are Analyses of Alternatives for future missile warning, protected satellite communications, and space based environmental monitoring

[16] S. Rep. No. 113-44, at 165 (2013).

capabilities.[17] Among the range of alternatives these analyses are considering are approaches that keep the current system, evolve the current system, and disaggregate the current system into more numerous, but smaller and less complex, satellites. DOD has nearly finished the space-based environmental monitoring study and expects to finish the other two in either this fiscal year or next.

Moreover, as DOD continues to build knowledge about different acquisition approaches, it will be essential to develop an understanding of key factors for decisions on future approaches that could impact the costs, schedules, and performance of providing mission capabilities. Some considerations for moving to a new or evolved architecture may include the following:

- Common definitions of key terms, such as resiliency and disaggregation, across all stakeholders, and a common measurement of these terms in order to compare architectural alternatives.
- The true costs of moving to a new architecture, including transition costs for funding overlapping operations and compatibility between new and legacy systems and non-recurring engineering costs for new-start programs, among others.
- Potential technical and logistical challenges. For example, with hosted payloads, our past work has found that ensuring compatibility between sensors and host satellites may be difficult because of variable interfaces on different companies' satellites.[18] In addition, scheduling and funding hosted payload arrangements may be difficult because the timeline for developing sensors may be much longer than that of commercial satellites.

[17] An Analysis of Alternatives (AOA) is a review in the DOD acquisition process that compares the operational effectiveness, suitability, and lifecycle cost of solutions to satisfy documented capability needs. Factors considered in the AOA include effectiveness, cost, schedule, concepts of operations, and overall risk of each alternative. A GAO report in 2009 found in many cases the AOAs did not effectively consider a broad range of alternatives and that DOD sponsors sometimes identify a preferred solution before an AOA is conducted. GAO, *Defense Acquisitions: Many Analyses of Alternatives Have Not Provided a Robust Assessment of Weapon System* Options, GAO-09-665 (Washington, D.C.: Sept. 24, 2009). These AOAs are to investigate follow-on programs for SBIRS, AEHF and the Defense Meteorological Satellite Program. In addition to missile warning, SBIRS supports missile defense, battlespace awareness, and technical intelligence missions.

[18] GAO-13-279SP.

- Impacts to supporting capabilities, such as ground control and operations and launch availability, and long-standing challenges we have identified regarding how these have been managed.[19]
- Readiness of the acquisition workforce and industrial base to support a new architecture.

Given that DOD is in the early stages of assessing alternatives, our ongoing work is continuing to identify potential benefits and limitations of disaggregation and examine the extent to which these issues are being factored into DOD's ongoing studies. We look forward to reporting on the results of this analysis this summer.

Recent and Upcoming Changes to the Evolved Expendable Launch Vehicle Program

DOD has made some changes to the way it buys launch services from its sole-source provider, and plans to allow other companies to compete with that provider for launch services in the near future. DOD's Evolved Expendable Launch Vehicle (EELV) program is the primary provider of launch vehicles for U.S. military and intelligence satellites. Since 2006, the United Launch Alliance (ULA) has been the sole-source launch provider for this program, with a record of 50 successful consecutive government missions. From 2006 through 2013, DOD had two types of contracts with ULA through which ULA provided launch services for national security space launches.[20] DOD utilized this dual-contract structure to achieve flexibility in launch schedules and to avoid additional costs associated with frequent launch delays.

In the last few years, though the dual contract structure met DOD's needs for unprecedented mission success and flexible launch capability, predicted costs continued to rise for launch services. In response to these cost predictions, DOD revised its acquisition strategy to allow for a "block buy" of launch vehicles, where DOD would commit to multiple years of launch purchases from ULA, with the goal of stabilizing production and

[19] GAO-13-315. GAO, *Evolved Expendable Launch Vehicle: DOD Needs to Ensure New Acquisition Strategy Is Based on Sufficient Information*. GAO-11-641. (Washington, D.C.: September 15, 2011) and *Space Acquisitions: Uncertainties in the Evolved Expendable Launch Vehicle Program Pose Management and Oversight Challenges*. GAO-08-1039. (Washington, D.C.: September 26, 2008).

[20] Under this two-contract structure, DOD bought launch capability on one series of contracts, and launch hardware on another series of contracts. Launch capability included things like overhead on launch pads, engineering support, and labor to conduct launches.

decreasing prices. In addition, and partially in response to GAO recommendations, DOD gathered large amounts of information on ULA's cost drivers to allow DOD to negotiate significantly lower prices under the contracting structure.[21] In December 2013, DOD signed a contract modification with ULA to purchase 35 launch vehicle booster cores over a 5-year period, 2013-2017, and the associated capability to launch them. According to the Air Force, this contracting strategy saved $4.4 billion over the predicted program cost in the fiscal year 2012 budget. We recently reported on some of the changes included in this new contract from the prior contracts.[22]

In addition to this change in the way DOD buys launch vehicles, DOD is also in the process of introducing a method for other launch services companies to compete with ULA for EELV launches. Since 2006, when ULA began as a joint venture between then-competitors Boeing and Lockheed Martin, the EELV program has been managed as a sole source procurement, because there were no other domestic launch companies that could meet the program's requirements. With the recent development of new domestic launch vehicles that can meet at least some EELV mission requirements, DOD plans to make available for competition up to 14 launches in fiscal years 2015-2017. Any launch company that has been certified by DOD to launch national security space payloads will be able to compete with ULA to launch these missions. DOD is currently finalizing their plan for this competition, including what requirements will be placed on the contractors and how they will compare proposals from the contractors.

Based on our discussions with DOD officials, they plan to use a best value approach for this competition, in which price is not the only consideration. DOD will likely consider several factors when comparing proposals for launch services for the 14 booster core competition between ULA and new entrants, including price, mission risk, and satellite vehicle integration risks. DOD could require competitive proposals to be structured in several ways. If DOD requires proposals to contain both fixed-price and cost reimbursement features for launch services and capability, respectively, similar to the way it currently contracts with ULA,

[21] GAO-11-641.

[22] GAO, *The Air Force's Evolved Expendable Launch Vehicle Competitive Procurement*, GAO-14-377R (Washington, D.C.: March 4, 2014).

there could be benefits to DOD and ULA, but potential burdens to new entrants. For example, DOD is familiar with this approach and has experience negotiating under these terms, and ULA is familiar with DOD's requirements given ULA's role as the EELV's sole launch provider. But use of a cost type contract may negate efficient contractor business practices and cost savings due to government data requirements under this type of approach, and it may give ULA a price advantage because DOD already funds launch capability for ULA. Alternatively, if DOD implements a fixed-price commercial approach to launch proposals with fewer data reporting requirements, DOD could lose insight into contractor cost or pricing, but may receive lower prices from new entrants due to these fewer data reporting requirements. DOD could also require a combination of elements from each of these approaches, or develop new contract requirements for this competition. We examined some of the benefits and challenges of the first two approaches, either of which can facilitate competitive launch contract awards, in a recent report.[23] DOD expects to issue a draft request for proposal for the first of the competitive missions, where the method for evaluating and comparing proposals will be explained, in the spring of 2014.

The planned competition for launch services may have helped DOD negotiate the lower prices it achieved in its December 2013 contract modification, and DOD could see further savings if a robust domestic launch market materializes. DOD noted in its 2014 President's Budget submission for EELV that after the current contract with ULA has ended, it plans to have a full and open competition for national security space launches. Cost savings on launches, as long as they do not come with a reduction in mission successes, would greatly benefit DOD, and allow the department to put funding previously needed for launches into programs in the development phases to ensure they are adequately resourced.

In conclusion, DOD has made significant progress in solving past space systems acquisition problems, and is seeing systems begin to launch after years of development struggles. However, systemic problems remain that need to be addressed as DOD considers changes to the way it acquires new systems. This is particularly important if DOD decides to pursue new approaches that could require changes in longstanding processes, practices, and organizational structures. Even if DOD decides

[23] GAO-14-377R.

not to pursue new approaches, these problems must still be tackled. In addition, challenging budget situations will continue to require tradeoffs and prioritization decisions across programs, though limited funds may also provide the impetus for rethinking architectures. We look forward to working with Congress and DOD in identifying the most effective and efficient ways to sustain and develop space capabilities in this challenging environment.

Chairman Udall, Ranking Member Sessions, this completes my prepared statement. I would be happy to respond to any questions you and Members of the Subcommittee may have at this time.

Contacts and Acknowledgements

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STATEMENT OF

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BEFORE THE

STRATEGIC FORCES SUBCOMMITTEE

OF THE

SENATE ARMED SERVICES COMMITTEE

ON

MILITARY SPACE PROGRAMS HEARING

MARCH 12, 2014

Introduction

Mr. Chairman, distinguished members of the Subcommittee, I am honored to appear before you today to address the Navy's space activities. Space capabilities underlie the Navy's ability to operate forward and meet increasing anti-access/area denial (A2AD) demands with a shifting focus towards the Pacific. The Navy continues to be highly dependent upon space-based systems for beyond line of sight communications; missile warning, intelligence, surveillance and reconnaissance, and environmental remote sensing to provide battlespace awareness in support of joint warfighting and global maritime operations; and positioning, navigation and timing information for critical command and control, battlespace and global navigation, and information system timing. The Air-Sea Battle Concept, whereby joint air and naval forces retain freedom of action through tight coordination of operations in and across multiple domains, highlights the particular importance and criticality of the space domain. With the emergence and proliferation of anti-satellite and counter-space weapons, the U.S. can no longer assume that the space domain will remain uncontested. Our service must remain nimble and agile as we deal with these new space threats.

In the face of rapidly emerging threats in space, the Navy must continue to pursue new investment strategies and widely diverse capabilities to provide resilient access to space and space services to ensure mission success. As adversaries become more proficient in their use of space capabilities, they will continue to develop both offensive and defensive space capabilities in an attempt to remove or reduce the asymmetric advantage the U.S. enjoys in the space domain. It is critical the Navy continue to leverage space capabilities while improving the resilience of future space architectures to meet information demands in an increasingly contested electromagnetic environment. The Navy must also identify alternative sources and capabilities and work with the other Services to develop and refine the necessary tactics, techniques, procedures, and operational plans to help preserve Navy fleet information dominance in degraded or denied areas.

The Navy's Information Dominance strategy fully integrates the Navy's information functions, capabilities, and resources to optimize decision-making and maximize warfighting effects. Navy leaders increasingly rely on critical satellite communications (SATCOM) paths; positioning, navigation, and timing (PNT) signals; environmental monitoring (EM) data; missile warning (MW); and intelligence, surveillance, and reconnaissance (ISR) reporting to satisfy the three pillars of Information Dominance: assured command and control (C2), battlespace awareness, and integrated fires. Maintaining access to, and proficiency in, operations utilizing all of these space capabilities enables decisiveness, responsiveness, and agility – critical attributes for a forward-deployed force operating in an anti-access/area denial environment.

Mobile User Objective System (MUOS)

The capabilities, flexibility, and robustness of our Navy and Joint forces across the board require improved access to reliable worldwide communications to successfully execute their missions. The Navy's MUOS, with its advanced technology wideband code division multiple access (WCDMA) payload, is the key enabler that will support worldwide multi-Service users in the Ultra High Frequency (UHF) band for many years to come. MUOS will provide increased communications capabilities to smaller terminal users that require greater mobility, higher data rates, and improved operational availability. As today's legacy UHF satellite constellation continues to age, MUOS, with its legacy payload, provides the bridge to allow our forces time to transition to the newer and more capable WCDMA terminals.

The MUOS program continues to make significant strides in achieving the overall program goals. In February 2012, the first satellite was launched and within eight months its legacy payload was made operational in order to replace a failing UFO-5 satellite, providing seamless transition without any degradation in service. The second MUOS satellite launched from Cape Canaveral, FL on July 19, 2013, and its legacy payload is now available for early operational use in the event of an unexpected failure of an on-orbit legacy satellite. The remaining three satellites are under a fixed price incentive fee contract and will launch in January 2015, August 2015, and a date TBD in 2016.

Production of satellites #4 and #5 has gone very well, however there have been challenges with satellite #3. During last year's thermal vacuum testing, satellite #3's legacy payload experienced an uncommanded shutdown. The subsequent investigation using photographic inspection, contractor logs and technician interviews identified the root cause as insufficient solder volume during the production of the Output Multiplexer (OMUX). The program office has initiated corrective actions and through extensive investigation has determined that this deficiency is isolated to satellite #3 only. It does not affect any of the other satellites.

In order to minimize impact on the launch schedule, the third satellite will be repaired and launched in a later launch slot, and the fourth production satellite is on track to take its place on the launch schedule in January 2015. That is a six month slip from the original schedule. Because of an effective contract structure, the government will not expend any additional funds to bring the third satellite up to standards. Additionally, thanks to flexible program management and the ability to launch satellite number four earlier than planned, the warfighters who depend on satellite communications will see no change in service.

In addition to the spacecraft, the MUOS program continues to meet objectives for the ground sites in Geraldton, Australia; Wahiawa, HI; and Northwest, VA. These sites have completed hardware installation and final acceptance testing, and have been officially handed over to Fleet Cyber Command. The fourth site at Niscemi, Sicily, has had several setbacks over the past year as Italian protesters have caused significant delays; however, the program recently cleared a major hurdle with the installation of the three large antenna dishes at the Niscemi site. The U.S. and the central Italian governments have worked together closely and Navy officials have increased cooperation with the local Sicilian authorities to maintain unfettered access to the site. Italian government studies were released in 2013, reassuring the local population that all RF levels at the site are within safe and normal operating levels. Two previous studies were conducted by the U.S. Navy with acceptable results by both American and Italian health standards. The Navy resumed work late last summer at the site, and the current projection is to finish work by the end of this year.

The final segment needed to achieve full MUOS capability is the fielding of the MUOS-capable terminals. The MUOS waveform software was completed in 2012, placed in the Joint Tactical Network Center (JTNC) Information Repository, and made available to industry in December 2012. The first terminal that will be fielded and has been used to complete the initial phase of the MUOS End-to-End (E2E) testing is the

AN/PRC-155 Manpack Radio. The U.S. Army PEO C3T Tactical Radio Program has developed this terminal by adding the MUOS capability to this new radio. Army fielding of MUOS capable Manpack radios is scheduled to begin in FY15 and continues through FY27.

Additionally, the Navy is currently adding the MUOS capability to its Digital Modular Radio (DMR) to support shipboard operations. Upgrade kits will be fielded in FY16 to existing UHF SATCOM DMRs and older systems will begin full DMR installations in FY17 with 196 radios fielded by 2020. The Navy has been contacted by several MUOS terminal vendors to gain access to the MUOS testing labs. Three vendors have been scheduled to utilize the Navy testing labs beginning in March and others will be scheduled in the near future as their terminals are ready for testing. These additional terminals are expected to greatly increase the numbers of MUOS terminals over the next several of years.

Since the beginning of the MUOS program, development of the full MUOS capability has been managed through multiple program offices, including PMW 146 (Navy), Tactical Radio Program Office (Army), Joint Tactical Networking Center (Army) and the Defense Information Systems Agency. Significant progress has been made since the Navy was assigned overall responsibility by USD (AT&L) in May of 2012 to deliver the MUOS End-to-End capability. The first phase of events designed to reduce risk associated with seams between each of the program offices has been completed. WCDMA voice and data calls were successfully transmitted by a Manpack Radio through the MUOS-1 satellite, routed through the MUOS ground system using a single ground site, and received by a second Manpack Radio. The second phase of risk reduction events is in progress and involves two MUOS satellites, two ground stations, and at least fifteen Manpack Radios. The next major event for the MUOS program is the completion of the Multiservice Operational Test and Evaluation (MOT&E) which will occur later this year. The MOT&E is the final test that will certify the system operational, testing the full E2E capability of the terminals, ground stations and satellites utilizing multiple operational scenarios. Once the system is certified the program will achieve Initial Operational Capability (IOC) followed by Full Operational Capability (FOC) after all five satellites have been launched and tested.

Additional developmental testing was sponsored by the prime contractor in 2013. Initial indications are that MUOS may provide some coverage for narrowband SATCOM in the Arctic. A recent test successfully communicated over MUOS to an aircraft flying at 23,000 feet at 89.5 North latitude. Further testing will be required to determine if and to what degree surface ships could employ MUOS to communicate in ice free waters in that region. Routine surface and subsurface operations in the region cannot be supported as there is insufficient coverage. The USAF EPS is required to support joint Arctic operations. MUOS is not capable of supporting joint Arctic operations, and it does not provide a protected SATCOM capability. Protected SATCOM is essential to these operations.

Navy Multiband Terminal

The increasing threat to access Space is a growing Navy concern. A2AD threatens satellite communications systems that enable critical warfighter commander assured C2 functions. The Advanced Extremely High Frequency (AEHF) Satellite communications program acquired and deployed by the USAF provides a means to protect satellite communications. The Navy Multiband Terminal (NMT) Program will allow the Navy to leverage the AEHF satellite communications program to mitigate this risk. NMT provides secure, protected, and survivable high capacity mission bandwidth access for all warfare areas in an A2AD environment. NMT variants are being installed on surface ships, submarines, and shore sites, including ground sites for the Enhanced Polar System program. Each order for a production lot of NMTs requires a 15-month lead time for the first unit of delivery. The remaining units can be delivered over a 12-month window. Once a unit is delivered to the Navy, it undergoes an additional period of Government testing of up to two months prior to being delivered to its ultimate installation platform. This timeline means that an NMT unit may be bought up to 29 months prior to installation, giving an inaccurate perception of being early to need. Further program cuts could lead to breaks in production, which will negate learning curve efficiencies and increase production costs, while delaying delivery of this much needed capability for the warfighter. Given these points, if current budget funding levels remain stable, program FOC will occur in 2022.

Positioning, Navigation, and Timing

Precise time and time interval (PTTI) is absolutely critical to the effective employment of a myriad of Department of Defense (DoD) systems. Coordinated Universal Time as referenced to the U.S. Naval Observatory (UTC-USNO) is the DoD standard and the primary PTTI reference for the Global Positioning System (GPS). The Navy remains at the forefront of timekeeping technology with the USNO Master Clock, an ensemble system of independent atomic clocks. Four Navy Rubidium Fountain (NRF) atomic clocks achieved FOC at USNO Washington, DC in August 2013. These additions to USNO's timing suite improve UTC-USNO to better than one nanosecond per day as required for GPS III. The DoD Alternate Master Clock facility in Colorado Springs, CO received its second of two planned NRF clocks in early February. IOC was delayed to September 2014 and September 2015, respectively, due to furloughs and funding cuts.

The Navy initiated a Critical Time Dissemination (CTD) program in 2013 to ensure PTTI remains available to DoD users in contested environments. This program will provide critical upgrades to timing stations to overcome dependence on GPS-only solutions and ensure correct PTTI delivery to the warfighter. These efforts are being resourced and executed in concert with DoD Chief Information Officer (CIO) priorities and the department's long term strategy for Assured PNT. CTD funding supports four lines of effort: development of a radio-frequency interface, a timing reference upgrade, timing system integration, and development of an optical interface. The $3M cut to CTD research and development in the FY14 budget due to 'excess growth' will retard program goals at least one year to FY19.

The Military-Code (M-Code) GPS signal is a new encrypted signal for military users designed for resiliency. The USAF led development of M-Code GPS User Equipment (MGUE) is critically important to the warfighter in order to capitalize on the advantage gained by precise PNT while enhancing its ability in a denied and degraded environment. Hand-held requirements are vital to the USMC, however current development has been deferred to increment 2, and delaying USMC access to M-code beyond FY22. Protecting the funding for its development is important to ensure that the ground segment keeps pace with on orbit capabilities and provide future access to space-based PNT for ground forces utilizing hand-held devices.

Environmental Monitoring

Environmental monitoring is a vital capability that the Navy relies on for its short and long term forecasts, as well as climate monitoring programs. Satellite data is the primary method for collecting these large volume data sources that are used to feed the Navy's, as well as other Federal and International numerical models. As the DoD budget has decreased over the past several years, the Navy has relied on other Federal agencies and International governments to provide the necessary data. The DoD is not the only organization feeling the budget crisis. Smaller budgets are a reality for space organizations around the world and thus there is the potential of being left without the necessary resources to ensure operations can be conducted safely and efficiently. In order to develop mitigation plans, the Navy has been participating with the Air Force in a study to review the operational requirements for Space-based Environmental Monitoring. This study has shown that space-based solutions are required; especially to support Ocean Surface Vector Wind and Tropical Cyclone Intensity. The study is due to report out by the end of April but the Navy is hopeful that the documented requirements will be met with the necessary resources to support this vital service need.

Intelligence, Surveillance, and Reconnaissance (ISR)

The nation's recent focus on the western Pacific and the Arctic has increased the need for better access to space-based ISR systems. The WESTPAC and Arctic key maritime operating areas of interest are located in remote regions of the earth, cover very large expanses of water, and offer limited access from land-based and airborne sensors. Space-based sensors are not restricted in these areas. In fact they are well suited to support the wide variety of missions the U.S. Navy is called upon to support, from both a strategic and defensive perspective, for the nation as well as our International Partners.

Significant progress has been made since last year's testimony in defining maritime collection needs for future national and commercial ISR systems. Over the last year the Director of National Intelligence has completed work on a series of capability documents for our next generation national systems. These documents outline required sensor collection capabilities as well as system architecture design specifications. The U.S. Navy has been actively engaged in ensuring the nation's maritime collection needs are properly defined so the sensors, when fielded, will be able to provide the required collections to support these missions well into the 2030 timeframe and beyond. The Navy is also working with the National Geo-Spatial Intelligence Agency to determine what role commercial satellite systems can play in meeting our collection needs. Commercial sensors offer unique collection capabilities for the maritime domain that in some cases exceed national systems capabilities, cost less than their national counterparts, and provide information at the unclassified level which ease data flow within DoD as well as with our allies and coalition forces. Although national security concerns do preclude use of commercial sensors for some collection operations, they can play a significant role in filling collection gaps.

<u>Nano Satellites</u>

With the increasingly contested nature of space and the promulgation of International counterspace capabilities, the pressure has been turned up for more resilient, cost-effective access to space and capability on orbit. In response, the Navy is participating in nano satellite initiatives designed to provide low cost and quick response capability for emerging space requirements. One such effort is the Vector Joint Capability Technology Demonstration (JCTD), which launched two, foot-long "CubeSats" in November 2013 to demonstrate advanced communications capabilities. Both satellites were part of the Operationally Responsive Space (ORS)-3 mission which launched from Wallops Island, VA on a MINOTAUR IV space vehicle. The satellites will be demonstrated and their military utility assessed by our mission partners through the spring of 2014. The multi-mission satellite is designed with an open payload interface that allows third party capabilities to be integrated quickly. Three companies are now developing prototype Naval payloads for the multi-mission satellite using our Small Business Innovative Research (SBIR) program. While not as capable as larger satellites, nano satellites can be launched in relatively short timelines in order to address a quickly evolving operational need.

Conclusion

The Navy continues to be reliant upon space for SATCOM, PNT, EM, MW and ISR information in order to enable decision-making in increasingly contested and denied environments. Growing global uncertainty and emerging and expanding adversary capabilities will continue to require the Navy to become more resilient and efficient in the use of available assets in order to maintain the level of effectiveness that the nation expects. This will require a re-validation of fleet information requirements and promotion of resilient measures to ensure that threats to space access and services are continuously evaluated and that mitigations are in place to ensure forward-deployed commanders have the tools necessary to ensure mission success.

Mr. Chairman - thank you for the opportunity to share our efforts with you today. We look forward to answering any questions you and the Subcommittee may have.