DEPARTMENT OF DEFENSE AUTHORIZATION OF APPROPRIATIONS FOR FISCAL YEAR 2014 AND THE FUTURE YEARS DEFENSE PROGRAM

WEDNESDAY, APRIL 24, 2013

U.S. SENATE,
SUBCOMMITTEE ON STRATEGIC FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

MILITARY SPACE PROGRAMS AND VIEWS ON DEPARTMENT OF DEFENSE USAGE OF THE ELECTROMAGNETIC SPECTRUM

The subcommittee met, pursuant to notice, at 2:30 p.m. in room SR–222, Russell Senate Office Building, Senator Mark Udall (chairman of the subcommittee) presiding.

Committee members present: Senators Udall, Sessions, and Fischer.

Majority staff member present: Jonathan S. Epstein, counsel.

Minority staff member present: Daniel A. Lerner, professional staff member.

Staff assistant present: Lauren M. Gillis.

Committee members' assistants present: Jason Rauch, assistant to Senator McCaskill; Casey Howard, assistant to Senator Udall; Lenwood Landrum, assistant to Senator Sessions; and Peter Schirtzinger, assistant to Senator Fischer.

OPENING STATEMENT OF SENATOR MARK UDALL, CHAIRMAN

Senator UDALL. Let me bring today's hearing of the Strategic Forces Subcommittee to order.

This afternoon, we will receive testimony from the Department of Defense (DOD) regarding military space programs for fiscal year 2014. We will also examine DOD's use of electromagnetic spectrum in a second panel.

For planning purposes, the first panel on DOD's space programs will end at 3:30 p.m. so that we can hear from the second panel on electromagnetic spectrum, and that second panel will end around 4 p.m.

We will take very short opening statements from our witnesses, no more than a minute or 2 to highlight anything they think is important for us to hear.

As always, I am honored to work with our distinguished ranking member, Senator Sessions. Colorado and Alabama have important

roles in space. Colorado is home to the Air Force's Space Command, and Alabama is home to the Army's Space and Missile Defense Command. We have the commanding generals from both commands here today, and I thank them and all the witnesses for taking the time to testify before the subcommittee.

With that, let me make some short comments regarding the fiscal year 2014 space budget.

The Air Force is finally making strides in bringing their satellite programs on track after years of cost overruns. That is a good news story. There are still open questions regarding launch services as DOD works to lower costs and balance the incumbent launch provider with new entrants. I would like to hear from General Shelton how we assure that we have reliable access to space while continuing to lower costs.

I look forward to hearing from the Army on how they are approaching access to space. My understanding is that they are developing low-cost, innovative space programs.

The Navy is now launching their mobile user satellite system which provides line-of-sight access to users around the world. I would like to hear how they are bringing the terminals online to receive the signals from the satellites.

In the policy area, I would like to hear about how we are implementing plans to protect our satellites from impacting with debris and other nations' satellites. I hope that we will be able to hear about policies to deter hostile actions that other nations might take against us in space.

Finally, I would like to hear from the Government Accountability Office (GAO) on what long-term problems they see in the area of disaggregation of large satellite systems. There has been a lot of talk here, but we do not know the long-term consequences.

Then finally for the second panel on electromagnetic spectrum, there has been much debate about DOD's use of a frequency band that has commercial potential. We must balance our national security while promoting cooperation and competition and economic growth that would come from commercial use of this band. I believe we can get there, and I think we all agree that it must be done in a careful and thoughtful way. I look forward to the second panel's views on this subject.

With that, let me turn to my ranking member and my friend, Senator Sessions, for his opening statement, and then we will move on to questions.

STATEMENT OF SENATOR JEFF SESSIONS

Senator SESSIONS. Thank you, Senator Udall. It is great to work with you and I appreciate your expertise and cooperativeness as we work together.

I will just be brief and maybe offer my full statement for the record.

We are keenly aware of the unprecedented budget situation facing DOD and we know that frugality is the order of the day. Managing capability development and acquisitions over the next 5 years will define for decades perhaps how space will either enable our warfighting capability or limit our warfighting capability.

I am pleased to see the Evolved Expendable Launch Vehicle (EELV) recorded a $1.1 billion reduction in costs over the next 5-year budget, and I applaud the Air Force in reducing cost. That was a competitive bid process you worked out. So we made some progress. I think that is something that people should know. That was quite a good thing.

We have the spectrum issue, as the chairman mentioned. I will not go into detail except that it has caused quite a bit of interest. It looks like DOD has estimated that moving to a new spectrum band could take at least 10 years and cost nearly $13 billion. So this is a matter that requires examination because we have private sector people who want to be engaged in this, and it is just a matter we will be able to talk about today.

Mr. Chairman, I look forward to hearing from this distinguished panel and appreciate the opportunity to share these remarks.

I welcome Senator Fischer for her great participation in these committees. She has weighed in already with great interest. I believe you like all these space, missile, atom bomb issues.

Senator FISCHER. I do.

Senator SESSIONS. I know. You do actually. Thank you for your leadership.

[The prepared statement of Senator Sessions follows:]

PREPARED STATEMENT BY SENATOR JEFF SESSIONS

Thank you very much, Mr. Chairman, I join you in welcoming our distinguished panel of witnesses. I would like to extend a special welcome to Lieutenant General Richard Formica, the Commander of the Army Space and Missile Defense Command in Huntsville. We have two panels and many witnesses so in the interest of time I will keep my opening remarks brief.

The purpose of the first panel of our hearing today is to discuss the President's fiscal year 2014 budget request for military space programs. We are all keenly aware of the unprecedented budget situation facing the Department of Defense. Nothing is immune to budget cuts, including strategic enablers such as defense space systems. Managing capability development and acquisitions over the next 5 years will define for decades how space will either enable our warfighting capacity or limit our global reach. Today's hearing affords us the opportunity to assess these challenges and better understand the impact they will have on the space enterprise. I look forward to discussing with each of our witnesses the steps they are taking to maximize capability with fewer resources.

After many years of cost overruns and delays, I am pleased to report that the fiscal year 2014 Air Force budget archives a cost savings of $2.8 billion across three of the Departments costliest space programs. I mentioned in our hearing last year that space launch is an area where more must be done to address affordability pleased to see that the Evolved Expendable Launch Vehicle, also known as EELV, recorded a $1.1 billion reduction over the 5 year budget and applaud the Air Force for its focus on reducing cost. I look forward to better understanding if and how such savings will be reinvested within the space program to ensure continued space dominance.

Our second panel will focus on the Defense Department's electromagnetic spectrum requirements and long-term planning. A national initiative to maximize usage and free up additional spectrum for public consumption has caused many to examine the Department of Defense's utilization. The private sector has expressed growing interest in freeing spectrum bands for auction currently occupied by DOD such as the 1755 to 1850 Megahertz band. Unfortunately, few thus far have proposed a plan which ensures full reimbursement and comparable alternative spectrum elsewhere for the Pentagon. The Department has estimated that moving to a new spectrum band would take at least 10 years and cost nearly $13 billion. While some have suggested breaking that band into smaller bites, the technical feasibility of doing so remains unclear.

I fully support the goal to free additional spectrum to ensure global competitiveness, but in doing so we must ensure that the Department is not left holding the bill. With over $1 trillion in Defense spending at risk under sequester, the Defense

Department is in no place to move to any new spectrum bands without guarantees that it will be fully reimbursed and that mission readiness will not be impeded.

Senator UDALL. Thank you, Senator Sessions. It is truly important that Senator Fischer is involved and we welcome her engagement in this important subcommittee.

In the spirit of my opening remarks, I mentioned I would like each one of you, if you are so inclined, to give us a 1- to 2-minute statement and then we will go right to questions. So we will start to our left and work right across the panel.

Secretary Loverro?

STATEMENT OF MR. DOUGLAS L. LOVERRO, DEPUTY ASSISTANT SECRETARY OF DEFENSE, SPACE POLICY

Mr. LOVERRO. Thank you, Chairman Udall and Ranking Member Sessions, Senator Fischer. Thank you for the opportunity to testify this afternoon.

A year ago, Assistant Secretary Madelyn Creedon testified here about the progress of implementing the national space security strategy. I am pleased to join General Shelton, Lieutenant General Formica, Dr. Zangardi, and Ms. Chaplain to continue that discussion today.

Let me start with the basic reality that space remains vital to our national security. You have both expressed that. But the evolving strategic environment increasingly challenges U.S. space advantages, advantages that both our warfighters and our adversaries have come to appreciate. As space becomes more congested, competitive, and contested, DOD must formulate programs and policies that will secure those advantages for years to come.

That reality is juxtaposed with the fact that as a Nation, we are providing these capabilities and environment that is increasingly cost-constrained. The growing challenges of budget, in addition to increasing external threats, compel us to think and act differently so that in the future what we choose to procure, how we choose to provision it, and the policies we govern it with reflect both our changed threat and fiscal environments.

While these two realities present us with a clear challenge, I do not, by any means, view them with a sense of doom or gloom. Newer entrepreneurial suppliers, alongside our legacy suppliers, are creating an ever-burgeoning commercial space market that can provide significant advantage to DOD if we formulate the policies and strategies to encourage their growth and use.

Similarly, there has been a growth worldwide in allied space investment and capability, and those provide a significant opportunity for DOD to help us build resilience into our space capabilities.

The policies and strategies that I will discuss here today begin to address those challenges and opportunities, but they are just the initial steps in an area that will continue to demand attention and action from all of us.

Thank you very much, and I look forward to your questions.

[The prepared statement of Mr. Loverro follows:]

PREPARED STATEMENT BY DOUGLAS L. LOVERRO

Chairman Udall, Ranking Member Sessions, and members of the subcommittee, I am pleased to join General Shelton, Lieutenant General Formica, Dr. Zangardi, and Ms. Chaplain to testify on Department of Defense space programs and policies. A year ago, Assistant Secretary Madelyn Creedon testified here about the progress in implementing the National Security Space Strategy. I am pleased to continue that discussion today.

Space remains vital to our national security, but the evolving strategic environment increasingly challenges U.S. space advantages. U.S. space capabilities allow our military to see with clarity, communicate with certainty, navigate with accuracy, and operate with assurance. Those capabilities, however, are being provided in a space environment that is increasingly congested, contested, and competitive. Space is increasingly congested, with tens of thousands of trackable manmade objects in orbit, contested, by an ever-increasing number of manmade threats, and competitive, as the U.S. technological lead in space is challenged.

As a country, we are providing these capabilities in an environment that is severely cost-constrained. Space programs are, by their very nature, expensive, and as vulnerable to budget pressure as other government activities. Poorly planned past approaches to space programs have trapped us in a vicious cycle of delayed capability, mounting cost, and increased risk. The growing challenges of the budget, in addition to increasing external threats, compel us now to think and act differently so that in the future what we choose to procure, and how we choose to provision it, will reflect the changed space and fiscal environments.

At the same time, it is not all doom and gloom. Over the last decade, we have seen a welcome growth in the U.S. space sector as newer entrepreneurial suppliers have begun to enter the space arena in both the launch and satellite markets. They are creating a burgeoning commercial space market that can provide significant advantage to DOD if we formulate the policies and strategies to encourage their growth and use. The policies and strategies that I will discuss today begin to address these challenges and opportunities, but these are just initial steps in an area that will continue to demand attention and action from us all.

I would like to begin with a success story, one that not only energizes our industrial base, but also illustrates that our response to the challenges we face must involve the whole U.S. Government—DOD, State, Commerce, Congress, and others—as well as industry. A robust, competitive, and healthy industrial base underpins everything that we do in space. Over the past 2 decades, the health and competitiveness of the U.S. space industrial base has been challenged by overly restrictive export controls on satellites and related items. The changes made in the National Defense Authorization Act for Fiscal Year 2013 put us on a path to modernize and appropriately tailor those export controls to allow industry to compete for sale of those items that are widely available, while focusing export controls on those items most critical to national security. I extend my thanks to Congress, and particularly this committee, for all of the hard work that went into enacting this legislative change.

Updating satellite export controls will provide the U.S. satellite industry with an opportunity to restore its leadership by allowing it to compete on a more level playing field with its international competitors. This will be particularly beneficial to small- and medium-sized second and third tier U.S. companies that manufacture parts and components for satellites. These reforms will reduce the current incentives for satellite and component manufacturers in other countries to design out or avoid U.S.-origin content. In addition to improving the health and competitiveness of our industrial base, tailoring satellite export controls benefits national security by facilitating cooperation with our Allies and export control regime partners while maintaining robust controls necessary to protect national security.

Moving forward, satellites and related items will follow the existing procedures of the President's Export Control Reform Initiative for rebuilding the categories of the U.S. Munitions List (USML) and their corresponding Commerce Control List (CCL) categories. The interagency team of Commerce, State, Defense, NASA, and the intelligence community will build on the substantial technical work they put into the report required by section 1248 of the National Defense Authorization Act for Fiscal Year 2010 to revise Category XV, Satellites and Related Items, of the USML and its CCL complement. Following a period of public comment on the draft categories, which should begin this spring, the interagency team will make changes based on those comments and consult with Congress both informally and formally before publishing final revised categories, hopefully by the end of the year. We look forward to working with you and our interagency partners to make these important changes to benefit the space industrial base and ultimately our national security.

I view this as an extremely positive first step. But if we are to fully empower our commercial sector, as well as continue to derive the substantial benefits space confers, it will require more than just enhanced supplier access. It requires that we create a safe, stable, and secure space environment. We are pursuing several initiatives that seek to do just that.

Space situational awareness (SSA) is foundational to all of our space activities. SSA capabilities provide the ability to avoid collision with debris or other active spacecraft, as well as rapidly detect, warn, characterize, and attribute natural or manmade phenomena affecting space systems. But effective SSA requires cooperation among space actors—we cannot do it alone. The increasingly congested space environment means that an unprecedented level of information sharing is needed among those actors to promote safe and responsible operations in space and to reduce the likelihood of mishaps, misperceptions, and mistrust. This year, the Commander of U.S. Strategic Command (STRATCOM) signed the first SSA data sharing agreement with a foreign government, and many more are in varying stages of negotiation. These agreements will complement STRATCOM's more than 35 existing SSA sharing agreements with commercial satellite operators. With the extension of this authority to foreign governments, the United States will be able to better assist our partners with current space operations and lay the groundwork for future cooperative projects. Consistent with existing legislative authority, we are committed to providing SSA services to increase the safety of spaceflight for space-faring nations.

As more countries and companies field space capabilities, it is in everyone's interest to act responsibly and protect the safety and sustainability of the space domain. Much as we promoted the now well-accepted rules of the sea in centuries past to stimulate commerce, enhance security, and isolate irresponsible actors, the United States is taking a leading role in international efforts to promote responsible, peaceful, and safe use of space. A more cooperative, predictable environment enhances U.S. national security and discourages destabilizing crisis behavior. Working closely with the Department of State, we are supporting development of data standards, best practice guidelines, and transparency and confidence-building measures for responsible space operations. For instance, we are actively participating with other U.S. departments and agencies in the United Nations (U.N.) Committee on the Peaceful Uses of Outer Space's work on furthering the long-term sustainability of space, as well as U.S. inputs to a study by a U.N. Group of Government Experts, which is examining possible transparency and confidence building measures.

The Department of Defense supports U.S. efforts to work with the European Union and other spacefaring countries to develop an International Code of Conduct for Outer Space Activities. A widely-subscribed Code will encourage responsible space behavior and help identify those who act otherwise, thereby reducing risk of misunderstanding and misconduct. The draft International Code of Conduct focuses on reducing the risk of debris creation and increasing the transparency of space operations. It reflects U.S. best practices and is consistent with current U.S. practices such as notification of space launches and sharing of space data to avoid collisions.

It is important to note that the draft Code of Conduct is not legally binding and that it recognizes the inherent right of self-defense. It focuses on activities, rather than unverifiable capabilities, and better serves our interests than the legally-binding but unverifiable ban on "space weapons" proposed by others. We are committed to ensuring that any Code of Conduct for space activities advances, rather than hampers, our national security, and we will continue to actively participate in international negotiations to shape the Code. With each subsequent draft of the Code, we will assess the text for any potential adverse programmatic or operational impact to ensure that a final Code fully supports our national interests. We are committed to working with the Department of State to keep you informed on the process of developing an international Code of Conduct.

Working with international partners to encourage responsible behavior in space is only a part of our engagement with other space actors. We are also pursuing opportunities to partner with responsible nations, international organizations, and commercial firms to augment the U.S. national security space posture. Through these partnerships, we can ensure access to information and services from a more diverse set of systems. This provides a direct advantage in a contested space environment. Decisions on partnering are made consistent with U.S. policy and international commitments and take mutual performance benefits, costs, protection of sources and methods, and effects on the U.S. industrial base into consideration.

While space is a domain in which we once operated unchallenged and independent, increasingly we need to operate in space as we do in other domains: in coalitions. Led by General Kehler at STRATCOM, the Department is working with close allies to develop the Combined Space Operations (CSpO) concept. CSpO is a multinational effort focused on cooperation, collaboration, and the integration of

military space activities to strengthen deterrence, improve mission assurance, and enhance resilience while optimizing resources across the participating countries. We have completed an initial period of discovery with close allies and are working to further refine the concept and eventually broaden participation to include additional spacefaring countries.

Our allies have significant and growing space-based capabilities in a range of mission areas. By leveraging their systems, we can augment our capabilities, add diversity and resilience to our architectures, and complicate the decisionmaking of potential adversaries. For example, last year we signed an agreement with Canada to incorporate data from their recently launched Sapphire sensor into the U.S. Space Surveillance Network, and an agreement with Australia to jointly operate a C-band ground-based radar system from the southern hemisphere. We are also exploring jointly operating a Space Surveillance Telescope (SST) on Australian soil. These efforts enhance our collective SSA capabilities, and will directly contribute to the long-term safety and sustainability of the domain. Cooperation can also better enable coalition operations on land, at sea, and in the air, since space-based capabilities are critical enablers of capabilities in these other domains.

As I already mentioned, commercial entities are increasingly important to the Department, and we are pursuing strategic partnerships with these firms to stabilize costs and improve resilience. We are exploring innovative approaches, such as multi-year contract authority or co-investment for commercial space services, hosted payloads, and disaggregated architectures in order to take advantage of the most competitive sectors of our space market. The Department has developed criteria to certify the reliability of new space launch vehicles and will openly compete up to 14 national security space launches in the next 5 years. To spur that certification and competition, we recently awarded two scientific missions to one of these firms and placed several other launch providers on contract for future similar missions. Those efforts will help to demonstrate the full range of capabilities necessary to launch the existing range of national security missions.

At the same time, we have guaranteed our current launch provider at least twenty-eight launches. Doing so provides stability to an industrial base that provides critical services, but also ensures a level playing field for competition that can spur innovation, improve capabilities, and most importantly reduce costs without increasing risk. To spur continued growth in the commercial space sector and to foster the competition that creates benefits, which DOD can reap, we will complement these efforts with policies that guarantee a level playing field in the future. Over the next few years we will begin those same steps on the satellite side of our architectures, emphasizing the use of the competitive market and diversity of capability to not only drive down costs but also to enhance resilience and U.S. industrial competitiveness.

All of these efforts across the Department are being led and overseen by a rejuvenated governance structure. The changes to the management and coordination of the national security space enterprise, including the establishment of the Defense Space Council, and the designation of the Secretary of the Air Force as the Executive Agent for Space, have resulted in significant improvements in information flow across DOD and among U.S. departments and agencies. It has also improved the process for acquisition and policy decisions. We understand Congress' action to reinstate the Operationally Responsive Space (ORS) office and funding, and are working to ensure its goals are realized across future space programs.

Many of the things that I discussed today have been briefed to you previously as part of the National Space Policy and National Security Space Strategy (NSSS). We have continued our implementation of the NSSS this year, incorporating these concepts into our first update of the Department of Defense's Space Policy in 13 years. The DOD Space Policy implements the National Space Policy and NSSS within the formal DOD system of directives, regulations, and guidance, and reflects the Department of Defense's 2012 Strategic Guidance. Together with the June 2012 National Military Strategy for Space Operations, the policy update institutionalizes the changes that DOD is making in a constrained budget environment to address the complex set of space-related challenges and opportunities it faces.

The Department looks forward to working closely with Congress, our interagency partners, our allies, and U.S. industry to continue implementing this new approach to space.

Senator UDALL. Thank you.
Secretary Zangardi?

STATEMENT OF DR. JOHN A. ZANGARDI, DEPUTY ASSISTANT SECRETARY OF THE NAVY FOR COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, INTELLIGENCE, INFORMATION OPERATIONS, AND SPACE

Dr. ZANGARDI. Good afternoon. Chairman Udall, Ranking Member Sessions and Senator Fischer, thank you for the privilege to speak before you today. I will keep my comments very brief.

At last year's hearing, we discussed the launch of the first Mobile User Objective System (MUOS) satellite and the great accomplishments of the program. I am happy to report that the program has continued to progress towards full capability. MUOS–1 became operational to the warfighter, supporting legacy Ultra-High Frequency (UHF) operations on November 2, 2012. Additionally, MUOS–2 is on schedule to launch from Cape Canaveral on July 19, which will bring us one step closer to providing global communications access to the warfighter.

Terminal development continues to progress as the MUOS waveform was completed in November 2012 and made available on the Joint Tactical Network Center information repository for use by commercial vendors in December 2012. Multiple vendors have downloaded the waveform and are working to develop radios which will be used by all Services. Once MUOS–2 completes its 90-day on-orbit checkout, the Navy will continue its risk reduction events to thoroughly test all portions of the wideband code division, multiple access (WCDMA) capability to include the satellites, ground stations, Defense Information Systems Agency (DISA) teleports, and the radios. Although we expect to have challenges in each of the scheduled risk reduction events, we are confident that this early testing will enable a successful operational evaluation. We expect to have an operational WCDMA capability by summer 2014.

Significant accomplishments have been made at three of the four ground stations. Sites at Geraldton, Australia, Wahiawa, Hawaii, and northwest Virginia have completed final hardware installation and will complete final acceptance testing this summer. The final site in Niscemi, Italy, is expected to be complete by December 2014.

The Navy will continue to focus on the successful deployment and development of the MUOS constellation and the replacement of legacy UHF capability. I want to point out that there has been tremendous teamwork in this program between the Navy, Army, DISA, and the Office of the Secretary of Defense (OSD) to deliver this capability. Industry has delivered in this case on cost.

Senator, I am standing by for your questions.

[The prepared statement of Dr. Zangardi follows:]

PREPARED STATEMENT BY DR. JOHN A. ZANGARDI

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 form the foundation of the Navy's ability to operate forward, especially as the Navy shifts it focus towards the Pacific. As a forward deployed force, the Navy is highly dependent upon space-based systems for over-the-horizon communications and battlespace awareness in support of joint warfighting and global maritime operations. Air-Sea

battle, the joint operational concept through which air and naval forces retain freedom of action through tight coordination of operations in and across multiple domains, highlights the particular importance of the space domain. The United States has enjoyed uncontested superiority in the space domain for several decades; however, cheaper access to space, proliferation of jamming technology and the emergence of counter-space weapons have begun to level the playing field against peer and near-peer forces.

In an environment of emerging threats in space, the Navy will require continued robust investment and access to space to ensure mission success in a contested environment. Adversaries are becoming more proficient in their use of space capabilities and are developing both offensive and defensive space capabilities in an attempt to remove or reduce the asymmetric advantage the United States enjoys in the space domain. It is imperative the Navy continue to leverage space capabilities and work with the other Services to develop and refine the necessary tactics, techniques, procedures, and capabilities to retain Navy fleet information dominance in degraded or denied environments.

The Navy Strategy for Achieving Information Dominance (2012–2016) defines Information Dominance as the operational advantage gained from fully integrating 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 data; missile warning (MW); and intelligence, surveillance, and reconnaissance (ISR) reporting for the full range of operations from humanitarian missions to combat operations in one or more theaters. Access to, and mastery in, operations utilizing this combination of space capabilities enables decisiveness, sustainability, responsiveness, and agility—critical requirements for a forward deployed and globally engaged force.

MOBILE USER OBJECTIVE SYSTEM (MUOS)

The increasing reliance on satellite communications and the uncertainty of the antiquated and aging legacy UHF capability are driving the Navy to improve narrowband capacity to support the joint warfighter. The Mobile User Objective System (MUOS) is the communications path that will best allow the Navy and DOD to meet the needs of the future while transitioning the user community from legacy UHF to a much improved wideband code division, multiple access (WCDMA) capability. This technology, which

is similar to third generation cellular technology, will not only improve bandwidth capacity but will also provide individual users true global access.

The MUOS program continues to make significant strides in achieving its program goals on time and within budget. In February 2012, the first satellite was launched and within 8 months was made operational, providing joint access that seamlessly transitioned without any degradation in service. The second MUOS satellite recently completed all pre-launch testing and is now undergoing final preparations for delivery to Cape Canaveral, FL in preparation for launch on July 19, 2013. The remaining three satellites are all on budget and on schedule.

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 recently completed final hardware installation and will complete final acceptance testing by the end of this summer. The last remaining site Niscemi, Sicily, in Italy, has had some setbacks in recent months as Italian protesters have delayed progress. The United States and the central Italian Governments are working together closely to maintain unfettered access to the site. Recently, the Italian government commissioned a radio frequency study to reassure the local population that all RF levels at the site are within normal operating levels. Two previous studies have been conducted by the U.S. Navy with acceptable results for both U.S. and Italian standards. The Navy's goal is to resume work at Niscemi by this summer to complete the site by the end of 2014 in preparation for the launch of MUOS 3.

The final segment needed to achieve full MUOS capability is the fielding of the MUOS-capable terminals. The MUOS waveform software was completed in November 2012 and 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 used to complete MUOS End-to-End (E2E) testing will be the AN/PRC–155 Manpack Radio, previously known as Joint Tactical Radio System Manpack terminal. The U.S. Army PEO C3T Tactical Radio Program is developing this terminal by adding the MUOS capability to this new radio. Additionally, the Navy is currently providing RDT&E funds to develop a MUOS-capable Digital Mod-

ular Radio (DMR) to support shipboard operations. Other manufacturers are developing radios for use with MUOS in the near future.

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), JTNC (Army) and the Defense Information Systems Agency. In May 2012, OSD (AT&L) assigned the Navy overall responsibility to deliver the MUOS E2E capability. In order to reduce risk associated with seams between each of the program offices, risk reduction testing has been added to the overall schedule. This testing will evaluate the interfaces between the space, ground, and terminal portions of the system. Testing began in March 2013 and will continue in phases through 2013 and 2014 as additional system components become available.

POSITIONING, NAVIGATION, AND TIMING

The Navy continues to use the Air Force's NAVSTAR Global Positioning System (GPS) as its primary source of space-based, precise PNT data for all platforms, munitions, combat systems, and command, control, communications, computer, and intelligence systems. GPS provides a common PNT reference for all U.S. military users as well as select coalition partners. GPS delivers the necessary underpinning for enabling Information Dominance across the Fleet. In order to maintain access to the data provided by GPS, especially in contested and denied environments, the Navy is taking proactive measures to ensure its continued reception and use.

Development of the Navy's recently awarded multi-year contract to Raytheon Integrated Defense Systems for a follow-on shipboard PNT fusion and distribution system, GPS-based PNT Service (GPNTS), continues to progress as scheduled. The GPNTS program is replacing legacy GPS shipboard user systems dating from the 1980s and 1990s and recently completed a successful Critical Design Review ahead of schedule. GPNTS incorporates the latest GPS security architecture and features redundant clocks as well as anti-jam antennas. It is being designed to incorporate the next generation of military GPS receivers capable of utilizing the new GPS M-code signal once it becomes available from the Air Force. GPNTS will also distribute common positioning data and synchronized precise time and frequency to all systems on a ship that require this information.

Additionally, the Navy continues to procure and install anti-jam GPS antennas on its manned aircraft and has initiated the development of GPS anti-jam antennas for both the submarine force and its fleet of unmanned aircraft systems.

Precise time and time interval is absolutely critical to the effective employment of a myriad of Department of Defense (DOD) systems, including weapons systems, command and control systems, communications systems, and information technology networks. The U.S. Naval Observatory (USNO) is responsible for maintaining precise time and time interval for all Department of Defense (DOD) users. Coordinated Universal Time (UTC) is the DOD standard and is the primary precise time reference for GPS and numerous other military applications. The Navy remains at the forefront of timekeeping technology. In fiscal year 2012, the USNO built and incorporated four new rubidium fountain atomic clocks to the Master Clock (MC) with full operating capability (FOC) scheduled for the end of fiscal year 2013. The installation of two rubidium fountain atomic clocks at the DOD Alternate Master Clock (AMC) facility is in progress with FOC scheduled for fiscal year 2015. These additions to USNO's timekeeping suite will improve the precision and accuracy of USNO UTC, which is required to support future Joint systems and operations. The Navy continues to closely coordinate with the Air Force to ensure the USNO Master Clock is fully supportive of the new GPS III architecture.

Additionally, the Navy has other ongoing initiatives to ensure precise time and time interval is readily available to all DOD users. These initiatives primarily include improving the current infrastructure for distributing precise time to DOD users and the development of alternate methods for distribution. These efforts are being resourced and executed in concert with DOD Chief Information Officer (CIO) priorities and long-term strategy for Assured PNT.

ENVIRONMENTAL MONITORING

Navy provides the DOD with global atmospheric modeling and global and regional ocean modeling. In October 2012, the Navy Operational Global Atmospheric Prediction System model was upgraded to the Navy Global Environmental Model, which immediately improved forecast accuracy. In order to produce these accurate forecasts, the Navy also relies on partnerships with the Air Force, civil, and international agencies to meet our space-based environmental sensing requirements. Meeting these requirements is critical to the planning for, and execution of, safe,

effective military operations. To this end, the Navy is fully engaged supporting the Space-Based Environmental Monitoring AoA that is being conducted by the Air Force to define requirements for the follow-on to the Defense Meteorological Satellite Program in order to mitigate potential national and international data collection gaps.

MISSILE WARNING AND INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE (ISR)

Space-based assets provide unique access to information critical to decision making, whether it is knowledge of an immediate military threat or insight into a hazard resulting from a natural disaster. The global maritime picture built by quilting together a variety of sources, including those that allow mapping ice boundaries in the polar regions and other oceanographic efforts, can result in greater maritime domain awareness and lead to more effective defenses from seaborne threats, as well as safer navigation for the world's merchant fleets.

The Navy continues to engage the Intelligence Community (IC) as it plans future acquisitions and considers commercial capabilities to help meet our Nation's ISR needs. The Navy is striving to foster a better understanding across the IC of the unique ISR requirements in the maritime domain, improving the ease with which Navy requirements can be factored into acquisition decisions and the probability they can be met, or partially met, in a highly competitive, cost-constrained environment. The Navy requirements are very different from land targets; in the open ocean, and especially in littoral areas, ships are constantly moving, requiring larger area coverage and more frequent revisits to maintain reliable tracks. The Navy continues to work toward greater U.S. and international collaboration using civil and commercial, as well as national security space systems, to gain increased persistence and area coverage, reduce cost, and improve global maritime domain awareness.

Navy continues to leverage its Tactical Exploitation of National Capabilities (TENCAP) effort as well as research labs to explore new methods for adapting existing systems to meet Navy requirements. Through TENCAP initiatives Navy has developed and fielded maritime-specific ISR capabilities at low cost, leveraging global Geospatial Intelligence and Signal Intelligence systems to enable a fused common operational picture. Efforts have resulted in improved onboard spacecraft sensor and ground processing, greater downlink bandwidth through advanced data compression, and enhanced geo-location techniques. Additionally, Navy, broader interagency and department collaboration, has fielded and transitioned capability that significantly enhances the indications and warning of adversary Unmanned Aircraft System activity, establishing a system baseline that can be adapted to meet evolving foreign unmanned system threats. Navy TENCAP, in partnership with the IC, DOD, and Services, is developing an integrated ISR and Cyber multi-source capability to fuse national intelligence system data with tactical unit collection within a single classified security domain. This initiative has the potential to unlock vast stores of operationally relevant data currently inaccessible to tactical users because of multiple security enclaves and related policies, proprietary industry designs, and organizational controls.

Commercial systems have collection capabilities well suited to support maritime surveillance that can also be used to fill collection gaps. These efforts are paying dividends, but more investment in research and development is needed. As budgets decline, it will be new collection modes, processing technologies, and exploitation strategies, combined with ensuring that future systems accommodate unique Navy maritime requirements, which will produce the timely, precise, and relevant information so vital to 21st century naval warfare.

CONCLUSION

The Navy continues to be heavily reliant upon space for SATCOM, PNT, MW, EM, and ISR information in order to enable swift and decisive decisionmaking in increasingly contested and denied environments. Growing global uncertainty, as well as the current fiscal environment, will continue to require the Navy to become more efficient in the use of available assets in order to maintain the level of effectiveness that the Nation expects. This will require continued vigilance to ensure that threats to the space constellations 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.

Senator UDALL. Thank you. Forgive me for an oversight. I should have properly introduced Secretary Loverro, who is the Deputy Assistant Secretary of Defense for Space Policy, and Dr. Zangardi, who is the Deputy Assistant Secretary of the Navy for Command, Control, Communications, Computers, Intelligence, Information Operations, and Space. That's quite a portfolio.

I now want to recognize a good friend of mine, General William L. Shelton, USAF, who is the Commander of the Air Force Space Command, based in Colorado, my home State. General Shelton, the floor is yours.

STATEMENT OF GEN. WILLIAM L. SHELTON, USAF, COMMANDER, AIR FORCE SPACE COMMAND

General SHELTON. Mr. Chairman, Senator Sessions, Senator Fischer, it is an honor to appear before you today as the Commander of Air Force Space Command. It is also my privilege to appear with these colleagues in the national security space business.

Since its inception a little over 30 years ago, Air Force Space Command has made significant progress in evolving and sustaining space capabilities to underpin operations across the spectrum of conflict.

We have established three major goals to ensure these foundational capabilities are available to the warfighter and to the Nation: (1) to provide assured full-spectrum space capabilities; (2) to develop highly skilled and innovative space professionals; and (3) to provide resilient, integrated systems that preserve operational advantage for the Nation.

Accomplishing this in an era of declining budgets, growing threats, and increasing requirements is no small challenge. We face a daunting new challenge, providing these foundational capabilities in an era of sequestration. In my command alone, I had to find $508 million in reductions for the remainder of fiscal year 2013. The chaos created by operation and maintenance account reductions this large in this short time period cannot be overstated. At the top of the list is the significant and justifiable angst of my civilian workforce facing the prospect of a 20 percent pay cut for the last 14 weeks of this fiscal year.

Despite our fiscal challenges, we will work together with our mission partners and with industry to find innovative approaches to providing vital space capability to the Nation.

I thank the committee for your steadfast support of Air Force Space Command and its people, and thank you, Mr. Chairman.

[The prepared statement of General Shelton follows:]

PREPARED STATEMENT BY GEN. WILLIAM L. SHELTON, USAF

INTRODUCTION

Mr. Chairman and Senator Sessions, it is an honor to appear before you and your committee today as the Commander of Air Force Space Command.

I have the distinct privilege of leading over 40,000 people who deliver our Nation's space and cyberspace capabilities around the world, 24 hours a day, 7 days a week. From the 14th and 24th Air Forces, to the Space and Missile Systems Center, to the entire breadth of this Command, we embody the fighting spirit, flexibility and ingenuity of the U.S. Air Force. Outstanding Airmen are the core of our team and I will take a moment to highlight a few individuals.

Major Kenneth Holmes spent 140 days deployed to Bagram Air Base, Afghanistan. During that deployment, his leadership and expertise enabled a Joint Task

Force to significantly disrupt thousands of hours of enemy communications, ultimately aiding in the capture or elimination of over 1,470 enemies, including 166 high-value individuals. In January 2013, Major Holmes was presented the Forrest S. McCartney National Defense Space Award in recognition of his ability to integrate space capabilities into the fight.

Captain Kathleen Sullivan, a flight test engineer at Buckley Air Force Base, Colorado, led the integration of the Space-Based Infrared System into live-fire Missile Defense tests. She incorporated next-generation missile warning data into the missile defense kill-chain during multiple test campaigns, testing capabilities that will better protect the United States and our allies. Captain Sullivan was also my command's nominee for the Air Force Lance P. Sijan Award, in recognition of her outstanding leadership.

Senior Airman Nicholas Hurt, a member of the 721st Security Forces Squadron, Cheyenne Mountain Air Force Station, CO, was responsible for helping secure Bagram Air Base, Afghanistan. During his deployment, he routinely led 13-person squads on outside-the-wire reconnaissance patrols, located and secured unidentified explosive ordnance and responded to indirect fire incidents. He was one of my Command's Outstanding Airmen of the Year and is now one of the Air Force's 12 Outstanding Airmen of the Year for 2012.

Major Holmes, Captain Sullivan, Senior Airman Hurt, and other members of the command bring foundational space and cyberspace capabilities to the Nation. It is imperative that the U.S. Armed Services operate effectively in space and cyberspace, as noted in the Secretary of Defense's January 2012 Sustaining U.S. Global Leadership: Priorities for 21st Century Defense strategic guidance. Additionally, the President's 2010 National Security Strategy states, the "space and cyberspace capabilities that power our daily lives and military operations are vulnerable to disruption and attack." We are mindful there are ever-changing threats to our systems and to our ability to operate effectively in space and cyberspace. Whether the threats originate from an adversary or are environmental or fiscal in nature, Air Force Space Command forces still have the day-to-day responsibility to conduct global operations in and through space and cyberspace, from peace through crisis and war, fulfilling tactical and strategic objectives on local and global scales.

Since its inception just over 30 years ago, the Command has made tremendous progress in evolving and sustaining space and cyberspace capabilities. In an era of declining budgets, growing threats and increasing requirements, the Command continues providing cost-effective, foundational space and cyberspace capabilities. I have three goals to ensure those foundational capabilities are available to the warfighter and the Nation: to provide assured full spectrum space and cyber capabilities, to develop highly-skilled and innovative space and cyberspace professionals and to provide resilient, integrated systems that preserve operational advantage. This statement is organized around these goals and the Command's national security space activities to fulfill them.

PROVIDE ASSURED FULL SPECTRUM SPACE CAPABILITIES

Space capabilities are critical to the Joint Force Commander's ability to deter aggression, win America's wars and conduct other missions such as humanitarian and disaster relief operations. In addition, the U.S. and global economies rely on space systems to enable vital activities such as navigation, commerce and agriculture. As the Air Force's space superiority lead, I am responsible for organizing, training and equipping our space capabilities. In the current fiscal climate, we are managing increased risks across the enterprise while modernizing, sustaining and acquiring space capabilities, consistent with national, Department of Defense, Joint and Air Force priorities. We have made significant strides in providing gamechanging effects to the warfighter and I would submit that, under the strong leadership of Lieutenant General Ellen Pawlikowski, Commander of our Space and Missile Systems Center, we have turned the corner on space acquisition, delivering cost-effective capabilities. Within this context, I would like to highlight some of our space capabilities that are critical to our Nation's security.

Nuclear, Survivable; Protected Tactical and Unprotected Communications

The 2011 National Military Strategy notes that the interlinked domains of air, space, and cyberspace are essential to the Joint forces' ability to deter and defeat aggression. Our communication satellites link the domains by providing nuclear-survivable communications for the President and national leaders as well as protected, tactical and unprotected communications to the warfighter.

The Advanced Extremely High Frequency Satellite Program and its secure communications capability is one of those protected, vital links. We launched the second satellite in 2012 and the third satellite is on track for a late 2013 launch. We also

continue to execute our near-term Space Modernization Initiative investment strategy, establishing a competitive industrial base and demonstrating fundamental elements for a resilient, next-generation, protected military satellite communications capability.

The Family of Beyond-Line-of-Sight Terminals will provide nuclear survivable communications to airborne and ground command posts, manned bombers and manned intelligence, surveillance and reconnaissance aircraft using the Milstar and Advanced Extremely High Frequency constellations. In 2012, to reduce cost risk to the Government, the current terminal development contract was converted from cost plus to fixed price, and competition was injected into the program with the award of an alternate source development contract. More recently, the program office released a Production Request for Proposal for the limited competition of both an Airborne Wideband Terminal and a Command Post Terminal with a planned contract award the first quarter of fiscal year 2014 and delivery of an initial Command Post Terminal with Presidential, National and Voice Conferencing capability in fiscal year 2015.

The Wideband Global Satellite (WGS) system provides high-capacity communications to the Department of Defense, the White House Communications Agency, the Department of State and an increasing number of international partners. We launched and tested the fourth satellite in 2012 and it is providing critical wideband communications to U.S. and coalition forces in U.S. Central Command and U.S. Pacific Command. The fifth and sixth satellites are on track for launch during fiscal year 2013 and are expected to be operational in mid fiscal year 2013 and early fiscal year 2014 respectively. Once WGS–5 becomes operational, the constellation will be postured to provide worldwide coverage.

To support our long-term investment strategy, we are conducting studies to determine the optimal mix of Department of Defense and commercial solutions to meet the growing wideband demand in the most affordable and resilient manner.

Launch Detection and Missile Tracking

Strategic missile warning is critical to the Nation's survival. Ballistic missiles pose a significant threat to the United States, our deployed forces, allies and coalition partners. The command supports the strategic and tactical missile warning missions by providing both space- and ground-based sensors.

The Space Based Infrared System (SBIRS) program, along with the legacy Defense Support Program satellites, provide advanced early warning of missile threats, allowing our Joint warfighters to take swift and appropriate actions. In September 2012, the first geosynchronous orbit SBIRS (GEO–1) began required operational testing. While the mission data is exceeding expectations, we uncovered an unexpected problem which will be resolved shortly with a software update. The fact that the fix is software only gave us the necessary confidence to launch GEO–2 on March 19, 2013.

Ground-based radars deliver missile warning and missile defense capabilities to counter current and emerging missile threats. We are executing several initiatives to modernize these radars. In addition, we are working several Upgraded Early Warning Radar initiatives with the Missile Defense Agency to improve the radars' ability to provide fire control data for missile defense assets. These initiatives will significantly improve our early warning capabilities by updating the original 1950's technology and standardizing our operations and sustainment baselines.

Positioning, Navigation, and Timing

This has been another successful year for Air Force Positioning, Navigation and Timing capabilities—ensuring the continued health and resilience of the constellation: legacy Global Position System (GPS) IIAs, current generation GPS IIFs and next generation GPS IIIs. Captain Jacob Hempen, a project engineer at our Space and Missile Systems Center, modified satellite battery charging procedures, significantly increasing GPS IIA constellation total battery life by 20 years. Under the leadership of Major Jason Smesny, also from the Space and Missile Systems Center, a combined Air Force and contractor team completed operational checkout of the third GPS IIF 4 days ahead of schedule. It became part of the operational constellation on November 13, 2012. Between March 2012 and March 2013, we completed production of five GPS IIF satellites, and we will complete production of the final GPS IIF satellite this year, for a total production run of 12 GPS IIF satellites. We plan to launch the fourth GPS IIF in May 2013 and the fifth, sixth, and seventh satellites during fiscal year 2014.

On GPS III, we heeded the lessons learned of the last 2 decades in terms of management, process rigor, technical discipline and programming to create both a realistic schedule and cost for delivery. As a result, the program team continues to re-

duce defects, test time and build time while driving down recurring cost. This approach includes the integration of a non-flight satellite testbed space vehicle used for production risk reduction this fiscal year. The team also delivered the propulsion subsystem for the first flight vehicle and completed its first exercise demonstrating space vehicle to ground segment integration. Looking forward to the production phase, we are also converting the unexercised cost plus space vehicle contract options to fixed price incentive contract options. As a result, GPS III continues to move forward and we fully expect that it will stay within the cost bounds we established in 2008. We are steadfast in the pursuit of affordability and effectiveness initiatives, including examination of alternative architectures as well as exploring dual-launch opportunities to lower costs of launching our next-generation satellites.

The GPS Next Generation Operational Control System, the modernized command and control system, will provide control of GPS IIA, IIF and III, satellites and signals, to include the new Military Code (M-code). The combination of GPS III capabilities, such as M-code, along with modernized user equipment and the new command and control system, will provide Joint warfighters vital capability in challenging environments, such as GPS jamming, as well as robust information assurance. It will ensure the use of the modernized signals by the United States and its allies for military purposes.

Space Situational Awareness

Space situational awareness underpins the entire spectrum of space activities, and our focus is on providing forces and capabilities to U.S. Strategic Command (STRATCOM) to detect, track, identify, and characterize human-made objects which orbit the Earth. Our efforts contribute to the collaborative, multi-agency endeavor required to ensure comprehensive space situational awareness for the Nation.

Air Force Space Command presents space forces and capabilities to STRATCOM through the 14th Air Force, under the command of Lieutenant General Susan Helms. She is dual-hatted as Commander, Joint Functional Component Command for Space (JFCC SPACE), and therefore is responsible for executing STRATCOM's space operations. JFCC SPACE's Joint Space Operations Center (JSpOC) is the avenue through which JFCC SPACE commands and controls space forces and it is the epicenter of the space situational awareness mission. The JSpOC is also the means by which JFCC SPACE coordinates space situational awareness with other agencies.

To support national security space operations in an increasingly challenged environment, the JSpOC collects and processes data from a worldwide network of radar and optical sensors, as well as a dedicated space surveillance satellite. Each day the JSpOC creates and disseminates over 200,000 sensor taskings, which result in nearly 500,000 observations for processing. JSpOC operators use this data to maintain a very accurate catalog for more than 23,000 objects and to perform over 1,000 satellite collision avoidance screenings daily. These operations form the basis of the United States' space situational awareness capability, which is then shared with other operators in the national security, civil and commercial sector of space operations.

The Space Defense Operations Center (SPADOC) is the system of record for cataloging space objects and debris. While essential to safe passage and navigation in space, this system was designed in the 1980s, fielded in the early 1990s, and is at its capacity limits and past its originally projected end-of-life. It is vital to our national security space capabilities that we transition from our current surveillance and catalog maintenance-focused methodology, which limited us to performing forensic analysis during and after a space event (e.g., a collision, break-up or anti-satellite test), to a more holistic space situational awareness capability. We are building the capacity to predict events in space to enable actionable, situational awareness to our space operators, Joint warfighters, allies and other mission partners. This transition requires fielding the next generation system, the JSpOC Mission System (JMS). With its open, service-oriented architecture, JMS will supply the automation necessary to make better use of the tremendous volume of available sensor data. It will allow improved integration of intelligence data and innovative changes to how we use our systems, thereby providing a more complete, real-time and predictive picture of activity in the space domain.

JMS does not just replace SPADOC, it establishes a baseline for integrating new command and control capabilities in support of the Commander, JFCC SPACE, and Combatant Commanders alike. We achieved a major milestone by completing the operational utility evaluation for the first increment and operational testing was completed on December 13, 2012. It is projected to achieve Initial Operational Capability this Spring.

On November 14, 2012, the U.S. Secretary of Defense and the Australian Minister of Defence signed a Memorandum of Understanding to relocate an Air Force C-band

radar on Antigua to Australia. This action represents the next phase in implementing the 2010 U.S. and Australia Space Situational Awareness Partnership.

When the Space Fence program replaces the existing Air Force Space Surveillance System, it will represent an order of magnitude increase in the Nation's Space Situational Awareness capability in Low and Medium Earth Orbits. The program has an approved acquisition strategy that reduces cost, adds much-needed capability, and meets the prescribed initial operational capability timeline. We have selected the Kwajalein Atoll in the Marshall Islands as the first site for the new Space Fence, improving our ability to track objects in all low-earth orbits, and particularly providing unique coverage of low inclination orbits.

The Space Based Space Surveillance satellite, launched in 2010, provides timely, continuous optical surveillance of deep space objects. I declared initial operational capability August 15, 2012, and the Commander of STRATCOM accepted the satellite for operational use on September 10, 2012. We continue to study options for a follow-on program to this vital capability.

Defensive Space Control

The Rapid Attack, Identification, Detection and Reporting System Block 10 program delivers global communication satellite signal interference detection and geolocation capabilities. The current operational prototype provides geo-location on over 500 electromagnetic interference events per month in support of U.S. Pacific Command and U.S. Central Command. Adversaries are getting more sophisticated and we are responding. By 2014, we plan to have global capability to identify and characterize electromagnetic interference and geo-locate electromagnetic interference sources.

Terrestrial Environmental Monitoring

We will extend a half century of Defense Meteorological Satellite Program (DMSP) unique weather monitoring capabilities by launching the final two satellites in the program. DMSP–19 is scheduled to launch in March 2014, and we expect to operate the satellite into 2020. We continue to store and maintain DMSP–20 for a launch on demand. The Joint Requirements Oversight Council has identified potential gaps in meteorological coverage when DMSP reaches its end-of-life in the 2025 timeframe. An Analysis of Alternatives is being conducted to study follow-on options, such as international partnerships, hosted payloads and a new satellite, to continue meteorological support to warfighters in the most cost-effective manner.

Assured Space Access/Spacelift

The 45th Space Wing at Patrick Air Force Base, Florida, and the 30th Space Wing at Vandenberg Air Force Base, CA, supported a combined 14 commercial and Government launches in 2012 extending the record-breaking streak to 57 successful Evolved Expendable Launch Vehicle launches since 2002. The Under Secretary of Defense for Acquisition, Technology, and Logistics authorized the Air Force to negotiate with the current launch provider, United Launch Alliance, to procure a block buy of launch vehicles while providing an opportunity for new entrant contract awards as early as fiscal year 2015. Lieutenant Colonel Tobin Cavallari, from the Space and Missile Systems Center, is implementing this acquisition strategy to provide competition and to save over $1 billion.

In the area of new entrants, we have made significant progress toward increasing competition for national security space launches. Jointly with National Aeronautics and Space Administration and the National Reconnaissance Office, we formalized new entrant certification criteria. The Air Force subsequently developed a guide providing a process for certifying a new entrant to launch National Security missions. Additionally, two launch service task orders were awarded to a new entrant under the Orbital/Suborbital Program-3 to provide launch services for the Deep Space Climate Observatory mission and the Space Test Program-2 mission.

Satellite Operations

The Air Force Satellite Control Network, the Command's satellite command and control capability, enables critical missile warning, surveillance, weather and communications for our Joint warfighters. In 2012, Joint and allied space professionals used the network to conduct an average of 427 satellite contacts per day with a 99.37 percent contact success rate. They supported 13 National Security Space launches and 19 space vehicle emergencies. On September 21, 2012 they accomplished a record 527 satellite contacts in a single day. Over the last 2 years the network successfully conducted over 316,000 supports—this was the busiest 2 years in its 50-year operational history.

In addition to this busy operations tempo, we upgraded the legacy electronics for the remote tracking station at Guam, modernizing our satellite control capability in

the Pacific. Similar upgrades are in progress at the Hawaii remote tracking station, and upgrades will begin in 2013 at the New Hampshire remote tracking station. In the future, we will transition to a modern, secure internet protocol-based architecture, and we are examining the potential of commercial augmentation of our network.

U.S. Nuclear Detonation Detection System

In a Joint effort with the Department of Energy and Department of State, many Air Force satellites have hosted sensors supporting detection, location and reporting of nuclear detonations in support of warfighter needs and treaty verification requirements. We will continue to support our partners, and I am confident we can jointly determine how to maximize our limited resources while still satisfying the requirements for these sensors.

FIELD RESILIENT, INTEGRATED SYSTEMS THAT PRESERVE THE OPERATIONAL ADVANTAGE

Resilient Architectures

Our satellites provide a strategic advantage for the United States, and as such, we must consider the vulnerabilities and resilience of our constellations. My staff at Headquarters Air Force Space Command, alongside the team at the Space and Missile Systems Center, is leading efforts at balancing resilience with affordability. They are examining disaggregated concepts and evaluating options associated with separating tactical and strategic capability in the missile warning and protected communications mission areas. We are also evaluating constructs to utilize hosted payload and commercial services, as well as methods to on-ramp essential technology improvements to our existing architectures. For example, we are learning lessons on how to make hosted payloads a realistic option through the Commercially Hosted InfraRed Payload Program, which is a pathfinder asset on orbit today. Beyond the necessity of finding efficiencies and cost savings, we may very well find that disaggregated or dispersed constellations of satellites will yield greater survivability, robustness and resilience in light of environmental and adversarial threats.

Electromagnetic Spectrum

Peacetime and warfighting operations are enabled via employment of a wide variety of advanced wireless systems, including satellites, aircraft, remotely piloted vehicles, land mobile radios, radars, data links and precision guided munitions. The Air Force Spectrum Management Office, led by Colonel Donald Reese, is tasked with preserving electromagnetic spectrum access for Air Force and selected Department of Defense activities and systems. Their efforts have been crucial to our ability to provide support using a variety of airborne and space-borne platforms to users across the globe.

The global and economic demand for this finite resource is continually increasing. In this environment, we strive to assure access for spectrum-dependent military systems and to maintain over 30,000 frequency assignments essential to Service and Joint operations, testing and training. We also support efforts to implement Presidential direction to identify available spectrum for broadband wireless services while protecting vital Air Force capabilities. We are working closely with other Federal agencies to implement actions to protect and advance U.S. and Air Force spectrum interests.

PROVIDE HIGHLY-SKILLED AND INNOVATIVE SPACE AND CYBERSPACE PROFESSIONALS

Air Force space and cyberspace professionals are the backbone of our success. They provide expertise and innovation for current and expanding missions. To ensure deliberate development of this expertise, the Command manages the Air Force Space and Cyberspace Professional Development Programs for all Air Force specialties. These programs ensure we are providing a well-educated space and cyberspace cadre to units worldwide.

A highlight of my year was presiding over the opening of the Moorman Space Education and Training Center at Peterson Air Force Base, CO. On September, 13, 2012, the Center was dedicated in honor of General (Retired) Thomas S. Moorman, Jr., a champion of space professional development. The opening of this center enhances the training provided to the more than 2,500 space professional students from across the Services and allied nations each year. These students receive specialized space system training and professional continuing education at the Advanced Space Operations School and the National Security Space Institute.

Given the technical nature of the space and cyberspace domains, it is essential we have Science, Technology, Engineering, and Math (STEM)-educated people in our units. We are strengthening our education requirements in space and cyber-

space, but we realize we compete with decreasing numbers of STEM graduates, a national security problem in its broadest sense. Therefore, we are actively promoting the benefits of STEM degrees, starting with elementary school and continuing through the entire educational process. As an example, our cyberspace professionals in 24th Air Force, under the leadership of their commander, Maj. Gen. Suzanne Vautrinot, mentor local teams competing in CyberPatriot, a national high school cyber defense competition created by the Air Force Association. In Colorado, Peterson Air Force Base and Buckley Air Force Base have both applied for acceptance into the STARBASE program, a Department of Defense program exposing youth to technological environments and appropriate role models. We believe our investment today in young people is a cornerstone for our success in the future.

CONCLUSION

The men and women of Air Force Space Command accomplish our mission through a combination of innovation, passion and courage. They are the core of America's space and cyberspace team operating in domains that span the globe. Our single focus endures: providing the best capability possible to ensure success on the battlefield. The joint warfighter demands it, and the Nation expects nothing less, and therefore, Air Force Space Command remains steadfast in delivering game-changing space and cyberspace forces.

However, we face a new, daunting challenge: providing these foundational capabilities in an environment of sequestration. The very rigid mechanics of the Budget Control Act of 2011 force us into corners, rather than giving us needed flexibility to accommodate current and future budget reductions. In my Command alone, I had to find $508 million in fiscal year 2013 reductions beginning March 1, 2013. The chaos created in my Command by operations and maintenance reductions this large, in this short time period, can't be overstated. It starts with the justifiable angst of my civilian workforce, facing the prospect of a significant pay cut starting in June for the remainder of the fiscal year. AFSPC Headquarters support contracts have been reduced by 50 percent, which means lost jobs and reduced staff technical expertise. Operationally, two missile warning radars will not operate at full capacity for the rest of the year, one of which is key to our missile defenses. A unique space surveillance system's coverage will be reduced by one-third, compounding the loss of space surveillance data normally collected by the aforementioned radars we've been forced to scale back. These are not operational decisions arrived at lightly; the so-called "easy" reductions were taken in previous years. We've minimized overall operational impacts as much as possible, but the rigidity in the law dictates we must cut every appropriated line item in our budget, severely restricting our trade space. I strongly ask for your support for the reprogramming actions that will be needed to enable smarter decisions.

I am truly privileged to lead this great Command and I appreciate the opportunity to represent Air Force Space Command before this committee.

Senator UDALL. Thank you, General Shelton.

We will next hear from Lieutenant General Richard P. Formica, Commander of U.S. Army Space and Missile Defense Command, USA, and Army Forces Strategic Command General, thank you for being here today.

Senator SESSIONS. Mr. Chairman, could I just add my welcome to General Formica? He does a great job in Huntsville at the Space and Missile Defense Command, and we are proud of his work. We look forward to hearing from you, General Formica.

STATEMENT OF LTG RICHARD P. FORMICA, USA, COMMANDER, U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND/ARMY FORCES STRATEGIC COMMAND

General FORMICA. Thank you, Senator.

Chairman Udall, Ranking Member Sessions, Senator Fischer, it is an honor and a privilege for me to appear here as the Commander of Space and Missile Defense Command and as a soldier in the U.S. Army. I want to thank you for your ongoing support of our soldiers, civilians, and families.

Today, I will reinforce the Army's enduring need of space capabilities, recognizing that they come during the present environment of declining resources. Space capabilities are and will remain critical to the Army as it conducts unified land operations, and they have been appropriately prioritized by headquarters Department of the Army. Nonetheless, fiscal uncertainties resulting from sequestration will impact our ability to provide space-based capabilities to the warfighter. It has also impacted our professional civilian workforce.

Space is essential to the Army. It is the ultimate high ground. Within DOD, the Army is the biggest user of space capabilities and is also a provider of space-based capabilities.

Our command at U.S. Army Space and Missile Defense Command contributes space capabilities to the joint force through three core tasks: (1) to provide trained and ready space and missile defense forces and capabilities today; (2) to build future space and missile defense forces and capabilities for tomorrow; and (3) to provide space missile defense and other related technologies like the nanosat technology that you referred to in your opening statement, Mr. Chairman, for the day after tomorrow.

Your committee's continued support of our Army and its space program is essential in maintaining and improving our space capabilities and the development of our cadre of space professionals.

I look forward to addressing any of your questions. Army Strong!

[The prepared statement of General Formica follows:]

PREAPRED STATEMENT BY LTG RICHARD P. FORMICA, USA

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 third appearance before this subcommittee; I appreciate the opportunity to testify again. Thank you for being strong advocates of the Army and the key capabilities that space affords our warfighters. Your past and future support is important as we pursue joint efforts to provide critical space capabilities for our Nation, our fighting forces, and our allies.

My role has not changed since my previous subcommittee appearances. I still have three distinct responsibilities in support of our warfighters. 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, I am the Army Service Component Commander (ASCC) to the U.S. Strategic Command (STRATCOM), or Commander, Army Forces Strategic Command. I am responsible for planning, integrating, and coordinating Army space and missile defense forces and capabilities in support of STRATCOM missions. Third, I serve as the Commander of STRATCOM's Joint Functional Component Command for Integrated Missile Defense (JFCC IMD), enabling me to leverage the capabilities and skill sets of the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) in a broader, joint environment.

In my role here today as the Commander of USASMDC/ARSTRAT, I am again honored to testify with this distinguished panel of witnesses—all providers of critical space capabilities to the warfighter and essential contributors to the Nation's continued advances to effectively leverage the capabilities derived from space and space-based assets.

Within the Army, space operations and space-related activities are pursued as an enterprise. While not the exclusive domain of USASMDC/ARSTRAT, the Army has assigned USASMDC/ARSTRAT as the Army's proponent for space. In this role, we coordinate with the other members of the Army space enterprise, to include the Army intelligence, signal, and geospatial communities. We are increasingly 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 mitigated to the greatest extent possible. We also collaborate with STRATCOM and its Joint Functional Component Command for Space (JFCC Space) and other members of the joint community to provide trained and ready space forces, 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.

Within the space arena, USASMDC/ARSTRAT continues to strive to provide space capabilities through our three core tasks:

- To provide trained and ready space forces and capabilities to the warfighter and the Nation—our operations function that addresses today's requirements.
- To build future space forces—our capability development function that is responsible for meeting tomorrow's requirements.
- To research, test, and integrate space and space-related technologies—our materiel development function that aims to advance the Army's and warfighter's use of space the day-after-tomorrow.

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

During my 2011 appearance before this subcommittee, my desire was threefold: to outline the Army as a user of space capabilities; to articulate the Army's space strategy and policy; and to inform the committee about the Army as a provider of space capabilities. Last year, I sought to further address the absolute necessity of space-based capabilities for our warfighters and to expand upon the above three core space tasks that our soldiers, civilians, and contractors diligently execute each and every day. This year, I would like to impress upon the subcommittee the need to ensure our space capabilities are maintained, if not further enhanced, despite the present environment of declining resources and increasing threats. We are facing the impacts of the current fiscal situation on our budget. The Army has our highest priority requirements. We will continue to monitor the impact on readiness as a result of sequestration.

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 professional cadre of space professionals to support our Army.

The ongoing fiscal uncertainties and the impacts of sequestration to the USASMDC/ARSTRAT Civilian workforce continue to cause concern for me and angst in the workforce. I have three concerns. First, I am concerned about the impact of a potential furlough, which has caused angst, impacted morale, and is expected to place personal hardships on much of the workforce. Second, the civilian hiring freeze is creating vacancies in the workforce. This impacts our ability to build our bench and will have longer-term impacts on the ability to provide space capabilities to the warfighter. Third, the elimination of our temporary and term employees, some of which are our future engineers, is impacting the next generation of Civilian professionals. We will work to mitigate these issues and reduce their impact on our ability to provide capabilities to the warfighter.

RELIANCE ON SPACE-BASED CAPABILITIES

As I reported during previous appearances, our Army must be organized, trained, and equipped to provide responsive and sustained combat operations in order to fight as a joint team and to respond, as directed, to crises at home and abroad. The Army is dependent on space capabilities to execute unified land operations in support of the combatant commanders' objectives. Army space forces contribute to the joint and 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 Operating Concept identifies six 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.

Army Space Capabilities are Combat Multipliers that Enable All Six Warfighting Functions

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 a potentially reduced forward presence. The bottom line is that we, as an Army, depend on space capabilities in everything we do. Retaining our global space superiority is a military imperative—there is no going back.

SPACE IN SUPPORT OF ARMY WARFIGHTING FUNCTIONS

While the Army is the largest DOD user of space, we are also a provider of space-based capabilities. There are five space force enhancement mission areas: satellite communications (SATCOM); position, navigation, and timing (PNT); intelligence, surveillance, and reconnaissance (ISR); missile warning (MW); and 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. Army and joint 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. STRATCOM 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 seamlessly integrated 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

In 2014, in this era of tight fiscal constraints, the Army plans to sustain the investment made in systems and people in pursuing space and space-related activities. As outlined in the Army's Space Strategy, our plans are to continue to evolve from a position of simply exploiting strategic space-based capabilities to one where the Army is fully engaged in the planning, development, and use of theater-focused operational and tactical space applications.

TODAY'S OPERATIONS—PROVIDE TRAINED AND READY SPACE FORCES AND 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 via access to space-based products and services that are essential in all phases of combat operations. The Brigade, a multi-component organization comprised of Active, National Guard, and U.S. Army Reserve 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-deployed space support teams.

Within the Army, space professional personnel management 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) develops policies, procedures, and metrics for the Army Space Cadre and executes the life-cycle management functions of Functional Area (FA) 40 Space Operations Offi-

cers. The Army's Space Cadre, utilizing FA 40s as its foundation, is comprised of over 2,800 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 Army and joint commands and 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, integrating, and operating space forces, systems, concepts, applications, and capabilities in any element of the DOD space mission areas. In general, they bring our Nation's space capabilities to combatant commanders to help them achieve their strategic, operational, and tactical objectives. During the past year, USASMDC/ARSTRAT space professionals have supported 16 major exercises, 3 mission rehearsal exercises for deploying units in support of Operation Enduring Freedom, and 17 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 commanders, other Services, joint task forces, and multinational forces. The teams, which have a continuous deployed 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. Over the past year, USASMDC/ARSTRAT deployed eight Army Space Support Teams and Commercial Imagery Teams to the U.S. Central Command's area of operation. Since the era of persistent conflict began, we have deployed teams on 78 occasions. In summary, these teams bring tailored products and capabilities that meet critical theater commander's 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 role in satellite communications (SATCOM) is to link tactical warfighter networks to the DOD Information Network primarily through the successful execution of the following tasks:

- Conducting payload operations and transmission control of the Defense Satellite Communications (DSCS) and Wideband Global SATCOM System (WGS) constellations. Transmission control for more than 97 percent of the DOD-owned SATCOM bandwidth is provided by Army operators controlling the payloads on these satellites.
- Serving as the consolidated SATCOM System Expert for the DOD narrowband and wideband SATCOM constellations which includes 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. Additionally, the Army has a significant role and assigned responsibilities in DOD's expanding use of military satellite communications on the WGS through a number of growing programs and initiatives. The Army is also the operational lead for multiple WGS international partnerships.
- Manning and operating the Wideband Satellite Communications Operations Centers (WSOCs) and the Regional Satellite Communications Support Centers (RSSCs). The satellite communications 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. Over the past year, we completed necessary modernization and replacement of aging antennas and terminal equipment of two WSOCs—one in Hawaii and the other in Maryland. Mod-

ernization and equipment replacement was required so that the centers were compatible with the fleet of new and expanding WGS assets being deployed by the Air Force. Construction of the final WSOC in Germany has been delayed while resolution of a permit issue is pursued with the host country. We now project construction to begin late this calendar year.

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 (PNT) information to enable confident, decisive maneuver by both ground and air assets. Accurate PNT data is also required for increased accuracy for weapons systems and precision munitions. The DOD's Friendly Force Tracking Mission Management Center, operated by USASMDC/ARSTRAT from Peterson Air Force Base, CO, interprets more than one and a half million location tracks a day to provide a common operating picture to command posts and operations centers. This capability, performed on behalf of STRATCOM, 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 the 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 enemy missile launch activity and other infrared events of interest and share the 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, as a member of the Army's intelligence community, provides geospatial intelligence production in direct support of the combatant commands, as an operational element of the Army National-To-Theater Program and member of the National System for Geospatial Intelligence. The Army's space and intelligence experts perform exploitation of 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. A few of the recent operational imagery support services provided by our GEOINT professionals include assistance to U.S. Northern Command during last summer's Colorado Springs fires and support to U.S. Army North in the intelligence training provided to the Mexican Army. Since my last appearance before this subcommittee, our GEOINT professionals were recognized by the Defense Intelligence Agency for their outstanding homeland border security support over the past 5 years.

Operations Reach-back Support and Services:

Our Colorado Springs, Colorado Operations Center continues to provide daily reach-back support for our space experts deployed throughout the operational force and enables us 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.

Tactical Exploitation of National Capabilities:

The Army Special Programs Office, under the direction of the assistant Secretary of the Army for Acquisition, Logistics, and Technology, is the Army's focal point for the exploitation of national intelligence, surveillance, and reconnaissance assets and products through the Tactical Exploitation of National Capabilities program. The Army continues to be fully integrated into the National Reconnaissance Office and the broader Intelligence Community.

Strategic Space Surveillance:

The Army also operates facilities and assets that are of utmost importance to protecting the Nation's use of space. The U.S. Army Kwajalein Atoll/Reagan Test Site, located in the Marshall Islands, is a national asset that provides unique radars and sensors that contribute to STRATCOM'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 readiness testing, ballistic missile defense testing, and is ideally located to provide equatorial launch benefits.

ADDRESSING TOMORROW'S REQUIREMENTS—BUILDING FUTURE SPACE FORCES

Over the past 2 decades, Army operations have transitioned from being "supported" by space capabilities to being truly "enabled" by them—space capabilities are an integral part in conducting 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 Army and joint 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. Assuring 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 continue to make certain that our Army does not face a day without space and space-related capabilities and that the Army is prepared to conduct operations in a space-degraded environment.

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

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 Army, joint, and coalition requirements. This regimented approach helps ensure limited resources are applied where warfighter operational utility is most effectively served. The approach enhances our pursuit and development of necessary capabilities across Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF) domains to mitigate 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 the space related DOTMLPF alternatives and solutions.

Preparing Today's Warfighter for the Challenges of Tomorrow

In 2011, the Chief of Staff of the Army approved the Army's Space Strategic 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. In April 2012, the Army Space White Paper was published—it serves as an integrated implementation plan of the Army's Space Strategic Plan.

The essence of our space strategy and the guiding vision of the Army space enterprise are to ensure access to resilient and relevant space-enabled capabilities to Army forces conducting unified land operations. 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.
- To pursue cross-domain solutions to create a resilient architecture to mitigate threats, vulnerabilities, and assure access to critical capabilities needed to sustain land force operations.

To achieve the three tenets, the Army developed the Space Operations Officer Qualification Course and the Army Space Cadre Basic Course to provide a foundation in properly training our space professionals. We also conduct space training via resident, mobile training teams, and distributed learning venues to support initial skills and qualification training, leader development, lifelong learning, and professional development in support of life cycle management. During the past year, USASMDC/ARSTRAT conducted approximately 160 space courses that provided about 5,500 soldiers and civilians essential space training. The Army continues to leverage the high-quality space training developed and administrated by the Air Force. In addition, each year, numerous space officers complete additional post-graduate studies at the Naval Postgraduate School, accredited civilian institutions, and training with industry. Finally, in conjunction with the Army Space Strategy Imple-

mentation Plan, we continue to incorporate space knowledge and leader development training into all Army schools. The Army remains committed to growing, training, developing, tutoring, advancing, and retaining space professionals. With the current fiscal constraints, we are concerned that essential space training will not maintain the necessary resources during the coming year and capabilities of tomorrow will suffer.

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 that 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 on capabilities that have great potential to 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.

Last year, I highlighted three responsive space Joint Capability Technology Demonstration (JCTD) Program efforts that have the potential to provide enhanced space capabilities to ground commanders and warfighters. Since last year, there has been much progress in these three space technology endeavors and I would like to provide you an update of these initiatives.

SMDC Nanosatellite Program-3 (SNaP–3):

Future constellations of relatively low cost nanosatellites, estimated to be approximately $300,000 each, 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 three of these small satellites to provide dedicated coverage to a wide range of underserved 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.

A Core Task—Provide Greater Capabilities to Future Warfighters

Kestrel Eye Visible Imagery Nanosatellite:

New technologies are enabling the production of low-cost nanosatellites which have ever increasing military utility. Kestrel Eye, an OSD-approved JCTD, is an endeavor to manufacture and fly three electro-optical near-nanosatellite-class imagery satellites that can be tasked directly by the tactical ground component warfighter. 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. At the production mode cost of approximately $1 million per spacecraft, the intent of this program is to demonstrate a small, tactical space-based imagery nanosatellite that could be propagated in large numbers to provide a cost effective, persistent capability to ground forces. Each satellite would have an operational life of greater than 2 years in low earth orbit. The initial Kestrel Eye launch is scheduled for next year.

Soldier-Warfighter Operationally Responsive Deployer for Space (SWORDS):

Concurrent with the shrinking size and reduced cost of militarily useful satellites is the need for an economical launch system. 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 non-exotic materials to provide launch for small weight payloads to low earth orbit for about $1 million per launch vehicle. SWORDS employs a very simple design, using commercial off-the-shelf hardware from outside the aerospace industry. It incorporates a benign bipropellant liquid propulsion system, and uses simple and low cost launch support and launch site hardware. SWORDS represents a game-changing approach to launch vehicle design and operations that holds great promise not only for the Army

tactical space enterprise, but for the civil and commercial space sectors launching small payloads into low earth orbit. In fact, we are partnering with NASA for development of the SWORDS initiative. The initial suborbital launch is scheduled for next year.

CONCLUSION

The Army is the largest user of space and space-based capabilities. As such, USASMDC/ARSTRAT is actively engaged in organizing, manning, equipping, and training space forces for the Army. We also, by working with organizations both internal and external to the Army, continue to develop and enhance technology to provide our warfighters 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. Our use of and reliance on space is integral and absolutely critical to the Army's successful defense of this Nation. We will have challenges ahead as we determine the best courses of action to implement DOD and Army budget guidance. In adapting to the budget realities, space capabilities will become even more critical to enabling adaptive Army missions.

Space—The Ultimate High Ground

Invariably, discussions regarding space focus on the technology. The most critical space asset we possess are the dedicated soldiers, sailors, airmen, marines, and civilian space professionals who develop, field, and operate that technology and deliver its capabilities to the warfighter. Just as other Army and other Services personnel, 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 and Army Strong!

Senator UDALL. Thank you, General.

We now turn to Ms. Cristina T. Chaplain, who is the Director, Acquisition and Sourcing Management, at the GAO.

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

Ms. CHAPLAIN. Thank you, Chairman Udall, Ranking Member Sessions, and Senator Fischer. I am pleased to be here today to talk about our work regarding space acquisitions.

The noteworthy thing is that our work continues to affirm that DOD is reducing acquisition risk on its satellite acquisitions. Cost growth is definitely less widespread. This is a very critical achievement in this time of constrained budgets to be reducing unnecessary cost growth, in my view.

We still have concerns about the systems and programs that support satellites. I wanted to highlight three of them today. They are also highlighted in my testimony in more detail.

First, we are still reporting gaps, adding up to years in some cases, between the time satellites are launched and the time ground systems and user equipment are delivered. That is really an issue because it could lead to waste of expensive space-based capability.

Second, we reported just last week that the networks that control and maintain satellites need to be streamlined and brought up to today's modern technology and practices. DOD concurred with these findings and recommendations.

Third, the rising cost of launching satellites is still an issue. We performed an analysis this year that showed about $46 billion is predicted to be spent over the next 5 years by the whole Federal

Government on launching satellites. Competition is key to reducing costs, but we will not know for several years whether there will actually be viable competitors. There is a long process they need to go through, and there are still unknowns about the outcome of that process. So it is something we will be watching.

Those are the three concerns I wanted to point out today. Again, they are highlighted more in my statement. I am happy to answer questions about them and anything else today.

[The prepared statement of Ms. Chaplain follows:]

PREPARED STATEMENT BY MS. CRISTINA T. CHAPLAIN

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.[1] Each year, DOD spends billions of dollars to acquire space-related capabilities that support military and other government operations—such as intelligence, reconnaissance and surveillance; communications; and homeland security—and to enable transformation of the way DOD collects and disseminates information. A single military satellite can cost more than $3 billion to acquire and more than $100 million to launch into orbit. Complementary systems, such as ground control software, can also cost billions. Given the expensive nature of space systems and today's fiscal environment, it is essential that DOD carefully manage these programs, apply best practices, and continually assess ways to reduce costs while maintaining a high degree of reliability and innovation.

This has not always been the case. Over the last decade, the majority of DOD's space acquisition programs were characterized by significant cost and schedule growth; new programs were canceled in the face of affordability concerns and other problems. In 2012, GAO reported that the worst of those space systems acquisition problems now appear to be behind the department.[2] Satellites long plagued by serious cost and schedule overruns are being launched. While new space systems acquisition programs are facing potential cost growth and schedule slips, they are not as widespread and significant as they were several years ago. Also, to its credit, DOD has taken an array of actions to reduce risks and strengthen leadership. However, the Department still faces serious challenges, such as the high cost of launching satellites, fragmented satellite control operations, as well as disconnects between fielding satellites and synchronizing ground systems.

My testimony today will focus on: (1) the current status and cost of DOD space systems acquisitions; (2) the results of GAO's space system-related reviews this past year; and (3) recent actions taken to address acquisition problems. This testimony is based on GAO reports issued over the past 5 years on space programs and weapon system acquisition best practices.[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.[4] 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 2012 through 2017 and interviewed officials from the Office of the Secretary of Defense. More information on our scope and methodology is available in our previously-issued reports. 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 conclu-

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[1] DOD space systems include space-based systems (satellites); ground based systems (command and control (C2), launch C2, processing stations, space surveillance stations); satellite launch vehicle systems (boosters, upper-stages, payload processing facilities, space launch facilities, ground support equipment), and user equipment (hand-held user terminals, data reception terminals, user terminals).

[2] GAO, DOD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements, GAO–12–563T (Washington, DC: Mar. 21, 2012).

[3] See GAO related reports at the end of this statement.

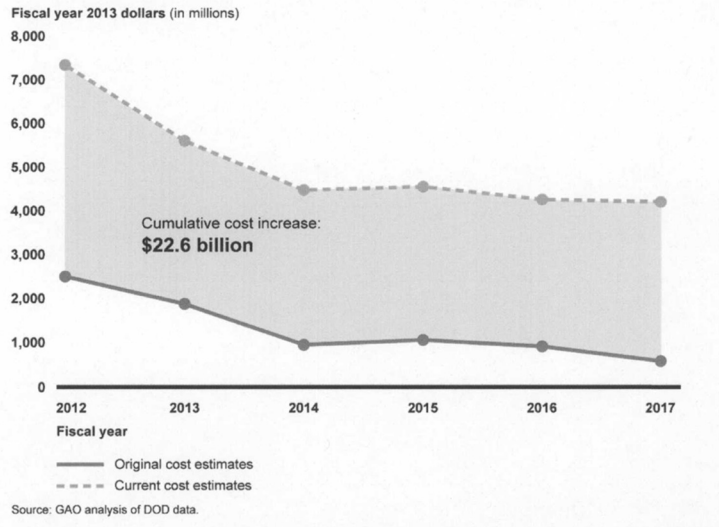
[4] GAO, Defense Acquisitions: Assessments of Selected Weapon Programs, GAO–13–294SP (Washington, DC: Mar. 28, 2013); 2013 Annual Report: Actions Needed to Reduce Fragmentation, Overlap, and Duplication and Achieve Other Financial Benefits, GAO–13–279SP (Washington, DC: Apr. 9, 2013); and 2012 Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue, GAO–12–342SP (Washington, DC: Feb. 28, 2012).

sions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

BACKGROUND

DOD has a long history of troubled space systems acquisitions. Over the past decade, most of the large DOD space systems acquisition programs collectively experienced billions of dollars in cost increases and delayed schedules. In particular, a longstanding problem in DOD space systems acquisitions is that program costs have tended to go up significantly from initial cost estimates. As shown in figure 1, estimated costs for selected major space systems acquisition programs have increased by about $22.6 billion—nearly 230 percent—from fiscal years 2012 through 2017. Figure 1: Comparison between Original Cost Estimates and Current Cost Estimates for Selected Major Space Systems Acquisition Programs for fiscal years 2012 through 2017.

Figure 1: Comparison between Original Cost Estimates and Current Cost Estimates for Selected Major Space Systems Acquisition Programs for Fiscal Years 2012 through 2017



Source: GAO analysis of DOD data.

Note: Includes estimates for acquisition programs related to Advanced Extremely High Frequency, Evolved Expendable Launch Vehicle, Global Broadcast System, Global Positioning System II and III, Global Positioning System Operational Control System, Mobile User Objective System, Space Based Infrared System, and Wideband Global SATCOM. This chart does not include estimates for planned new space systems acquisition efforts such as Weather Satellite Follow-on, Joint Space Operations Center Mission System, Precision Tracking Space System, Space Based Space Surveillance Follow-on, and Space Fence for which total cost data were unavailable.

The gap between original and current estimates shows that DOD has fewer dollars available to invest in new programs or add to existing ones. DOD's overall level of investment over the 5-year period decreases until fiscal year 2014, at which point it levels off. The declining investment in the later years is the result of mature programs that have planned lower out-year funding, cancellation of a major space systems acquisition program and several development efforts, and the exclusion of several space systems acquisition efforts for which total cost data were unavailable. These efforts include the Joint Space Operations Center Mission System (JMS), Space Fence, Space Based Space Surveillance (SBSS) Follow-on, Precision Tracking Space System (PTSS), and Weather Satellite Follow-on.

We have previously reported that programs have experienced cost increases and schedule delays that have resulted in potential capability gaps in missile warning,

military communications, and weather monitoring.[5] For instance, unit costs for one of the most troubled programs, the Space Based Infrared System (SBIRS) have climbed about 230 percent to over $3 billion per satellite, with the launch of the first satellite about 9 years later than predicted. Similarly, 8 years after a development contract for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program was awarded in 2002, the cost estimate had more than doubled—to about $15 billion, launch dates had been delayed by over 5 years, significant functionality had been removed from the program, and the program's triagency management structure had proven to be ineffective. In February 2010, it was announced that the National Oceanic and Atmospheric Agency (NOAA) and DOD would no longer jointly procure the NPOESS satellite system and, instead, each agency would undertake separate acquisitions. Consequently, the risks of gaps in weather satellite monitoring data have increased. Other programs, such as the Transformational Satellite Communications System, were canceled several years earlier because they were found to be too ambitious and not affordable at a time when the DOD was struggling to address critical acquisition problems elsewhere in the space systems portfolio.

Our past work has identified a number of causes of acquisition problems, but several consistently stand out. At a higher level, DOD tended to start more weapon programs than was affordable, creating a competition for funding that focused on advocacy at the expense of realism and sound management. DOD also tended to start its space systems programs before it had the assurance that the capabilities it was pursuing could be achieved within available resources and time constraints. For example, when critical technologies planned for a satellite system are still in relatively early stages of discovery and invention, there is no way to accurately estimate how long it would take to design, develop, and build the system. Finally, programs typically 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 stretched technology challenges beyond current capabilities in some cases. In the past, funding instability, poor contractor oversight, and relaxed quality standards have also contributed to acquisition problems.

We have also reported 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.[6] Past studies and reviews have found that responsibilities for acquiring space systems are diffused across various DOD organizations, even though many of the larger programs, such as the Global Positioning System (GPS) and those to acquire imagery and environmental satellites, are integral to the execution of multiple agencies' missions. We reported that with multiagency space programs, success is often only possible with cooperation and coordination; however, successful and productive coordination appears to be the exception and not the rule. This fragmentation is problematic not only because of a lack of coordination that has led to delays in fielding systems, but 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.

Over the past 5 years, 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 newer satellite acquisition efforts, DOD has attempted to incorporate lessons learned from its experiences with earlier efforts. For example, the GPS III program, which began product development in 2008, is using a "back to basics" approach, emphasizing rigorous systems engineering, use of military specifications and standards, and an in-

[5] GAO, Space Acquisitions: DOD Poised to Enhance Space Capabilities but, Persistent Challenges Remain in Developing Space Systems, GAO–10–447T (Washington, DC: Mar. 10, 2010).

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

cremental approach to providing capability. Thus far, the work performed on the development of the first two satellites is costing more than expected—but not on the scale of earlier programs—and its schedule remains on track efforts. For example, the GPS III program, which began product development in 2008, is using a "back to basics" approach, emphasizing rigorous systems engineering, use of military specifications and standards, and an incremental approach to providing capability. Thus far, the work performed on the development of the first two satellites is costing more than expected—but not on the scale of earlier programs—and its schedule remains on track efforts. For example, the GPS III program, which began product development in 2008, is using a "back to basics" approach, emphasizing rigorous systems engineering, use of military specifications and standards, and an incremental approach to providing capability. Thus far, the work performed on the development of the first two satellites is costing more than expected—but not on the scale of earlier programs—and its schedule remains on track.[7]

Our prior testimonies have cited an array of actions as well.[8] For instance, the Office of the Secretary of Defense created a new office under the Undersecretary of Defense for Acquisition, Technology and Logistics to oversee all major DOD space and intelligence related acquisitions and it began applying its broader weapon system acquisition policy (DOD Instruction 5000.02, Operation of the Defense Acquisition System (Dec. 8, 2008)) to space systems, instead of allowing a tailored policy for space that enabled DOD to commit to major investments before knowing what resources will be required to deliver promised capability.[9] Among other initiatives, the Air Force undertook efforts to improve cost estimating and revitalize its acquisition workforce and program management assistance programs. Further, in 2009, for major weapons programs, Congress enacted the Weapon Systems Acquisition Reform Act of 2009, which required greater emphasis on front-end planning and, for example, refining concepts through early systems engineering, strengthening cost estimating, building prototypes, holding early milestone reviews, and developing preliminary designs before starting system development.

THE CURRENT STATUS AND COST OF SPACE SYSTEMS ACQUISITIONS

Most of DOD's major satellite programs are in mature phases of acquisition and cost and schedule growth is not as widespread as it was in prior years. However, the satellites, ground systems, and user terminals are not optimally aligned and the cost of launching satellites continues to be expensive.

Most of DOD's major satellite programs are in mature phases of acquisition, that is, the initial satellites have been designed, fabricated and launched into orbit while additional satellites of the same design are being produced. Only two major satellite programs are in earlier phases of acquisition—the GPS III program and the PTSS program. For the portfolio of major satellite programs, new cost and schedule growth is not as widespread as it was in prior years, but DOD is still experiencing problems in these programs. For example, though the first two SBIRS satellites have launched, program officials are predicting a 14 month delay on the production of the third and fourth geosynchronous earth orbit (GEO) satellites due in part to technical challenges, parts obsolescence, and test failures. As we reported in March 2013, program officials are predicting about a $440 million cost overrun for these satellites.[10] Also, the work performed to date for development of the first two GPS III satellites continues to cost more than DOD expected. Since the program entered system development, total program costs have increased approximately $180 million. The GPS III program office has attributed this to a variety of factors, such as inefficiencies in the development of the satellite bus and the navigation payload.[11]

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[7] Air Force officials recently stated that, although GPS III is still maintaining an April 2014 "available for launch" date for the first satellite, the Air Force delayed the launch of the first GPS III space vehicle by a year in order to synchronize it with the availability of the GPS Operational Control Segment (OCX) Block 0, without which the satellites cannot be launched and checked out.

[8] GAO, Space Acquisitions: DOD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements, GAO–12–563T (Washington, DC: Mar. 21, 2012); and Space Acquisitions: DOD Delivering New Generations of Satellites, but Space System Acquisition Challenges Remain, GAO–11–590T (Washington, DC: May 11, 2011).

[9] DOD Instruction 5000.02, Operation of the Defense Acquisition System (2008).

[10] GAO, Defense Acquisitions: Assessments of Selected Weapon Programs, GAO–13–294SP (Washington, DC: March 28, 2013).

[11] Every satellite has a bus and payload. The bus is the body of the satellite. It carries the payload and is composed of a number of subsystems, like the power supply, antennas, telemetry and tracking command, and mechanical and thermal control subsystems. The bus also provides electrical power, stability, and propulsion for the entire satellite. The payload—carried by the

Program officials stated that the cost growth was partially due to the program's use of a back to basics approach, which they stated shifted costs to earlier in the acquisition as a result of more stringent parts and materials requirements. They anticipate these requirements will result in fewer problems later in the acquisition.

Table 1 describes the status of the satellite programs we have been tracking in more detail.

Table 1: Status and Cost of Selected Satellite Programs

Program (mission)	Program details
Advanced Extremely High Frequency (AEHF) (satellite communications)	Original total program cost: $6.3 billion Current total program cost: $14.1 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 is scheduled for fall of 2013, and 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: $4.2 billion Quantity: 8 Schedule: First launch is anticipated in 2015. GPS is a constellation of multiple generations of GPS satellites that provide global positioning, navigation, and timing capability to both military and civil users worldwide.
Mobile User Objective System (MUOS) (satellite communications)	Original total program cost: $6.9 billion Current total program cost: $7.3 billion Quantity: 6 Schedule: The first satellite was launched in February 2012—26 months later than planned at development start. The second satellite is scheduled to be launched in July 2013. 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) (infrared intelligence, surveillance, and reconnaissance)	Original total program cost: $4.7 billion Current total program cost: $18.8 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. 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 will 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.

bus—includes all the devices a satellite needs to perform its mission, which differs for every type of satellite.

Precision Tracking Space System (PTSS) (ballistic missile defense)	Total program cost: Cost baseline not established. Quantity: 9 Schedule: The program planned to first launch two laboratory-built developmental satellites in March 2018 and then launch industry-built satellites, achieving the full satellite constellation no sooner than 2023. The Missile Defense Agency (MDA) is developing PTSS as an operational component of its Ballistic Missile Defense System to track ballistic missiles after boost and through the middle part of their flight. PTSS was recently proposed for termination in the President's 2014 budget submission based on schedule risk and cost associated with the concurrent acquisition strategy.
Weather Satellite Follow-on (WSF) (climate and weather monitoring)	Total program cost: Cost baseline not established. Quantity: Not established. Schedule: Schedule baseline not established. WSF is to replace the Defense Meteorological Satellite Program, which the Air Force uses to obtain environmental data that are processed to provide graphical weather images and specialized weather products.
Wideband Global SATCOM (WGS) (satellite communications)	Original program cost: $980 million Current total program cost: $3.9 billion Original quantity: 3 Current quantity: 10 Schedule: The first satellite was launched in October 2007, over 3 years later than estimated at program start. Currently, four satellites are in orbit and the fifth satellite is estimated to launch in May 2013. WGS is intended to provide 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 data and previous GAO reports.

Though satellite programs are not experiencing cost and schedule problems as widespread as in years past, we have reported that ground control systems and user terminals in most of DOD's major space systems acquisitions are not optimally aligned, leading to underutilized on-orbit satellite resources and limited capability provided to the warfighter.[12] For example:

- Over 90 percent of the MUOS's planned capability is dependent on the development of compatible user terminals. Although the first MUOS satellite was launched over a year ago, operational testing of MUOS with production-representative user terminals is not expected to occur until the second quarter of fiscal year 2014.
- The SBIRS program revised its delivery schedule of ground capabilities to add increments that will provide the warfighter some capabilities sooner than 2018, but complete and usable data from a critical sensor will not be available until about 7 years after the satellite is on orbit.
- The Family of Advanced Beyond Line-of-Sight Terminals (FAB–T) program, which is developing user terminals intended to communicate with AEHF satellites, has experienced numerous cost and schedule delays and is currently not synchronized with the AEHF program, which launched its second satellite last year while the FAB–T program has yet to deliver any capabilities. Current estimates show that FAB–T will reach initial operational capability for some requirements in 2019, about 5 years after AEHF is scheduled to reach its initial operational capability.
- GPS OCX is required for the launch of the first GPS III satellite because the existing ground control software is not compatible with the new GPS satellites. Realizing that the new ground control system would not be delivered in time to launch the first GPS III satellite, the Air Force added funding to the contract to accelerate development of the software that can launch and checkout the GPS III satellite, leaving the other capabilities—like the ability to command and control the satellite—to be delivered in late 2016. Subsequently, the launch of the first GPS III satellite has been delayed to May 2015 to better synchronize with the availability of the launch software.

Though there are inherent difficulties in aligning delivery of satellites, ground control systems, and user terminals, we reported in 2009 that the lack of synchronization between segments of space acquisition programs is largely the result of the same core issues that hamper acquisitions in general—requirements instability,

[12] GAO, Defense Acquisitions: Challenges in Aligning Space System Components, GAO–10–55 (Washington, DC: Oct. 29, 2009); Space Acquisitions: DOD Poised to Enhance Space Capabilities but, Persistent Challenges Remain in Developing Space Systems, GAO–10–447T (Washington, DC: Mar. 10, 2010); and GAO, Defense Acquisitions: Assessments of Selected Weapon Programs, GAO–13–294SP (Washington, DC: Mar. 28, 2013).

funding instability, insufficient technology maturity, underestimation of complexity, and poor contractor oversight, among other issues.[13] In addition, user terminals are not optimally aligned because of a lack of coordination and effective oversight over the many military organizations that either develop user terminals or have some hand in development. We recommended that the Secretary of Defense take a variety of actions to help ensure that DOD space systems provide more capability to the warfighter through better alignment and increased commonality, and to provide increased insight into ground asset costs. DOD generally agreed with these recommendations.

Another acquisition challenge facing DOD is the cost of launching satellites into space. DOD has benefited from a long string of successful launches, including three military and four intelligence community satellites this year. However, each launch can range from $100 million to over $200 million. Additional money is spent to support launch infrastructure. An analysis we performed this year showed that from fiscal years 2013 through 2017, the government can expect to spend approximately $46 billion on launch activities.[14] Meanwhile, we reported in prior years that too little was known about the factors that were behind cost and price increases.[15] The Air Force has developed a new launch acquisition strategy which includes a block buy approach for future launches. At the same time, it is implementing an effort to introduce new launch providers. Both efforts are designed to help lower costs for launch, but they face challenges, which are discussed further in the next section.

RECENT GAO FINDINGS RELATED TO SPACE SYSTEMS ACQUISITIONS

Over the past year, we have reported on DOD's progress in closing knowledge gaps in its new Evolved Expendable Launch Vehicle (EELV) acquisition strategy, DOD's efforts to introduce new launch providers, opportunities to help reduce satellite program costs, and the Air Force's satellite control operations and modernization efforts with comparisons to commercial practices. These reports further highlight the successes and challenges that have faced the space community as it has sought to mitigate rising costs and deliver modernized capabilities.

EELV Acquisition Strategy

We reported in September 2011 that DOD needed to ensure the new acquisition strategy was based on sufficient information, as there were significant uncertainties relating to the health of the launch industrial base, contractor cost or pricing data, mission assurance costs and activities, numbers of launch vehicles needed, and future engine prices which were expected to double or triple in the near term.[16] As a result, DOD was at risk of committing to an acquisition strategy-including an expensive, multi-billion dollar block buy of launch vehicle booster cores-before it had information essential to ensuring business decisions contained in the strategy were sound.[17] Among other things, we recommended DOD assess engine costs and mission assurance activities, reassess the length of the proposed block buy, and consider how to address broader launch acquisition and technology development issues. DOD generally concurred with the recommendations. The Air Force issued its new EELV acquisition strategy in November 2011. Following our review, the National Defense Authorization Act for Fiscal Year 2012 required that DOD report to congressional committees a description of how it implemented the recommendations contained in our report and for GAO to assess that information.[18]

We reported in July 2012, that DOD had numerous efforts in progress to address the knowledge gaps and data deficiencies identified in our September 2011 report, such as completing or obtaining independent cost estimates for two EELV engines

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[13] GAO, Defense Acquisitions: Challenges in Aligning Space System Components, GAO–10–55 (Washington, DC: Oct. 29, 2009).

[14] The $46 billion is based on the President's budget submission for fiscal year 2013. In June 2012, DOD estimated the total cost of the EELV program to be nearly $70 billion through 2030. This represents the costs incurred since the inception of the program in 1995. The Air Force is currently developing a new cost estimate that considers potentially lower contract prices resulting from future competition in the program.

[15] GAO, Evolved Expendable Launch Vehicle: DOD Is Addressing Knowledge Gaps in Its New Acquisition Strategy, GAO–12–822 (Washington, DC: July 26, 2012); and Evolved Expendable Launch Vehicle: DOD Needs to Ensure New Acquisition Strategy Is Based on Sufficient Information, GAO–11–641 (Washington, DC: Sept. 15, 2011).

[16] GAO, Evolved Expendable Launch Vehicle: DOD Needs to Ensure New Acquisition Strategy Is Based on Sufficient Information, GAO–11–641 (Washington, DC: Sept. 15, 2011).

[17] The booster core is the main body of a launch vehicle. In the EELV program, common booster cores are used to build all of the Atlas V and Delta IV launch vehicles. Medium and intermediate launch vehicles use one core each, while the Delta IV Heavy launch vehicle requires three.

[18] Pub. L No 112–81, § 839 (2011).

and completing a study of the liquid rocket engine industrial base.[19] We reported that officials from DOD, NASA, and NRO had initiated several assessments to obtain needed information, and had worked closely to finalize new launch provider certification criteria for national security space launches. However, we found that more action was needed to ensure that launch mission assurance activities were not excessive, to identify opportunities to leverage the government's buying power through increased efficiencies in launch acquisitions, and to strategically address longer-term technology investments. We reported that some information DOD was gathering could set the stage for longer-term strategic planning for the program, especially in critical launch technology research and development decisions and that investing in a longer-term perspective for launch acquisitions was important to fully leverage the government's buying power and maintain a healthy industrial base.

Launch Services New Entrant Certification Guide

In 2011, the Air Force, National Aeronautics and Space Administration (NASA), and National Reconnaissance Office (NRO) began implementing a coordinated strategy—called the Air Force Launch Services New Entrant Certification Guide (Guide)—to certify new entrants to provide launch capability on EELV-class launch vehicles. New entrants are launch companies that are working toward certifying their launch vehicle capabilities so that they may be allowed to compete with the current sole-source contractor for government launches. Launch vehicle certification is necessary to ensure that only proven, reliable launch vehicles will be used to launch government satellites. The House Armed Services Committee Report accompanying the National Defense Authorization Act for Fiscal Year 2013 directed GAO to review and analyze the implementation of the Guide.[20]

In February 2013, we reported that the Air Force based its Guide on existing NASA policy and procedures with respect to payload risk classification and launch vehicle certification.[21] We found that the Air Force, NASA, and NRO were working to coordinate and share information to facilitate launch vehicle certification efforts, but that each agency would determine for itself when certification had been achieved. As a result, some duplication and overlap of efforts could occur. We also found that the Air Force had added other prerequisites to certification for new entrants that were not captured within the Guide.

We reported that while potential new entrants stated that they were generally satisfied with the Air Force's efforts to implement the Guide, they identified several challenges to certification, as well as perceived advantages afforded to the incumbent launch provider. For example, new entrants stated that they faced difficulty in securing enough launch opportunities to become certified. In November 2012, the Under Secretary of Defense for Acquisition, Technology and Logistics directed the Air Force to make available up to 14 launches for competition to new entrants, provided they demonstrate the required number of successful launches and provide the associated data in time to compete. If new entrants had not completed their final certification launch in time to compete, the newly-available launches would likely be awarded to the incumbent provider. New entrants stated they must also respond to changes in Air Force requirements that could impact their launch vehicle design and certification schedules, and considered some Air Force requirements to be overly restrictive; for example, they must be able to launch a minimum of 20,000 pounds to low earth orbit from specific Air Force launch facilities (versus facilities the new entrants currently use). The Air Force stated that 20,000 pounds represented the low end of current EELV lift requirements, and that alternate launch sites were not equipped for the Air Force's national security launches. Further, new entrants noted that the incumbent provider received ongoing infrastructure and development funding from the government, an advantage not afforded to the new entrants, and that historical criteria for competition in the EELV program were more lenient. The Air Force acknowledged that criteria for competition are different, reflective of differences in the acquisition environment.

Opportunities to Help Reduce Government Satellite Program Costs

In our April 2013 report on reducing duplication, overlap, and fragmentation within the Federal Government, we found that government agencies, including DOD, could achieve considerable cost savings on some missions by leveraging com-

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[19] GAO, Evolved Expendable Launch Vehicle, DOD Is Addressing Knowledge Gaps in Its New Acquisition Strategy, GAO–12–822 (Washington, DC: July 26, 2012).

[20] H.R. Rep. No. 112–479, at 186 (2012); Pub. L. No 112–239 (2013).

[21] GAO, Launch Services New Entrant Certification Guide, GAO–13–317R (Washington, DC: Feb. 7, 2013).

mercial spacecraft through innovative mechanisms.[22] These mechanisms include hosted payload arrangements where government instruments are placed on commercial satellites, and ride sharing arrangements where multiple satellites share the same launch vehicle.

We reported that DOD is among the agencies that are actively using or beginning to look at these approaches in order to save costs. For instance, DOD has two ongoing hosted payload pilot missions and has taken preliminary steps to develop a follow-on effort.[23] DOD estimated that the Commercially Hosted Infrared Payload Flight Demonstration Program answered the majority of the government's technical questions through its commercial partnership, while saving it over $200 million over a dedicated technical demonstration mission. In addition, DOD is investigating ride sharing to launch GPS satellites beginning in fiscal year 2017, which could save well over $60 million per launch.

While hosted payloads and ride sharing hold promise for providing lower-cost access to space in the future, we found that there are a variety of challenges. For instance, government agencies that have traditionally managed their own space missions face cultural challenges in using hosted payload arrangements and in November 2010, we found that the DOD space community is highly risk averse to adopting technologies from commercial providers that are new to DOD.[24] In addition, agency officials expressed concerns about using a commercial host for their payloads, noting that they would lose some control over their missions. DOD officials noted that their security and mission assurance requirements and processes may make integrating hosted payloads on commercial satellites more complicated to manage. Further, agency officials expressed concerns about scheduling launches and noted that commercial providers may not be flexible about changing launch dates if the instruments or satellites experience delays.

We reported that using hosted payloads and ride sharing are likely to reduce government launch costs and savings estimates reported to date are in the hundreds of millions of dollars over the life of the projects. However, we were unable to quantify the potential for further financial benefits because there is too limited a pool of available data. Once the government has collected more data and gained more experience in collaborating with commercial satellite vendors on ride sharing and hosted payloads, actual data on cost savings and cost avoidances should be more readily available.

Satellite Control Operations

DOD manages the Nation's defense satellites, which are worth at least $13.7 billion, via ground stations located around the world. These ground stations and supporting infrastructure perform, in part, the function of maintaining the health of the satellite and ensuring it stays in its proper orbit (activities collectively known as satellite control operations). Some of DOD's ground stations are linked together to form networks. The Air Force Satellite Control Network (AFSCN) is the largest of these networks. Based on the direction in a House Armed Services Committee Report for our review and discussions with defense committee staff, we reviewed the Air Force's satellite control operations and modernization efforts.[25]

We reported this month that DOD's satellite control networks are fragmented and potentially duplicative.[26] Over the past decade, DOD has increasingly deployed standalone satellite control operations networks, which are designed to operate a single satellite system, as opposed to shared systems that can operate multiple kinds of satellites. Dedicated networks can offer many benefits to programs, including possible lower risks and customization for a particular program's needs. How-

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[22] GAO, 2013 Annual Report: Actions Needed to Reduce Fragmentation, Overlap, and Duplication, and Achieve Other Financial Benefits, GAO–13–279SP (Washington, DC: Apr. 9, 2013).

[23] The missions are the Internet Protocol Routing in Space Joint Capability Technology Demonstration, which is to provide Internet routing onboard the satellite in order to provide users with increased speed and direct access to the Internet, eliminating the need for a ground-based teleport; and the Commercially Hosted Infrared Payload Flight Demonstration Program, which is an experiment designed to support next-generation infrared sensor development by placing a wide field of view infrared sensor on a commercial communications satellite.

[24] See GAO, Space Acquisitions: Challenges in Commercializing Technologies Developed under the Small Business Innovation Research Program, GAO–11–21 (Washington, DC: Nov. 10, 2010).

[25] House of Representatives Armed Services Committee Report No. 112–78, at 117 (2011), accompanying H.R. 1540, the bill for the National Defense Authorization Act for Fiscal Year 2012 (Pub. L. No. 112–81 (2011)), directed GAO to assess DOD satellite operations modernization efforts and identify potential best practices and efficiencies. To fulfill this mandate, we delivered an oral briefing to the House and Senate Armed Services committees on February 6, 2012.

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

ever, they can also be more costly and have led to a fragmented, and potentially duplicative, approach which requires more infrastructure and personnel than shared operations. We reported that, according to Air Force officials, DOD has not worked to move its current dedicated operations towards a shared satellite control network, which could better leverage DOD investments. We also reported that the AFSCN was undergoing modernization efforts, but these would not increase the network's capabilities. The efforts—budgeted at about $400 million over the next 5 years—primarily focus on sustaining the network at its current level of capability and do not apply a decade of research recommending more significant improvements to the AFSCN that would increase its capabilities.

Additionally, we found that commercial practices like network interoperability, automation, and use of commercial off-the-shelf products have the potential to increase the efficiency and decrease costs of DOD satellite control operations. Both DOD and commercial officials we spoke to agreed that there were opportunities for DOD to increase efficiencies and lower costs through these practices. Numerous studies by DOD and other government groups have recommended implementing or considering these practices, but DOD has generally not incorporated them into DOD satellite control operations networks.

Finally, we found that DOD faced barriers that complicate its ability to make improvements to its satellite control networks and adopt commercial practices. For example, DOD did not have a long-term plan for satellite control operations; DOD lacked reliable data on the costs of its current control networks and was unable to isolate satellite control costs from other expenses; there was no requirement for satellite programs to establish a business case for their chosen satellite control operations approach; and even if program managers wanted to make satellite control operations improvements, they did not have the autonomy to implement changes at the program level. We concluded that until DOD begins addressing these barriers, the department's ability to achieve significant improvements in satellite control operations capabilities would be hindered. We recommended that the Secretary of Defense direct future DOD satellite acquisition programs to determine a business case for proceeding with either a dedicated or shared network for that program's satellite control operations and develop a department-wide long-term plan for modernizing its AFSCN and any future shared networks and implementing commercial practices to improve DOD satellite control networks. DOD agreed with our recommendations.

RECENT ACTIONS TAKEN TO ADDRESS SPACE ACQUISITION PROBLEMS

Congress and DOD continue to take steps towards reforming the defense acquisition system to increase the likelihood that acquisition programs will succeed in meeting planned cost and schedule objectives. For example, in December 2012, we reported that the DOD had taken steps to implement fundamental Weapon Systems Acquisition Reform Act of 2009 (the Reform Act) provisions, including those for approving acquisition strategies and better monitoring weapon acquisition programs.[27, 28] The offices established by the Reform Act are in the process of developing, issuing, and implementing policies in response to the Reform Act's provisions. We reported that DOD has taken steps to:

- develop policy and guidance to the military services for conducting work in their respective areas,
- approve acquisition documents prior to milestone reviews,
- monitor and assess weapon acquisition program activities on a consistent basis, and
- develop performance measures to assess acquisition program activities.

Fundamentally, these Reform Act provisions should help (1) programs replace cost and schedule risk with knowledge and (2) set up more executable programs. Addi-

[27] GAO, Weapons Acquisition Reform: Reform Act Is Helping DOD Acquisition Programs Reduce Risk, but Implementation Challenges Remain, GAO–13–103, (Washington DC: Dec. 14, 2012).

[28] Pub. L. No. 111–23, as amended by the Ike Skelton National Defense Authorization Act for Fiscal Year 2011, Pub. L. No. 111–383 §§ 813 and 1075, and the National Defense Authorization Act for Fiscal Year 2012, Pub. L. No. 112–81 §§ 819 and 837; as implemented by DOD Directive-Type Memorandum (DTM) 09–027, "Implementation of Weapon Systems Acquisition Reform Act of 2009" (Dec. 4, 2009, incorporating Change 4, Jan. 11, 2013). The Act, among other things: established high-level acquisition oversight offices and positions (including Cost Assessment and Program Evaluation, Program Assessment and Root Cause Analyses, Director of Developmental Test and Evaluation, and Director of Systems Engineering); required competitive prototyping as part of the technology development phase; required preliminary design review before the start of development; required competition throughout the acquisition lifecycle; and encouraged trade-offs among cost, schedule, and performance objectives at Milestone B to ensure affordability.

tionally, as part of its Better Buying Power initiative, DOD in November 2012 issued descriptions of 36 initiatives aimed at increasing productivity and efficiency in DOD acquisitions.[29] DOD plans to solicit industry and stakeholder comments on these initiatives and plans to ultimately provide detailed requirements on implementing these initiatives to the acquisition workforce.

Further, in January 2013, Congress passed the National Defense Authorization Act of 2013, which required that DOD's Under Secretary of Defense for Acquisition, Technology and Logistics submit a report on schedule integration and funding for each major satellite acquisition program.[30] The report must include information on the segments of the programs; the amount of funding approved for the program and for each segment that is necessary for full operational capability of the program; and the dates by which the program and each segment are anticipated to reach initial and full operational capability, among other items. If the program is considered to be non-integrated, DOD must submit the required report to Congress annually. Tracking the schedules of major satellite programs and the ground systems and user equipment necessary to utilize the satellites may help DOD synchronize its systems.

Additionally, officials from the Space and Intelligence Office, within the Office of Secretary of Defense, told us that DOD has undertaken additional actions to improve space systems acquisitions since we last reported on its efforts in March 2012.[31] These actions include chartering Defense Space Council architecture reviews in key space mission areas that are ongoing or completed, such as resilient protected, narrowband, and wideband satellite communications; environmental monitoring; overhead persistent infrared; and space control, according to these officials.[32] The architecture reviews are to inform DOD's programming, budgeting, and prioritization for the space mission area. According to the officials, the Defense Space Council has brought a high-level focus on space issues through active senior-level participation in monthly meetings. DOD also participates in the newly reformed Space Industrial Base Council, which is made up of senior level personnel at agencies across the Federal Government that develop space systems. The purpose of the council is to understand how DOD's and other agencies' acquisition strategies impact the space industrial base. Additionally, according to the officials, the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics completed a major study on space acquisition reform to assess the root causes of poor performance in the space acquisition enterprise, focusing on the largest areas of cost growth. Furthermore, the officials stated that they are continuing efforts to buy blocks of AEHF and SBIRS satellites to realize savings that will be reinvested in high-priority research and development for space programs to mitigate the challenges associated with planned use of critical technologies when a satellite system is in the early stages of development. The officials stated that these block buys will also encourage stable production and help to achieve affordability targets DOD has set for the majority of the large, critical space programs. While these actions are encouraging, we have not evaluated their effectiveness.

The changes DOD has been making to leadership and oversight appear to be increasing senior management attention on space programs, but it is unclear whether the changes will be enough to overcome the problems we identified with fragmented leadership in the past. We have consistently found that the lack of a single authority for cross cutting missions, such as GPS or space situational awareness, has contributed to disconnects in the delivery of related systems as well as delays in the development of architectures and other tools important to balancing wants versus needs. Fragmented leadership has also been a contributing factor to other challenges we have noted in this statement—increasing launch service costs, synchronizing ground and satellite systems, and improving satellite operations. This condition persists. As part of our April 2013 annual report on reducing duplication, overlap, and fragmentation within the Federal Government, we reported that the administration has taken an initial step to improve interagency coordination, but has

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[29] DOD Memorandum, Better Buying Power 2.0: Continuing the Pursuit for Greater Efficiency and Productivity in Defense Spending, Washington, DC: Nov. 13, 2012.

[30] Pub. L. No. 112–239, § 911 (2013).

[31] GAO, Space Acquisitions: DOD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements, GAO–12–563T (Washington, DC: Mar. 21, 2012).

[32] In November 2010, the Deputy Secretary of Defense directed the creation of a Defense Space Council—chaired by the DOD Executive Agent for Space (currently the Under Secretary of the Air Force) and with representatives from across DOD—to inform, coordinate, and resolve space issues for DOD.

not fully addressed the issues of fragmented leadership and a lack of a single authority in overseeing the acquisition of space programs.[33]

Lastly, the Air Force and other offices within DOD are also considering different acquisition models for the future, including the use of hosted payloads as well as developing larger constellations of smaller, less-complex satellites that would require small, less-costly launch vehicles and offer more resilience in the face of growing threats to space assets. However, such a transition could also have risk and require significant changes in acquisition processes, requirements setting, organizational structures, and culture. The long-standing condition of fragmented leadership and the risk-averse culture of space could stand in the way of making such a change.

In conclusion, DOD has made credible progress in stabilizing space programs. However, there are challenges still to be dealt with, such as disconnects between the delivery of satellites and their corresponding ground control systems and user equipment and the rising cost of launch. The ultimate challenge, however, will be preparing for the future, as budget constraints will require DOD to make tough tradeoff decisions in an environment where leadership is fragmented. We look forward to continuing to work with Congress and DOD in assessing both today and tomorrow's challenges in space acquisition and identifying actions that can be taken to help meet these challenges.

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 ACKNOWLEDGMENTS

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Senator UDALL. Thank you for that summary.

Let us go right to questions. We will do 5-minute rounds and I will recognize myself for the first 5 minutes.

General Shelton, let us start with sequestration. You have had to cut back on a number of missions, including some missile warning and space surveillance operations. Can you describe which of your systems are affected by sequestration, and do you anticipate additional sequestration cutbacks toward the end of this fiscal year?

General SHELTON. Mr. Chairman, specifically there are two radars, missile warning radars, one of which is key to missile defense which we reduced the operating tempo on. In one case, we are operating at a lower power. In another case, we are operating for a reduced number of hours per day.

In the case of the one that is necessary for missile defense, we have continued to operate that one at full power because of the threat from North Korea. If that posture is sustained through the rest of the fiscal year, that is another $5 million I need to find in my budget somewhere.

We have taken down one-third of Space Fence receiver sites. So we have a reduced length of the Space Fence that goes across the southern United States.

We have reduced the sustainment dollars that are being spent on the legacy Defense Satellite Communications System constellation, wideband communications satellites, which means we will be slower to respond to problems. We will not do as much trending analysis, that sort of thing.

There are a host of other things across the command, but those are the big operational impacts, and then of course, the civilian furloughs that are upcoming.

Senator UDALL. Would you anticipate additional cutbacks if we do not, obviously, get our act together in the next fiscal year? But what I hear you saying is, yes, you see additional cutbacks.

General SHELTON. In the remainder of fiscal year 2013, I think we are on target with the exception of the $5 million I mentioned.

Senator UDALL. Okay.

General SHELTON. For fiscal year 2014, it all depends on the President's budget, of course, how that is enacted, whether or not we go into a Continuing Resolution, whether the Budget Control Act targets remain in place. All of that is yet to be determined.

Senator UDALL. Thanks for that further information.

Let me turn to the EELV. Senator Sessions mentioned it in his remarks.

As I understand it, you are working to bring new entrants into the medium and heavy lift launch market while assuring reliable access to space. Those two go hand-in-hand. I am interested in how

you will structure the contracts to account for launch services, including mission assurance and vehicle integration, in addition to the acquisition of the rocket itself.

As a follow-on, can you explain the difference in contracts between the launch providers in the current 50 core block buy and your plans for contracting in the next block buy past the current 50 cores?

General SHELTON. Yes, sir. Let me start with how we will work the leveling of the playing field, if you will.

We have not fully determined how we will do that because there was a very efficient mechanism of providing launch capability. With a single provider, you can look at providing launch capability from both coasts. We even fly crews back and forth between the coasts because that is the more efficient way to do business. So we provide the launch pads. We provide the crews. We provide all that under a launch contract that just sustains that capability. It is a level of effort capability, and then we buy individual boosters.

Trying to introduce new entrants with some sort of construct that is parallel so that there is not a competitive disadvantage, so to speak, for those new entrants is still a work in progress. We have not solved that yet, but we will. We will get to the place where we define what United Launch Alliance's (ULA) costs are versus a new entrant's costs so that they can compete head-to-head here in the future.

We will soon contract for the 36 cores, another 14 cores to be competed. ULA will be able to compete against any new entrants that are certified by that time, and then we will be in good shape for determining the most efficient, most reliable access to space.

Senator UDALL. Let me slip a final question in to you, General, and this is in reference to Buckley Airfield and the space-based infrared satellites (SBIRS). My understanding is we are now fielding that next generation, but the ground system has been lagging behind the satellites. What are your timelines in regards to bringing the ground system online at Buckley?

General SHELTON. Senator, that has had a very checkered history. When we had a Nunn-McCurdy breach in 2005, we went after the satellite, spent more money on the satellite system than we did on the ground system. So we knew this problem would exist, that the ground system would lag behind. But by 2016, we will have all this put back together.

We have full capability now to do what we need to do. It is in various locations, but it will all be combined in 2016.

Senator UDALL. Thank you.

Senator Sessions.

Senator SESSIONS. Thank you.

General Shelton, your comments related to what Ms. Chaplain was saying about the delay between the launch of a satellite and the ground system capability, can Congress fund your programs that have complicated your ability to have that come out in an effective timing sequence?

General SHELTON. Yes, sir. I would say that there are two factors. One is ground systems and satellites are typically contracted for independently, and trying to manage the technical risk and the

tempo of those programs independently is a challenge, trying to keep them on track going down the same schedule.

There are also funding challenges. As we run into difficulties, as we run into just normal fiscal challenges and there are reductions in the budget, that can slip one program out of sync with the other. So the only way that I know of to pull this all back together is manage it in one big contract, and that has its own challenges. I do not think what we have done is necessarily wrong. Keeping them together in a funding and schedule perspective has been a challenge.

Senator SESSIONS. I can see that. Sometimes DOD gets blamed for funding irregularities in Congress, and we should work really hard and you should keep us advised of extraordinary cost that might occur, particularly as we go through this sequestration dangerous period.

General Formica, a question involving prompt global strike which is dependent on space-related technologies. During the past missile defense testimony, you have highlighted the need for defensive and offensive capabilities to address the ballistic missile threat. I remain hopeful that a prompt global strike capability will provide this necessary offensive capability.

Can you provide a quick update on the progress of the advanced hypersonic weapon technology demonstration that is managed by your command? What are some of the strategic implications?

I felt like we have made this much more difficult. I felt like we could have used the original plan that was to use existing submarine-launched missiles, but that turned into a complication. So now we are on a more expensive track. How do you see it coming out and the value of it?

General FORMICA. Senator Sessions, thank you for the question.

As I have testified in the past to the subcommittee, we were successful in our first test of the advanced hypersonic weapon (AHW) in November 2011. We attributed that success to the great work of Sandia Lab and our partnership with the Aviation Missile Research Development and Engineer Center at the technology campus at Redstone Arsenal in Huntsville with our engineers from our technical center. We provided that test under the leadership of OSD's prompt global strike program.

It was successful. We believe that it has strategic and operational applications. Just from my narrow vantage point, I see it as a potential left-of-launch capability in the missile defense business. I spent yesterday at a missile defense symposium hosted by the Director of the Missile Defense Agency, and every one of the speakers talked about the need for offense-defense integration and attack ops to complement our missile defense capability. I see AHW has clearly a capability that has potential for application there.

We continue to work closely with OSD as we move towards a second flight test in fiscal year 2014. In fact, the Director of the Technology Center and my civilian deputy are meeting with OSD by Mr. Holter just today, and that is one of the subjects. The technology continues to advance, and we think we are on track to get ready for that test next year, sir.

Senator SESSIONS. Thank you very much.

To all of you, I am concerned that the President's budget does not identify the impacts of the sequester in the fiscal year 2014 budget. If the sequester is not averted, how will it impact the budget? We have a $52 billion assumption more in the President's $526 billion DOD budget. I believe it is $526 billion. But the current law is that the sequester takes effect, and if that takes effect, then the real budget you have to live with is $52 billion less. So I am really concerned about that.

Senator McCain and I, and others, asked a lot of questions about why we were not planning for this in advance on the assumption that it might happen. As a result, no serious planning was done, and you have had to make cuts in a very rapid situation.

The sequester is in law, signed by the President, voted for by Congress. We are not seeing the kind of movement I would like to see if we can avoid it. I am worried about that.

That is past my time. I will just leave it at that right now and just say that it is a matter of all of our concern. I know Senator Udall and we all care about it, but we are not making a lot of progress. I am afraid you definitely need to be seriously figuring how you are going to operate with less money than the President's budget assumes.

Senator UDALL. Thank you, Senator Sessions.

Senator Fischer.

Senator FISCHER. Thank you, Chairman Udall and Ranking Member Sessions. It is good to be with you again today.

Thank you for being here and being willing to answer some questions that we have for you.

General Shelton, I understand that the Air Force is exploring sensor disaggregation and hosting sensors on less expensive commercial satellites. Are you confident that that approach is going to work?

General SHELTON. Senator, we are actively studying that. It is not something where we have wholesale decided, but part of the savings that we have garnered from new acquisition approaches is being plowed into what we call space modernization initiative programs for advanced extremely high frequency, for SBIRS, and for Global Positioning System. That money goes to architectural studies to look at exactly what you are talking about. We will be a lot smarter by the summer. Right now, it is a bit in the study phase, but I would tell you from everything that I have seen so far, there is no reason not to be confident.

Senator FISCHER. How long have you been studying it?

General SHELTON. About 6 months now. We are just starting to scratch the surface of this.

We do have a hosted payload on orbit right now that is doing extremely well and is a trail-blazing effort. So that is part of the confidence, but also as we look at trying to establish resilience in our most important constellations, we know that we have to do something different. Whether that is disaggregation in terms of more numbers of satellites on orbit to make the targeting problem more difficult for an adversary, survivability concerns just from a premature failure point of view, all those sorts of things we are bringing into this equation to try to understand what is the best thing for the future.

Senator FISCHER. I would assume that if you do head in that direction, more satellites that you would be putting up would be less expensive and maybe less capable than the ones that you currently have up?

General SHELTON. In aggregate, we are not looking to reduce capability. As you look at each individual satellite, it would be less complex. It would be based on very mature technology and it would be smaller. So in theory—and again, part of the study effort—we think it would be less expensive to launch, less expensive to build, and less expensive to operate.

Senator FISCHER. Thank you.

Secretary Loverro, do you have anything to add on that?

Mr. LOVERRO. Senator Fischer, I think General Shelton has summed it up very well.

Disaggregation we view as one piece of the larger resiliency equation. There is no question that putting all of your eggs in a single basket, as we have in some of our satellite systems to date, does not present a resilient front to threats or even unintended consequences that we might see in the future.

There is certainly a large body of evidence that disaggregation can help us in this way, but it is not going to be the only thing that we use. Sometimes disaggregation is thought of as simply hosting a sensor on a commercial satellite. Disaggregation means allowing other nations to provide capability.

In a meeting a couple of days ago, we were talking about weather, which General Shelton and his team are running an analysis of alternatives on right now. It is interesting to note that our weather capabilities are comprised of contributions from well over 100 different sensors, and when you go ask the scientists who sit in the weather system which satellite contributes what piece of the weather, they cannot tell you. If the scientists who sit there cannot tell you, imagine the complexity an adversary would have in trying to eliminate our weather capability because they cannot tell either. They would have to either target 100 different sensors which would be cost-prohibitive, or they stop trying and look at other ways to deny that. Now, not that we are interested in having them look at other ways. But complicating the enemy's calculus is an absolute hallmark of the resiliency discussion that we have been having.

Senator FISCHER. Thank you.

Ms. Chaplain, have you looked at that at all through GAO? Do you know will it be less expensive? Have you looked at costs? Are you working on this? Are you in on the study?

Ms. CHAPLAIN. Yes. We have several studies that will be covering this issue. You will see them later this year. But these issues have been talked about in previous work, and I would say our work confirms these theoretical benefits. If you build satellites that are more executable, they are smaller, the timeframes are going to be shorter, the launch costs could go down.

But there are a couple of cautions here. Like even transitioning to a disaggregated scenario, costs could go up in the short term because you will need an overlap between the current structure and where you are going, and there could be startup costs to put a new infrastructure in place to support this different kind of architecture.

Then there are some other issues that just are risks, I think, that are associated with this kind of architecture. Interoperability. You have more satellites out there that have to work together. It is not just all on one package. Data fusion. That is where you are going to get your capability by bringing all these thing together. Both those things alone are not easy to achieve and have been difficult to achieve in the past. Modernizing control systems is another issue. Developing common interfaces and common standards. There has been slow progress on that front, and just the general broader issue of leadership fragmentation. Right now, it is difficult. You can see just coordinating user assets and ground systems and the satellite to deliver at one time—that is pretty difficult. If you get into a scenario where you have a lot of——

Senator FISCHER. I think you said it takes years sometimes before it is coordinated?

Ms. CHAPLAIN. Yes. So I think the fragmentation of leadership needs to be addressed to make this scenario work.

Senator FISCHER. Thank you very much.

Thank you, Mr. Chairman.

Senator UDALL. Thank you, Senator Fischer.

General Formica, let me turn to you. In the spirit of Senator Sessions' comment and also the question I asked to General Shelton, tell us, if you can, briefly how sequestration is affecting your operational capability.

General FORMICA. Thank you, Mr. Chairman, for that question.

Of course, sequestration and the fiscal realities impact all of our operations. We were somewhat relieved in our fiscal situation in fiscal year 2013 with the enactment of a fiscal year 2013 appropriation. That has taken some pressure off this year. I would add that the Army prioritized space and missile defense programs very high in its prioritization list. So as we were working our way through the impacts of the fiscal year 2013 budget, I think space and missile defense was accorded appropriate consideration by the Army.

That said, as Senator Sessions indicated, our fiscal year 2014 budget request does not yet reflect sequestration. We know that there will be some degradation from that budget request.

I anticipate two primary challenges to our program based on sequestration.

First, we are already delaying some of our training courses. I expect training readiness to be challenged in fiscal year 2014.

Then the second, as General Shelton mentioned in his opening statement, the impact on the civilian workforce. I am concerned about that, frankly, in four different areas.

First, you have the threat of a furlough beginning in June, which has caused angst in the force, and if it actually is executed will cause hardships to our civilians and will challenge our ability to meet our day-to-day operations.

Second, we have already implemented a hiring freeze, and that hiring freeze means that we are creating gaps in our civilian workforce because people continue to retire, move, get sick, and those gaps are not being backfilled because of the hiring freeze.

Third, we have eliminated our temporary and term civilians, and that means, in my view, the next generation of public servants that

we are trying to develop are no longer being nurtured at the entry level.

Then fourth and last, like with our military training programs, we have taken a reduction in the development of our civilian workforce and the dollars that are afforded to that. We are going to take some impact in the ability to continue to train the civilian workforce that we have.

Senator UDALL. Thank you for that update.

Let us turn to nanosatellites (nanosat). Senator Fischer talked with General Shelton about the Air Force's interest in this. Your command is credited with pioneering a number of low-cost, small nanosat programs such as the Kestrel Eye, which is an imaging satellite. Can you give us a perspective on where those programs are headed in the Army? Particularly, I wanted your thoughts—the Operational Responsive Space (ORS) program was chartered to pioneer many of these initiatives, and I know it was popular among its customers. Do you still value the overall program?

General FORMICA. Thank you, Mr. Chairman.

We do value the ORS program, and the warfighter continues to benefit from the space capabilities that they are providing.

That said, we see nanosat technology as a complementary space capability, and we are, in fact, developing that technology as part of a DOD joint technology capability development program, approved by DOD and funded by Congress. That nanosat technology is principally two different satellites, one for beyond-line-of-sight communications and one for imagery, the Kestrel Eye, as you mentioned. We are in the middle of that capability demonstration. We continue to make very good advances with the technology and are learning a lot from our engineering efforts. The Joint Capabilities Technology Demonstrations (JCTD) are, in fact, on track. We expect to be able to launch satellites in both categories, both from the communications satellite SNAP and Kestrel Eye next year.

Where they are going is at the end of the JCTD, there will be a joint military utility assessment, and we think that that is the time for DOD to assess the military utility of this technology and then to have a cost-benefit discussion as to where we go. My expectation is that if the technology works correctly, then we would advocate for it to ultimately become a program of record. But the time is not right yet for that. We need the joint military utility assessment to have that discussion.

Senator UDALL. Thank you for that update.

Let me turn to Senator Sessions.

Senator SESSIONS. Generals Shelton and Formica, earlier this month President Vladimir Putin announced his intention to build a system to neutralize space weapons. According to the press reports, Deputy Prime Minister Dmitry Rogozin has said that Russia will,"have the technical means by 2030 to counteract threats from space by other countries."

Do we know what the Russians are referring to there? Do you believe we require similar capabilities, and do you believe Russian efforts being referred to are defensive or offensive in nature?

General SHELTON. Senator, I do not know specifically what might be talked about there. In a different forum, we could talk about some other capabilities.

Senator SESSIONS. There could be some areas of classification that we should not talk about, I certainly acknowledge.

General SHELTON. But suffice it to say, there are nations—and I will just use the plural here—who are developing capabilities to counter our advantages in space, and we are doing what we need to do to address that.

Senator SESSIONS. General Formica, would you like to comment on that?

General FORMICA. I think General Shelton covered it, Senator Sessions. Thank you.

But, obviously, we would be concerned about any of those capabilities because we are fully dependent on space as we conduct operations on the ground.

Senator SESSIONS. Would you say, General Shelton, that the need for counterspace capabilities are increasing rather than decreasing today?

General SHELTON. I think everything that we have seen from a policy perspective, from an intelligence perspective, would lead us to believe that counterspace is a growing area for all of us.

Senator SESSIONS. Potential adversaries seem to be advancing their capabilities. Would you agree?

General SHELTON. I do.

Senator SESSIONS. The ORS concept—for a second year in a row, the budget request proposes a termination of the congressionally-established ORS Office. The budget proposes a termination of that.

How does DOD intend to fulfill short-term capability gaps quickly and inexpensively in the future? Now, I ask any of you. Maybe, Secretary Loverro, you want to start to comment on that.

Mr. LOVERRO. Thank you, Senator.

As you have articulated, the budget has zeroed the ORS program again.

Clearly, though, we received your message in the National Defense Authorization Act that passed this year, and DOD has taken steps to go ahead and establish both the executive committee called for in that Act and to move the ORS Office under the Space and Missile Systems Center under Air Force Space Command, reporting to General Shelton. So while we recognize that the budget reality that is in the President's budget does not reflect the direction that we have gotten from you, we do recognize that we do have to figure out how to go ahead and best manage ORS.

I think that is the key that we will be working on through the executive committee, is how do we add ORS to the host of capabilities I spoke with Senator Fischer about in terms of providing the resilience and reconstitution that we need in the future.

I will let General Shelton talk to any specifics beyond that.

Senator SESSIONS. Thank you.

General Shelton, we have talked about it for a long time. We thought it was a way to provide redundant, immediate, fairly quick response to a challenging situation, and we thought it would result in less expense. So do you have any comments on the Secretary's statements?

General SHELTON. Yes, sir. This is just a matter of how much budget we have. What we are trying to do is inculcate the ORS lessons learned into the mainstream programs at the Space and Mis-

siles Systems Center. Rather than having a dedicated office with a dedicated budget, we take those lessons learned and the disaggregated concepts, the hosted payload concepts, all those kinds of things are things that we have learned from our ORS experiences. It is mainstreaming what we learned.

Senator SESSIONS. Thank you.

Senator UDALL. Senator Fischer?

Senator FISCHER. Thank you, Mr. Chairman and Ranking Member Sessions.

General Shelton, if I can just follow up on Senator Sessions' comments here.

So we have zeroed out the budget. I think it is by 2016. Is that correct?

General SHELTON. Are you talking about counterspace, ma'am?

Senator FISCHER. Yes.

General SHELTON. Yes.

Senator FISCHER. You have said that it is going to be absorbed by other areas of the budget?

General SHELTON. No, ma'am. By 2016, the budget that you see has now gone into a sustainment program. It is in operation and maintenance funds, not in procurement funds. We have completed the procurement of that particular capability.

Senator FISCHER. So you believe that we do not need to expand or grow in that area anymore. We are just at operation and maintenance. Right?

General SHELTON. Ma'am, we would have to take this into another forum.

Senator FISCHER. Can you say what other forum at this point, or is that part of——

General SHELTON. It is beyond the classification of this session.

Senator FISCHER. Okay, thank you.

How would that compare, what we are now looking at doing in the future past 2016, to what other nations are doing—say, the Chinese—and the amount of money that they are throwing at these programs?

General SHELTON. Again, I am a little bit hamstrung here.

Senator FISCHER. Okay.

General SHELTON. I would love to sit down and talk to you in a closed session.

Senator FISCHER. Okay. I appreciate that. I am sorry that I headed in that direction. We will talk again. I will try another track. Okay?

You have command over both the Air Force's cyber and space forces, and I understand that you are going to be required to generate a large number of airmen in order to meet U.S. Cyber Command (CYBERCOM) needs. Is that correct?

General SHELTON. That is true. It is a little over 1,200.

Senator FISCHER. Have you identified a path forward towards providing for these forces, and do you have any concerns that cyber requirements may draw resources from your space requirements?

General SHELTON. We have not fully settled on exactly how the Air Force is going to fund those positions. It is going to happen. A little bit of an arm wrestling contest——

Senator FISCHER. It is going to happen or does it have to happen?

General SHELTON. It is direction to the Air Force. OSD said, Air Force, this is your share of the overall CYBERCOM manpower for specific purposes, and so the Air Force has direction to fund those. So there is no doubt in my mind. We will fund those. The precise mechanism for that has yet to be determined.

It will not come at the expense of space capability, though. It will not be a trade that is just given to me to fund, find this somewhere within your resources. It is an Air Force-wide problem.

Senator FISCHER. When you take into consideration the sequester and the cuts that you will be looking at, and when you look at the budget that was presented, which did not take into consideration the sequester, how are you going to make this work? Do you not have to take it from somewhere?

General SHELTON. It does. It has to come inside the top line of authorized manpower. It has to come from somewhere, and that will be the challenge that will occur at the Air Force corporate level, if you will, to try to determine where we find 1,200 positions to fund those cyber positions.

Senator FISCHER. But you are saying your preference would be not to take it from space?

General SHELTON. Not only my preference, but I am a strong advocate of not doing that.

Senator FISCHER. Thank you very much.

Thank you, Mr. Chairman.

Senator UDALL. Senator Fischer, that is an important line of questioning. In the last two NDAAs, I have explored what we could do to think of this as not a zero sum game, but maybe we and our teams could work together and work with the General and others because both functions are really crucial. But we do not want to rob Peter to pay Paul. I appreciate the General's wry smile in saying he is not going to give any quarter, given his responsibilities, but he knows the importance of cyber.

General Formica, let me come back with one final question for you. Kwajalein, an important little place out in the Pacific. Can you talk about how the site supports space situational awareness? It is your responsibility, as you well know.

General FORMICA. Yes, Mr. Chairman. Thank you.

Kwajalein, as you know from your question, is a strategic asset out in the middle of the South Pacific. The longer I have been in this command, the more I have come to appreciate the importance of Kwajalein, and therefore, the role I play as the senior commander there is one of the most important duties that I have actually. Kwajalein is a host to the Reagan Test Site, which is a national class test that host tests for missile defense, intercontinental ballistic missiles, and other tests that require the kind of space that Kwajalein Atoll affords.

We have very sophisticated radar capability out there, and those radars, when they are not being used for test, are made available for space situational awareness and to meet missions in support of U.S. Strategic Command (STRATCOM) and in direct support of the Joint Functional Component Command for space, which is subordinate to STRATCOM.

We provide space object identification and space situational awareness from those radars. We are strategically located in the

Pacific to identify space launch, and we soon will be the home for the Air Force's Space Fence.

Senator UDALL. Thank you for that update. You do underline the importance of that jewel of an asset.

Secretary Loverro, let me turn to you and we will talk space policy here. I understand you are new to your job, but that does not mean you are new to the topic. You come from the Air Force Space Command, Space and Missile Systems Center. Welcome. Thank you for, again, your willingness to serve.

What actions is DOD taking to ensure that we support some sort of rules-of-the-road, so to speak, with respect to space navigation between countries?

Mr. LOVERRO. Mr. Chairman, DOD has multiple activities ongoing in that regard. One was just mentioned by General Formica in terms of space situational awareness. Obviously, space situational awareness is fundamental to understanding what is going on in space. The Space Fence, which Air Force Space Command is going to put on Kwajalein, is a critical asset. But just as critical is our cooperative assets that we are looking at putting into Australia, the C-band radar that Air Force Space Command will be placing down there under an allied agreement. Those kinds of activities are firmly supported by DOD and are foundational to anything we do in terms of space traffic management and the freedom of space.

But it is more than just the technical capabilities. It is the agreement on what the rules-of-the-road are for space, how do you operate in space. I think we all understand that in any economic and commerce sphere, there are rules of operations, whether that is rules of the sea, rules of the airways. So rules of space we view in very much the same way, not in a legally binding way, not in a way that will constrain U.S. national security. In fact, one of the reasons DOD is intimately involved in this is to make sure we do not constrain national security as we move forward. Yet, we all recognize that good rules allow us to go ahead and detect irresponsible behavior on the part of others.

So we are engaged with both the European Union on the international code of conduct. We have a member from the Department of State, Secretary Rose, and the group of government experts to go ahead and talk about what should be the rules. Obviously, we remain very committed to working with our allies through multiple mechanisms to establish those rules. I think that covers most of it.

Senator UDALL. That is very helpful. You anticipated my question about Australia. That is important to get that on the record.

Let me follow on Senator Sessions' comments when it comes to those who are developing—we will put it in a politic way—an ability to deny access to space. What is our country's and DOD's policy when it comes to ensuring that we have safe access to space and the disaggregating of our assets we have been discussing? Does that help ensure the survivability of those space assets?

Mr. LOVERRO. I absolutely believe that it does. Our policy that was published in 2010, both the National Space Policy and the National Security Policy that followed in 2011, all recognize that not only do we garner great benefit from space, but that we have an inherent right of protection in space.

So there will be a mixture of capabilities both from a protective standpoint, a resilience standpoint that we look to put into our systems in the future and offensive actions we may need to take in order to assure that we are not threatened in our space capabilities. As General Shelton has already indicated, a lot of that we cannot talk about in this session here, but we absolutely believe our policy supports all of those actions.

Senator UDALL. We are going to work on, what I hear you saying, the political, diplomatic, economic fronts, but we are also not going to be shy about developing our defensive capabilities, and there is no reason we should not develop offensive capabilities as well to show we are serious. We are going to be tough, but we will be smart as well. We will hold out a hand, but we are also not going to have our access limited.

Mr. LOVERRO. Yes. Just like in any other area of warfare, we understand that it takes both sides of protection and offensive capability to ensure that the warfighters get what they need.

Senator UDALL. Thank you for that.

Senator Sessions.

Senator SESSIONS. Thank you all. It is difficult to overstate the importance of space and missile capability to our modern day defense capability. It is just so critical to it.

Mr. Secretary, I will just ask you one final question from me. The history of warfare has shown that virtually every code, every security system gets penetrated at some point or another. We are so dependent on communication through satellite guide and other things. We have the leaks and some private somewhere is intercepting the communications from the Ambassador to Russia to the Secretary of State. It is just hard to believe that that kind of thing could happen.

Do you believe we have given sufficient concern to the ability of adversaries to intercept and decode communications that we have?

Mr. LOVERRO. Senator, I think if you are asking, if I understand the question, as we decide how do we go ahead and host our satellite communications capabilities, do we recognize the potential vulnerabilities if we use satellite capabilities from other nations—is that the question?

Senator SESSIONS. I am also thinking about just the basic communications system in which we send information, data through satellites that could be intercepted giving our adversaries valuable information we would not want to be made public.

Mr. LOVERRO. Understood. Absolutely. In normal departmental policy, all of our satellite communications are encrypted to the best of our ability. Now, I will readily admit there are some places that that has not been able to be implemented, but that is certainly where we are going.

There are efforts underway within DOD to provide more protective capability to our warfighters. Some of the space modernization investments that General Shelton spoke about are aimed directly at that problem because we recognize the need for wideband communications that are protected is growing quickly, especially with the modern war systems that we have today, especially as we adopt a more continental United States-based capability for many of these controls. So we are very focused on assuring that we can pro-

vide the protective communications in the future. Those are not always available everywhere in the world today that we fight, but that is our bias.

Senator SESSIONS. There is a lot of technology out there and we have a lot of penetration of all kinds of systems that are occurring today, and cybersecurity has become a huge issue for us. I think it would be a mistake, as we spend large amounts of money developing our systems, if we do not give sufficient attention to security.

Thank you very much.

Senator UDALL. Thank you, Senator Sessions.

I am going to exercise my prerogative, Senator Fischer, with her understanding, to bring this portion of the hearing to a conclusion.

Although I did want to thank Ms. Chaplain for your insights when Senator Fischer asked questions. We will direct some additional questions to you particularly on the FAB–T situation. I know you have some real expertise there.

I did not want to leave the Navy with the impression that they either were forgotten or they were doing a perfect job. So I did want to ask Secretary Zangardi a brief question about the MUOS system. It is going to replace the so-called Ultra High Frequency follow-on system, which is known as UFO. How fragile is the current UFO system and will the MUOS system be able to backstop the UFO as it ages out?

Dr. ZANGARDI. Yes, sir. Right now, MUOS–1 contains two packages. It contains a WCDMA package and a legacy UFO package. When UFO number 4 failed last year, we activated operationally the UHF package on board MUOS–1. It has provided backstop.

But let me back up a little bit more into this question. The UFO constellation provides a UHF communications capability to the joint warfighter. The Navy plans on meeting the joint staff legacy UHF requirement until MUOS full operational capability which occurs in 2017. Statistical reliability analysis has shown that the current UFO constellation plus the legacy payloads and other mitigating efforts will maintain the legacy UHF requirements for satellite communications through 2017 and probably beyond 2018. Other mitigation efforts include a host of payloads and leased satellite capability.

Presently right now, we have an additional 111 channels above the capability, which is the rough equivalent of about three UFO satellites. We believe that despite the age or fragility of the existing UFO constellation, we have sufficient capability to backstop.

Senator UDALL. Thank you for that update. We will ask some follow-on questions. Again, for the record, I want it to be shown that Senator Fischer and I have a lot of sailors in our States. We appreciate what the Navy does. In fact, Admiral Winnefeld headed U.S. Northern Command before he moved over to the Joint Chiefs. Thank you for what you do. We would not be anywhere without the Navy corpsmen and corpswomen. Thank you for being here today.

Thanks to the entire panel. We will excuse you and we will ask the second panel to join us. [Pause.]

Gentlemen, welcome. We will go right to, if it is okay with all of you, a 1- to 2-minute statement, and then we will move right to questions.

Major General Wheeler has joined us. Major General, the floor is yours.

STATEMENT OF MAJ. GEN. ROBERT E. WHEELER, USAF, DEPUTY CHIEF INFORMATION OFFICER FOR COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS AND INFORMATION INFRASTRUCTURE CAPABILITIES; OFFICE OF THE SECRETARY OF DEFENSE

General WHEELER. Senator Udall, it is good to be back here again. I appreciate your having me here today. I will be quick this morning. I have also brought my full statement, which is sitting out in the other room there that goes into much more depth.

Senator UDALL. We will put it in the record, without objection. Thank you.

General WHEELER. Sir, thank you for the opportunity today to testify before the subcommittee regarding the vital importance of scarce radio frequency spectrum to U.S. national defense capabilities, the economy, and consumers.

I will make this statement short, highlighting the key points from my full formal written statement that I have already provided for the record, and leave the rest of the time for questions, as we have discussed.

Spectrum is a critical enabler that ensures information is dependably available to train our military forces and ensure safe and successful mission accomplishment. Within DOD, we understand that the strength of our Nation is rooted in the strength of our economy. In that regard, we remain fully committed in support of the national economic and security goals of the President's 500 megahertz initiative, the implementation of more effective and efficient use of this finite radio spectrum and the development of solutions to meet these goals is equally important to both national security and economic goals. We understand that.

DOD continues to cooperatively work with the National Telecommunications and Information Administration (NTIA), other administrative partners, and industry to develop the information required to ensure balanced spectrum repurposing decisions that are technically sound and operationally viable from a mission perspective.

The ability to operate spectrum-dependent national security capabilities without causing and receiving harmful interference, while understanding the critical need of our Nation's economy, remains paramount to DOD. DOD also recognizes the importance of the growing need for spectrum for economic development, technological innovation, and consumer demand. However, any repurposing decisions made without proper technical, operational, and cost impact assessment could preempt critical requirements and could cause adverse impact to military training operations and readiness. No spectrum repurposing decision is without risk, but risks can and must be managed. Together we will develop long-term solutions to achieving a balance between national security spectrum requirements and meeting the expanding demand of commercial broadband services.

Thank you, sir.

[The prepared statement of General Wheeler follows:]

PREPARED STATEMENT BY MAJ. GEN. ROBERT E. WHEELER, USAF

INTRODUCTION

Good morning Mr. Chairmen and distinguished subcommittee members. Thank you for the opportunity to testify before the Subcommittee regarding the vital importance of scarce radio frequency spectrum to U.S. national defense capabilities, the economy, and consumers. My name is Major General Robert Wheeler and I am the Deputy Chief Information Officer for Command, Control, Communications, and Computers (C4) and Information Infrastructure Capabilities. My testimony today will focus on the importance of spectrum to the Department of Defense (DOD) in ensuring that our warfighters and mission partners have the critical capabilities they need to prepare for and execute the missions assigned to them by the Commander in Chief as safely and effectively as possible.

IMPORTANCE OF SPECTRUM TO DOD

The DOD remains fully committed in support of the national economic and security goals of the President's 500 MHz initiative to make spectrum available for commercial broadband use, the implementation of more effective and efficient use of this finite radio-frequency spectrum and the development of solutions to meet these goals while ensuring national security and other Federal capabilities are preserved. Spectrum has become increasingly important to the Department's missions, consumers, and the economy of the Nation as a whole.

Military spectrum requirements are diverse and complex given the variety of different missions the Department must support around the world. DOD uses spectrum for command and control operations, communications, intelligence, surveillance, and target acquisition, on land, at sea, in the air and in space. In the United States, our systems utilize spectrum in order to properly train as we must fight.

For example, the Air Combat Training System (ACTS) uses the federally allocated and regulated 1755–1850 MHz band to support combat readiness pilot certification through robust United States aircrew training along with crews from allied countries. The system is used at training ranges and bases across the United States with over 10,000 training flights per month. ACTS is also used for 10–12 large Carrier Strike Group exercises annually, where it is used 24 by 7 for up to 6 weeks in duration.

In short, spectrum is the critical enabler that ensures information is dependably available to train our forces and ensure safe and successful mission accomplishment.

The Department, like the rest of the country and world, also has growing requirements resulting from our increasing reliance on spectrum-dependent technologies. An example is the Department's use of unmanned aerial systems (UAS) requires spectrum to process volumes of critical intelligence, surveillance, and reconnaissance data in support of our missions in military areas of operation. Our inventory of UAS platforms has increased from 167 in 2002 to nearly 7,500 in 2010. This has resulted in a dramatic increase in UAS use and training requirements, and consequently an increase in demand for spectrum to adequately satisfy those missions.

While the Department critically depends on wireless and information technology that require spectrum, DOD is cognizant of the scarcity of this resource and its importance to the economic well-being of our Nation. When referencing the U.S. Frequency Allocation chart, and using the strict interpretation of the allocations, one will find in spectrum between 225 and 3,700 MHz 18 percent Federal exclusive use, 33 percent non-Federal exclusive use, and 49 percent Federal/non-Federal shared use. When you apply real-world factors for how spectrum is actually used within the United States, these numbers will vary, but they do illustrate the fact that there is not a significant gap between the amount of spectrum allocated to Federal and non-Federal/commercial users. Even within spectrum allocated for exclusive Federal use, the majority of the spectrum is shared between DOD and all of the other Federal agencies, across a wide array of systems, performing a multitude of varied missions, often with very different technologies.

As noted above, the Department also recognizes the importance of the growing needs for spectrum for economic development, technology innovation and consumer services. Within the DOD, we understand that the strength of our Nation is rooted in the strength of our economy in harmony with the strength of our national security. We are dependent on industry for innovative products that can be used for national security.

The Department continues to work with the National Telecommunications and Information Administration (NTIA), other administration partners, and industry to develop the information required to ensure balanced spectrum repurposing decisions that are technically sound and operationally viable from a mission perspective. The

results so far have been promising. For instance, in support of the President's 500 MHz initiative, the initial frequency band assessment, commonly referred to as the "fast track study," resulted in arrangements to geographically share the 1695–1710 and 3550–3650 MHz bands. The reallocation feasibility assessment of the 1755–1850 MHz band also marks another important step. NTIA concluded in its assessment report that while there are significant challenges yet to overcome, it is possible to repurpose all 95 MHz of spectrum, based on the conditions outlined in the report. DOD is fully engaged in addressing these challenges, by closely working with industry to evaluate sharing possibilities.

In general, in order to avoid critical mission impacts and maintain comparable capability, there are three things the DOD requires if we are to relocate our systems out of spectrum to be repurposed for wireless broadband; cost reimbursement, sufficient time, and, if necessary, alternate spectrum with comparable technical characteristics to restore lost capabilities (note Public Law 106–65).

Existing statutes provide for relocation and sharing costs to be reimbursed through the Spectrum Relocation Fund, using auction revenue. Auction revenues by law must meet 110 percent of the estimated Federal relocation costs for the auction to go forward. During the Department's study of the 1755–1850 MHz band relocation feasibility, the Service Cost Agencies led the development of cost estimates for their respective systems, while the entire process was led and overseen by the Department's independent Cost Assessment and Program Evaluation (CAPE) organization to ensure consistency in methodologies and assumptions. The costs to modify or replace existing systems to use the identified comparable spectrum (e.g., 2025–2110 MHz, 5150–5250 MHz) were included in the analysis. NTIA report shows total cost for all Federal agencies is about $18 billion, approximately $13 billion is DOD's cost. Any affected systems planned to be retired or already programmed to be replaced within the 10-year transition period (e.g., Air Force Precision Guided Munitions and Army Explosive Ordinance Disposal robots) were excluded. The Service Cost Agencies interviewed technical experts associated with each of the major systems to understand what components needed modification, made site visits to major test and training ranges to view the actual equipment, and gathered cost data for similar modifications and new components where available. The cost estimates were peer-reviewed through the respective Service Cost Agencies and reviewed again by CAPE and the DOD Chief Information Officer.

Sufficient time to relocate systems from the 1755–1850 MHz band is dependent upon the schedule of developing and deploying alternative capabilities, and can vary from a few years for simple systems with readily available alternatives, up to 10 years for more complex systems, and upwards of 30 years for space systems, where modification is not an option.

The last requirement is maintaining comparable capabilities. This includes alternate spectrum with comparable technical characteristics to relocate systems into, i.e., spectrum with the physical properties to support the missions currently being performed in the 1755–1850 MHz band. With the finite nature of spectrum, and growing requirements, this has become a tough requirement to meet.

Let me also address the issue of the lower 25 MHz or the 1755–1780 MHz band. We fully understand the desire to bring this 25 MHz to market rapidly, particularly with a potential pairing band called out for auction within 3 years in the Middle Class Tax Relief and Job Creation Act, but the Department has some significant reservations. As we worked within NTIA's established process to identify the 500 MHz directed by the President, the Federal agencies, including DOD, were instructed to study reallocation of the entire 95 MHz band. Thus, a detailed study of vacating solely the lower 25 MHz has not been conducted, and the results of the full 95 MHz band study cannot be extrapolated to a solution for just the lower 25 MHz. Further, it is important that DOD understand the long-term status of the full band as part of any decision on the lower 25 MHz, in order to fully understand the impacts on DOD warfighting missions and cost implications of any relocation. In order to make balanced decisions about relocating from or sharing spectrum, the Department requires adequate time to conduct operational, technical, cost and schedule-feasibility analysis to ensure national security and other Federal capabilities are preserved, while supporting the economic benefits spectrum use affords the Nation. These studies are critical to preserving the warfighting advantages our weapons systems provide so that our soldiers, sailors, airman, and marines can perform their missions with the greatest possible advantage over our adversaries, and return home to their loved ones safely.

Recognizing the relocation challenges, focus is shifting to spectrum sharing as a potential option for repurposing spectrum bands for commercial wireless broadband use.

The Department has and is continuing to work with NTIA and the Federal Communications Commission (FCC) to determine ways to share spectrum with commercial users when possible. Recent successes include the FCC's new rules which allow Dish networks to roll out a Broadband network across the country in the 2180–2200 MHz band adjacent to the 2200–2290 MHz band that is critical to our satellite communications downlink and aeronautical mobile telemetry testing, yet collectively DOD and Dish were able to establish the rules to permit this new use to enter the band without risk of harmful interference. We are also working with the FCC and NTIA to explore ways to share the 3550–3650 MHz and 5GHz bands as well for commercial broadband use. To date we have identified ~400 MHz of Federal spectrum for potential commercial broadband use.

While large-scale spectrum sharing between Federal systems and commercial licensed cellular broadband services presents new challenges, DOD is committed to working with government and industry partners to develop equitable spectrum sharing solutions. DOD is actively supporting efforts through NTIA-established working groups under its Commerce Spectrum Management Advisory Committee (CSMAC) to further the 1755–1850 MHz band assessment, working with interagency partners, NTIA, FCC, and industry. The main focus of the evaluation is to determine the feasibility of sharing the 1755–1850 MHz band versus relocation. DOD is also cooperatively working with three major wireless providers to evaluate sharing the 1755–1850 MHz band including spectrum monitoring at selected DOD sites as well as modeling, simulation and analysis to develop an understanding of the sharing environment in the band. Results will inform the NTIA CSMAC working groups. These efforts are also examples of an unprecedented collaboration between the DOD and the commercial industry to assess highly complex technical issues with a goal of ensuring practical and balanced spectrum repurposing decisions that are technically sound and operationally viable from a mission perspective.

DOD recognizes the need to look forward. The Department is developing a spectrum strategy focused on investing in technologies and capabilities aimed at more efficient use and management of spectrum, and for increased interoperability with our Coalition partners and with Federal, State, and commercial entities.

SUMMARY

The ability to have assured access to spectrum in order to operate spectrum-dependent national security capabilities without causing and receiving harmful interference while understanding the critical needs of our Nation's economy remains paramount to the Department. The Federal Government and our industry partners have built an impressive team that is working toward solving the technical and policy issues so we can move ahead. Together, we will develop long-term solutions to achieving a balance between national security spectrum requirements and meeting the expanding demand of commercial broadband services.

I want to thank you for your interest in hearing the importance of spectrum to DOD.

Senator UDALL. Thank you, General. Again, for the record, let me acknowledge your role as the Deputy Chief Information Officer for Command, Control, Communications, and Computers and Information Infrastructure Capabilities on the staff of the Secretary of Defense, and you are a member of the U.S. Air Force. So again, welcome.

General WHEELER. Thank you, sir.

Senator UDALL. We also have Mark L. Goldstein, who is the Director of Physical Infrastructure at the GAO. Welcome, Mr. Goldstein. We look forward to your comments.

STATEMENT OF MR. MARK L. GOLDSTEIN, DIRECTOR, PHYSICAL INFRASTRUCTURE, GOVERNMENT ACCOUNTABILITY OFFICE

Mr. GOLDSTEIN. Thank you, Mr. Chairman and members of the subcommittee. Thank you for inviting GAO to testify on the issue of past spectrum auctions and the potential cost of moving some Government functions off certain spectrum bands. This testimony

addresses our preliminary findings and report to be issued in several weeks to this committee.

Our review found the following.

First, actual cost to relocate some Federal users from the 1710–1755 megahertz band have exceeded the original $1 billion estimate by about $474 million as of March 2013. In contrast, DOD expects to complete relocation for about $275 million, or approximately $80 million less than its $355 million estimate. The relocation of systems from this band has been less expensive than originally estimated because many systems were simply retuned to operate in the adjacent 1755 to 1850 megahertz band.

Second, DOD's preliminary cost estimate for relocating systems from the 1755 to 1850 megahertz band substantially or partially met GAO's best practices, but changes in key assumptions may affect future costs. Most importantly, decisions about which spectrum band DOD would relocate to are still unresolved. Nevertheless, DOD's cost estimate was consistent with its purpose of informing the decision to make additional spectrum available for commercial wireless services.

Third, no Government revenue forecast has been prepared for a potential auction of licenses in the 1755 to 1850 megahertz band, and a variety of factors could influence auction revenues. The price of spectrum and ultimately auction revenue is determined by supply and demand. Several factors would influence profitability and demand, including whether the spectrum is cleared to Federal users or must be shared.

Thank you, Mr. Chairman. I would be happy to respond to questions later.

[The prepared statement of Mr. Goldstein follows:]

PREPARED STATEMENT BY MR. MARK L. GOLDSTEIN

Chairman Udall, Ranking Member Sessions, and members of the subcommittee: Thank you for the opportunity to be here today as the subcommittee examines the Department of Defense's (DOD) requirements for radio frequency spectrum.[1] DOD requires spectrum to support military operations, testing, and training at home and around the world. For example, DOD has dramatically increased its use of unmanned aerial systems in support of overseas missions; these systems require spectrum to transmit volumes of critical intelligence, surveillance, and reconnaissance data, leading to an increase in DOD's demand for spectrum. Similarly, as the demand for and use of smart phones, tablets, and other wireless devices continues to grow, commercial requirements for spectrum are expanding as well, with important implications for economic growth. Thus, balancing competing industry and government demands for a limited amount of spectrum, today and in the future, is a challenging and complex task.

In June 2010, the administration issued a presidential memorandum directing the National Telecommunications and Information Administration (NTIA) to collaborate with the Federal Communications Commission (FCC) to make available a total of 500 MHz of Federal and nonFederal spectrum for wireless broadband within 10 years.[2] As part of this effort, DOD studied the feasibility of relocating military sys-

[1] The radio frequency spectrum is the part of the natural spectrum of electromagnetic radiation lying between the frequency limits of 3 kilohertz (kHz) and 300 gigahertz (GHz). Radio frequencies are grouped into bands and are measured in units of Hertz, or cycles per second. The term kHz refers to thousands of Hertz, megahertz (MHz) to millions of Hertz, and GHz to billions of Hertz. The Hertz unit of measurement is used to refer to both the quantity of spectrum (such as 500 MHz of spectrum) and the frequency bands (such as the 1755–1850 MHz band).

[2] See, Memorandum for the Heads of Executive Departments and Agencies, Unleashing the Wireless Broadband Revolution, 75 Fed. Reg. 38387 (June 28, 2010).

tems from the 1755–1850 MHz band,[3] which is ideally suited to enabling highly mobile, yet reliable communication links for commercial and Federal users. Relocating to other parts of the radio frequency spectrum means that many of these military systems would need to be redesigned. In addition, few other comparable spectrum bands are available that can effectively support the Federal operations currently in the band. In September 2011, DOD estimated that the cost to relocate most military systems from the 1755–1850 MHz band would be about $12.6 billion over 10 years.

My statement today discusses our ongoing review, requested by the Senate Committee on Armed Services, of Federal agencies' spectrum relocation costs and auction revenues. Our review focuses on (1) the differences between estimated and actual Federal relocation costs, and revenue from the auction of the 1710–1755 MHz band; (2) the extent to which DOD followed best practices to prepare its preliminary cost estimate for vacating the 1755–1850 MHz band and the limitations, if any, of its analysis; and (3) what government or industry revenue forecasts exist for an auction of the 1755–1850 MHz band, and what factors, if any, could influence the actual auction revenue. To determine the estimated and actual Federal relocation costs, and revenue from the auction of the 1710–1755 MHz band, we reviewed annual progress reports for the 1710–1755 MHz transition published by NTIA and spectrum auction data published by FCC as of December 2012.[4] We limited our analysis to the Advanced Wireless Services-1 (AWS–1) auction involving the 1710–1755 MHz band; this is the only spectrum auction involving Federal agencies, including DOD, with significant, known relocation costs.[5] To assess whether the cost of vacating the 1755–1850 MHz band is sufficiently captured in DOD's preliminary cost estimate, we assessed DOD's preliminary estimate against GAO's Cost Estimating and Assessment Guide (Cost Guide), which has been used to evaluate cost estimates across the government;[6] these best practices help ensure cost estimates are comprehensive, well-documented, accurate, and credible. To identify any limitations affecting DOD's estimate, we also interviewed DOD officials responsible for developing the department's preliminary cost estimate. To identify any government or industry forecasts of revenue from a future auction of the 1755–1850 MHz band and any factors that would affect the value of spectrum licenses, we reviewed academic, government, and public policy literature. We also interviewed officials from the Congressional Budget Office (CBO) and the Office of Management and Budget (OMB), and stakeholders with knowledge of spectrum licensing issues, including industry and policy experts. We are conducting our work 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. We plan to issue our final report on this work in May 2013.

BACKGROUND

The radio frequency spectrum is the resource that makes possible wireless communications and supports a vast array of government and commercial services. DOD uses spectrum to transmit and receive critical voice and data communications involving military tactical radio, air combat training, precision-guided munitions, unmanned aerial systems, and aeronautical telemetry and satellite control, among others. The military employs these systems for training, testing, and combat operations throughout the world. Commercial entities use spectrum to provide a variety of wireless services, including mobile voice and data, paging, broadcast television and radio, and satellite services.

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[3] Within the United States, this band is allocated exclusively to the Federal Government, particularly for defense purposes, such as military tactical communications, air combat training, and space systems.

[4] To assess the reliability of the relocation cost and auction revenue data, we reviewed documentation related to the data, compared the data to other sources, including government reports, and discussed the data with FCC and NTIA officials. We determined that the FCC and NTIA data were sufficiently reliable for our purposes.

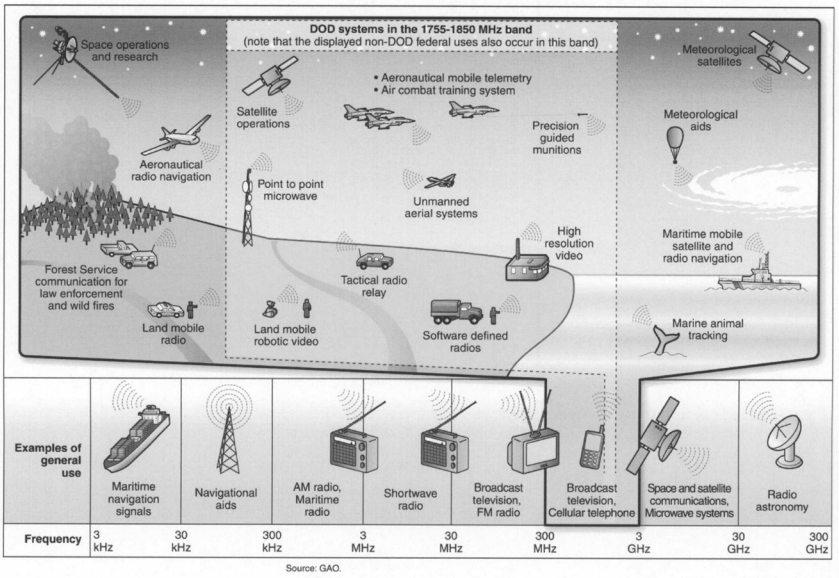
[5] There have been other auctions involving the relocation of Federal Government agencies. For example, the National Oceanic and Atmospheric Administration (NOAA), Air Force, and National Science Foundation previously operated systems in the 1670–1675 MHz band. The estimated cost to relocate these systems was $35–55 million for NOAA and $515,000 for the Air Force. See NTIA, Spectrum Reallocation Final Report: Response to Title V—Omnibus Budget Reconciliation Act of 1993 (Washington, DC: February 1995). FCC auctioned the band in April 2003, and the auction generated $12.6 million. Final relocation costs are unclear.

[6] GAO, GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs, GAO–09–3SP (Washington, DC: March 2009).

In the United States, FCC manages spectrum for nonFederal users under the Communications Act,[7] while NTIA manages spectrum for Federal Government users and acts for the President with respect to spectrum management issues as governed by the National Telecommunications and Information Administration Organization Act.[8] FCC and NTIA, with direction from Congress and the President, jointly determine the amount of spectrum allocated for Federal, nonfederal, and shared use. FCC and NTIA manage the spectrum through a system of frequency allocation and assignment.

- Allocation involves segmenting the radio spectrum into bands of frequencies that are designated for use by particular types of radio services or classes of users. (Fig. 1 illustrates examples of allocated spectrum uses, including DOD systems using the 1755–1850 MHz band.) In addition, spectrum managers specify service rules, which include the technical and operating characteristics of equipment.

Figure 1: Examples of Allocated Spectrum Uses and DOD Systems Using the 1755-1850 MHz band



Source: GAO.

- Assignment, which occurs after spectrum has been allocated for particular types of services or classes of users, involves providing users, such as commercial entities or government agencies, with a license or authorization to use a specific portion of spectrum. FCC assigns licenses within frequency bands to commercial enterprises, state and local governments, and other entities. Since 1994, FCC has used competitive bidding, or auctions, to assign certain licenses to commercial entities for their use of spectrum.[9] Auctions are a market-based mechanism in which FCC assigns a license to the entity that submits the highest bid for specific bands of spectrum. NTIA authorizes spectrum use through frequency assignments to Federal agencies. More than 60 Federal agencies and departments combined have over 240,000 frequency assignments, although 9 departments, including DOD, hold 94 percent of all frequency assignments for Federal use.

Congress has taken a number of steps to facilitate the deployment of innovative, new commercial wireless services to consumers, including requiring more Federal

[7] Communications Act, 47 U.S.C. § 309.
[8] Pub. L. No. 102–538, title I, 106 Stat. 3533, codified as amended at 47 U.S.C. ch. 8.
[9] Not all licenses are assigned via auctions. For example, in some frequency bands, FCC authorizes unlicensed use of spectrum—that is, users do not need to obtain a license to use spectrum. Rather, an unlimited number of unlicensed users can share frequencies on a noninterference basis. Thus, the assignment process does not apply to the use of unlicensed spectrum.

spectrum to be reallocated for commercial use. Relocating communications systems entails costs that are affected by many variables related to the systems themselves as well as the relocation plans. Some fixed microwave systems, for example, can use off-the-shelf commercial technology and may just need to be re-tuned to accommodate a change in frequency. However, some systems may require significant modification if the characteristics of the new spectrum frequencies differ sufficiently from the original spectrum. Specialized systems, such as those used for surveillance and law enforcement purposes, may not be compatible with commercial technology, and therefore agencies have to work with vendors to develop equipment that meets mission needs and operational requirements.

In 2004, the Commercial Spectrum Enhancement Act (CSEA) established a Spectrum Relocation Fund,[10] funded from auction proceeds, to cover the costs incurred by Federal entities that relocate to new frequency assignments or transition to alternative technologies.[11] The auction of spectrum licenses in the 1710–1755 MHz band was the first with relocation costs to take place under CSEA. Twelve agencies previously operated communication systems in this band, including DOD. CSEA designated 1710–1755 MHz as "eligible frequencies" for which Federal relocation costs could be paid from the Spectrum Relocation Fund.[12] In September 2006, FCC concluded the auction of licenses in the 1710–1755 MHz band and, in accordance with CSEA,[13] a portion of the auction proceeds is currently being used to pay spectrum relocation expenses.[14]

In response to the President's 2010 memorandum requiring that additional spectrum be made available for commercial use within 10 years, in January 2011, NTIA selected the 1755–1850 MHz band as the priority band for detailed evaluation and required Federal agencies to evaluate the feasibility of relocating systems to alternative spectrum bands. DOD provided NTIA its input in September 2011, and NTIA subsequently issued its assessment of the viability for accommodating commercial wireless broadband in the band in March 2012.[15] Most recently, the President's Council of Advisors on Science and Technology published a report in July 2012 recommending specific steps to ensure the successful implementation of the President's 2010 memorandum.[16] The report found, for example, that clearing and vacating Federal users from certain bands was not a sustainable basis for spectrum policy largely because of the high cost to relocate Federal agencies and disruption to the Federal missions. It recommended new policies to promote the sharing of Federal spectrum. The sharing approach has been questioned by CTIA—The Wireless Association and its members,[17] which argue that cleared spectrum and an exclusive-use approach to spectrum management has enabled the U.S. wireless industry to invest hundreds of billions of dollars to deploy mobile broadband networks resulting in economic benefits for consumers and businesses.

SOME AGENCIES UNDERESTIMATED 1710–1755 MHZ BAND RELOCATION COSTS, ALTHOUGH AUCTION REVENUES APPEAR TO EXCEED THOSE COSTS

Some Federal Agencies Underestimated Relocation Costs

Actual costs to relocate communications systems for 12 Federal agencies from the 1710–1755 MHz band have exceeded original estimates by about $474 million, or 47 percent, as of March 2013. The original transfers from the Spectrum Relocation Fund to agency accounts, totaling over $1 billion, were made in March 2007. Subsequently, some agencies requested additional monies from the Spectrum Relocation Fund to cover relocation expenses. Agencies requesting the largest amounts of subsequent transfers include the Department of Justice ($294 million), the Department

[10] 47 U.S.C. § 928.

[11] Eligible relocation expenses are those costs incurred by a Federal entity to achieve comparable capability of systems, regardless of whether that is achieved by relocating to a new frequency assignment or utilizing an alternative technology. 47 U.S.C. § 923(g)(3).

[12] 47 U.S.C. § 923(g)(2).

[13] 47 U.S.C. § 928(d)(1), appropriates from the Spectrum Relocation Fund such sums as may be required to pay authorized relocation or sharing costs. See, also 47 U.S.C. § 928(c).

[14] This auction included licenses in the 1710–1755 MHz and 2110–2155 MHz bands. In August 2008, FCC held a second auction of the licenses that were not sold in the first auction.

[15] NTIA, An Assessment of the Viability of Accommodating Wireless Broadband in the 1755–1850 MHz Band (Washington, DC: March 2012).

[16] Executive Office of the President, President's Council of Advisors on Science and Technology, Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth (Washington, DC: July 2012).

[17] CTIA—The Wireless Association is an international nonprofit membership organization that has represented the wireless communications industry since 1984. Membership in the association includes wireless carriers and their suppliers, as well as providers and manufacturers of wireless data services and products.

of Homeland Security ($192 million), the Department of Energy ($35 million), and the U.S. Postal Service ($6.6 million). OMB and NTIA officials expect the final relocation cost to be about $1.5 billion compared with the original estimate of about $1 billion. Total actual costs exceed estimated costs for many reasons, including unforeseen challenges, unique issues posed by specific equipment location, the transition timeframe, costs associated with achieving comparable capability, and the fact that some agencies may not have properly followed OMB and NTIA guidance to prepare the original cost estimate. NTIA reports that it expects agencies to complete the relocation effort between 2013 and 2017.

Although 11 of the 12 agencies plan to spend the same amount or more than they estimated, DOD expects to complete the 1710–1755 MHz transition for about $275 million, or approximately $80 million less than its cost estimate. DOD's cost estimates, some made as early as 1995, changed over time as officials considered different relocation scenarios with differing key assumptions and their thinking evolved about the systems that would be affected, according to DOD and NTIA officials. Cost estimates to relocate military systems from the late 1990s and early 2000s ranged from a low of $38 million to as much as $1.6 billion, depending on the scenario. DOD's final cost estimate to relocate from the band was about $355 million. DOD officials told us that the relocation of systems from the 1710–1755 MHz band has been less expensive than originally estimated because many of its systems were simply re-tuned to operate in the 1755–1850 MHz band.

Auction Revenues Appear to Exceed Agency Relocation Costs

The auction of the 1710–1755 MHz band raised almost $6.9 billion in gross winning bids from the sale of licenses to use these frequencies.[18] This revenue minus the expected final relocation costs of approximately $1.5 billion suggests that the auction of the band will raise roughly $5.4 billion for the U.S. Treasury. As mentioned above, NTIA reports that it expects agencies to complete the relocation effort between 2013 and 2017; therefore, the final net revenue amount may change. For example, the Department of the Navy has already initiated a process to return almost $65 million to the Spectrum Relocation Fund.

DOD'S PRELIMINARY COST ESTIMATE SUBSTANTIALLY OR PARTIALLY MET GAO'S IDENTIFIED BEST PRACTICES, BUT CHANGES IN ASSUMPTIONS MAY AFFECT FUTURE COSTS

DOD's Preliminary Cost Estimate for Relocating from the 1755–1850 MHz Band Substantially or Partially Met GAO's Identified Best Practices

DOD's Office of Cost Assessment and Program Evaluation (CAPE)[19] led the effort to prepare the department's preliminary cost estimate portion of its study to determine the feasibility of relocating its 11 major radio systems from the 1755–1850 MHz band. To do so, CAPE worked closely with cost estimators and others at the respective military services regarding the technical and cost data needed to support the estimate and how they should be gathered to maintain consistency across the services. The services' cost estimators compiled and reviewed the program data, identified the appropriate program content affected by each system's relocation, developed cost estimates under the given constraints and assumptions, and internally reviewed the estimates consistent with their standard practices before providing them to CAPE. CAPE staff then reviewed the services' estimates for accuracy and consistency, and obtained DOD management approval on its practices and findings. According to DOD officials, CAPE based this methodology on the cost estimation best practices it customarily employs.

We reviewed DOD's preliminary cost estimation methodology and evaluated it against GAO's Cost Guide, which also identifies cost estimating best practices that help ensure cost estimates are comprehensive, well-documented, accurate, and credible. These characteristics of cost estimates help minimize the risk of cost overruns, missed deadlines, and unmet performance targets:

- A comprehensive cost estimate ensures that costs are neither omitted nor double counted.
- A well-documented estimate is thoroughly documented, including source data and significance, clearly detailed calculations and results, and explanations for choosing a particular method or reference.

[18] Although the AWS–1 auction of spectrum licenses raised $13.7 billion, the portion of the auction proceeds associated with the transferred government spectrum amounted to almost $6.9 billion and was deposited in the Spectrum Relocation Fund.

[19] The Director of Cost Assessment and Program Evaluation (CAPE) is a principal staff assistant and advisor to the Secretary of Defense and Deputy Secretary of Defense in the Office of the Secretary of Defense.

- An accurate cost estimate is unbiased, not overly conservative or overly optimistic, and based on an assessment of most likely costs.
- A credible estimate discusses any limitations of the analysis from uncertainty or biases surrounding data or assumptions.

DOD officials developed the preliminary cost estimate as a less-rigorous, "rough-order-of-magnitude" cost estimate[20] as outlined by NTIA, not a budget-quality cost estimate. Because of this, we performed a high-level analysis, applying GAO's identified best practices to DOD's cost estimate and methodology, and did not review all supporting data and analysis.

Overall, we found that DOD's cost estimate was consistent with the purpose of the feasibility study, which was to inform the decision-making process to reallocate 500 MHz of spectrum for commercial wireless broadband use. Additionally, we found that DOD's methodology substantially met the comprehensive and well-documented characteristics of reliable cost estimates, and partially met the accurate and credible characteristics.[21]

- Comprehensive—Substantially Met: We observed that DOD's estimate included complete information about systems' life cycles, an appropriate level of detail to ensure cost elements were neither omitted nor double-counted, and overarching study assumptions that applied across programs. However, some programs did not list all the discrete tasks required for relocation, and not all the individual programs had evidence of cost-influencing ground rules and assumptions.
- Well-documented—Substantially Met: We found that management reviewed and accepted the estimate, the estimate was consistent with the technical baseline data, and documentation for the majority of programs was sufficient that an analyst unfamiliar with the program could understand and replicate what was done. However, the documentation also captured varying levels of detail on source data and its reliability, as well as on calculations performed and estimation methodology used, some of which were not sufficient to support a rough-order-of-magnitude estimate.
- Accurate—Partially Met: We found that DOD properly applied appropriate inflation rates and made no apparent calculation errors. In addition, the estimated costs agreed with DOD's prior relocation cost estimate for this band conducted in 2001.[22] However, no confidence level was specifically stated in DOD's cost estimate to determine if the costs considered are the most likely costs, which is required to fully or substantially meet this characteristic.
- Credible—Partially Met: We observed that DOD cross-checked major cost elements and found them to be similar. However, some sensitivity analyses and risk assessments were only completed at the program level for some programs, and not at all at a summary level.[23] Performing risk assessments and sensitivity analyses on all projects and at the summary level is required to fully meet this characteristic, and is required on a majority of projects and at the summary level to substantially meet this characteristic.

As the Assumptions Supporting DOD's Cost Estimate for Relocating from the 1755–1850 MHz Band Change, Costs May Also Change

Even though DOD's preliminary cost estimate substantially met some of our best practices, as the assumptions supporting the estimate change over time, costs may also change. According to DOD officials, any change to key assumptions about the

[20] The rough-order-of-magnitude estimate is typically developed to support "what-if" analyses, and is helpful in examining differences in high-level variation alternatives to see which are most feasible. Because it is developed from limited data and in a short time, it should never be considered a budget-quality cost estimate.

[21] GAO's Cost Guide includes five levels of compliance with its best practices. Not Met: Provided no evidence that satisfies any of the characteristic. Minimally Met: Provided evidence that satisfies a small portion of the characteristic. Partially Met: Provided evidence that satisfies about half of the characteristic. Substantially Met: Provided evidence that satisfies a large portion of the characteristic. Fully Met: Provided complete evidence that satisfies the entire characteristic.

[22] CAPE compared the overall cost estimate using constant fiscal year 2011 dollars with DOD's 2001 cost estimate for relocating from the same band (Department of Defense, Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755–1850 MHz Band (February 9, 2001)), adjusting for changes in the types and quantities of the systems, and demonstrated that the two estimates are within 5 percent of each other.

[23] A sensitivity analysis examines how changes to key assumptions and inputs affect the estimate. A risk assessment identifies the factors underlying an estimate that might be uncertain and the risks they pose to the estimate.

bands to which systems would move could substantially change relocation costs. Because decisions about the timeframe for relocation and the spectrum bands to which the various systems would be reassigned have not been made yet, DOD based its current estimate on the most likely assumptions, provided by NTIA, some of which have already been proven inaccurate or are still undetermined. For example:

- Relocation bands: According to DOD officials, equipment relocation costs vary depending on the relocation band's proximity to the current band. Moving to bands further away than the assumed relocation bands could increase costs; moving to closer bands could decrease costs. In addition, congestion, in both the 1755–1850 MHz band and the potential bands to which its systems might be moved, complicates relocation planning. Also, DOD officials said that many of the potential spectrum bands to which DOD's systems could be relocated would not be able to accommodate the new systems unless other actions are also taken. For example, the 2025–2110 MHz band, into which DOD assumed it could move several systems and operate them on a primary basis, is currently allocated to commercial electronic news gathering systems and other commercial systems. To accommodate military systems within this band, FCC would need to withdraw this spectrum from commercial use to allow NTIA to provide DOD primary status within this band, or FCC would have to otherwise ensure that commercial systems operate on a non-interference basis with military systems. FCC has not initiated a rulemaking procedure to begin such processes.
- Relocation start date: DOD's cost estimate assumed relocation would begin in fiscal year 2013, but no auction has been approved, so relocation efforts have not begun. According to DOD officials, new equipment and systems continue to be deployed in and designed for the current band, and older systems are retired. This changes the overall profile of systems in the band, which can change the costs of relocation. For example, a major driver of the cost increase between DOD's 2001 and 2011 relocation estimates for the 1755–1850 MHz band was the large increase in the use of unmanned aerial systems. DOD deployed these systems very little in 2001, but their numbers had increased substantially by 2011. Conversely, equipment near the end of its life cycle when the study was completed may be retired or replaced outside of relocation efforts, which could decrease relocation costs.
- Inflation: Inflation will drive up costs as more time elapses before the auction occurs.

In addition to changing assumptions, the high-level nature of a rough-order-of-magnitude estimate means that it is not as robust as a detailed, budget-quality lifecycle estimate, and its results should not be considered or used with the same confidence. DOD officials said that for a spectrum-band relocation effort, a detailed, budget-quality cost estimate would normally be done during the transition planning phase once a spectrum auction has been approved, and would be based on specific auction and relocation decisions.

NO GOVERNMENT REVENUE FORECASTS EXIST FOR A POTENTIAL AUCTION OF THE 1755–1850 MHZ BAND, AND A VARIETY OF FACTORS COULD INFLUENCE AUCTION REVENUES

Federal Agencies Have Not Produced a Revenue Forecast for the 1755–1850 MHz Band

No official government revenue forecast has been prepared by CBO, FCC, NTIA, or OMB for a potential auction of the 1755–1850 MHz band licenses, but some estimates might be prepared once there is a greater likelihood of an auction. Officials at these agencies knowledgeable about estimating revenue from the auction of spectrum licenses said that it is too early to produce meaningful forecasts for a potential auction of the 1755–1850 MHz band. Moreover, CBO only provides written estimates of potential receipts when a congressional committee reports legislation invoking FCC auctions. OMB officials said NTIA, with OMB concurrence, will transmit Federal agency relocation cost estimates to assist FCC in establishing minimum bids for an auction once it is announced.[24] OMB would also estimate receipts and relocation costs as part of the President's budget. OMB analysts would use relocation cost information from NTIA to complete OMB's estimate of receipts.

Although no official government revenue forecast exists, an economist with the Brattle Group, an economic consulting firm, published a revenue forecast in 2011 for a potential auction of the 1755–1850 MHz band that forecasted revenues of $19.4

[24] FCC calculates minimum bids for spectrum auctions typically based on bandwidth and license-area population. Bidders for specific licenses must put forth opening bids that match or exceed the minimum bid to be in contention.

billion for the band.[25] We did not evaluate the accuracy of this revenue estimate. Like all forecasts, the Brattle Group study was based on certain assumptions. The study assumed that the 1755–1850 MHz band would be generally cleared of Federal users. It also assumed the AWS–1 average nationwide price of $1.03 per MHz-pop as a baseline price for spectrum allocated to wireless broadband services,[26] and that the 1755–1780 MHz portion of the band would be paired with the 2155–2180 MHz band, which various industry stakeholders currently support. The study assumed that the 95 MHz of spectrum between 1755 and 1850 MHz would be auctioned as part of a total of 470 MHz of spectrum included in 6 auctions sequenced 18 months apart and spread over 9 years with total estimated net receipts of $64 billion. In addition, the study adjusted the price of spectrum based on the increase in the supply of spectrum over the course of the six auctions,[27] as well as for differences in the quality of the spectrum bands involved.

A Variety of Factors Could Influence Auction Revenues

Like all goods, the price of licensed spectrum, and ultimately the auction revenue, is determined by supply and demand. This fundamental economic concept helps to explain how the price of licensed spectrum could change depending on how much licensed spectrum is available now and in the future, and how much licensed spectrum is demanded by the wireless industry for broadband applications. Government agencies can influence the supply of spectrum available for licensing, whereas expectations about profitability determine demand for spectrum in the marketplace.[28]

Supply

In 2010, the President directed NTIA to work with FCC to make 500 MHz of spectrum available for use by commercial broadband services within 10 years. This represents a significant increase in the supply of spectrum available for licensing in the marketplace. As with all economic goods, the price and value of licensed spectrum are expected to fall as additional supply is introduced, all other things being equal.

Demand

The expected, potential profitability of a spectrum license influences the level of demand for it. Currently, the demand for licensed spectrum is increasing and a primary driver of this increased demand is the significant growth in commercial-wireless broadband services, including third and fourth generation technologies that are increasingly used for smart phones and tablet computers. Some of the factors that would influence the demand for licensed spectrum are:

- Clearing versus Sharing: Spectrum is more valuable, and companies will pay more to license it, if it is entirely cleared of incumbent Federal users, giving them sole use of licensed spectrum; spectrum licenses are less valuable if access must be shared. Sharing could potentially have a big impact on the price of spectrum licenses. In 2012, the President's Council of Advisors on Science and Technology advocated that sharing between Federal and commercial users become the new norm for spectrum management, especially given the high cost and lengthy time it takes to relocate Federal users.
- Certainty and Timing: Another factor that affects the value of licensed spectrum is the certainty about when it becomes available. Any increase in the probability that the spectrum would not be cleared on time would have a negative effect on the price companies are willing to pay to use it. For example, 7 years after the auction of the 1710–1755 MHz band, Federal agencies are still relocating systems. The estimated 10-year timeframe to clear Federal users from the 1755–1850 MHz band, and potential uncer-

[25] Coleman Bazelon, The Brattle Group, Inc., Expected Receipts From Proposed Spectrum Auctions (Washington, DC: July 28, 2011).

[26] The unit price of licensed spectrum is typically expressed in terms of dollars per MHz-pop, where MHz-pop is the product of total MHz of a band and population covered by the region of a license. The $1.03 price represents the current price for AWS–1 spectrum based on the original AWS–1 price adjusted for inflation using the SpecEx Spectrum Index.

[27] To adjust the price of spectrum for the increased supply, the study used the price elasticity for spectrum. According to the study, wireless broadband spectrum is generally thought to have a price elasticity of around -1.2, which implies that a 1 percent increase in the base supply of spectrum should result in a 1.2 percent decrease in its price.

[28] The value of a spectrum license, and hence the future price of licensed spectrum at a given auction, depends on many factors, ranging from the physical characteristics of the spectrum that is licensed to the general investment climate and the existence of applicable technology infrastructure. For the purposes of this discussion, we focus only on those supply and demand factors directly influenced by government decisions or wireless companies.

tainty around that timeframe, could negatively influence demand for the spectrum.

• Available Wireless Services: Innovation in the wireless broadband market is expected to continue to drive demand for wireless services. For example, demand continues to increase for smartphones and tablets as new services are introduced in the marketplace. These devices can connect to the Internet through regular cellular service using commercial spectrum, or they can use publicly available (unlicensed) spectrum via wireless fidelity (Wi-Fi) networks to access the Internet.[29] The value of the spectrum, therefore, is determined by continued strong development of and demand for wireless services and these devices, and the profits that can be realized from them.

Chairman Udall, Ranking Member Sessions, and members of the subcommittee, this concludes my prepared remarks. I am happy to respond to any questions that you or other members of the subcommittee may have at this time.

GAO CONTACTS AND STAFF ACKNOWLEDGMENTS

For questions about this statement, please contact Mark L. Goldstein, Director, Physical Infrastructure Issues, at (202) 512–2834 or goldsteinm@gao.gov. In addition, contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals who made key contributions to this statement include Mike Clements, assistant Director; Stephen Brown; Jonathan Carver; Jennifer Echard; Emile Ettedgui; Colin Fallon; Bert Japikse; Elke Kolodinski; Joshua Ormond; Jay Tallon; and Elizabeth Wood.

[29] Wi-Fi networks can permit multiple computing devices in each discrete location to share a single wired connection to the Internet, thus efficiently sharing spectrum.

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Senator UDALL. Thank you, Mr. Goldstein.

Finally, we have been joined by Mr. Christopher Guttman-McCabe, Vice President, Regulatory Affairs, CTIA-The Wireless Association. Welcome.

STATEMENT OF MR. CHRISTOPHER GUTTMAN-MCCABE, VICE PRESIDENT, REGULATORY AFFAIRS, CTIA—THE WIRELESS ASSOCIATION

Mr. GUTTMAN-MCCABE. Thank you and good afternoon, Mr. Chairman, Ranking Member Sessions, and Senator Fischer. I appreciate the opportunity to testify before you today.

CTIA represents the wireless carriers, manufacturers, and vendors that drive America's leadership in wireless broadband.

If I may, I would like to ask consent to amend my written testimony to include a letter that was submitted to NTIA this afternoon, regarding the issues that we are going to talk about on the panel today.

Senator UDALL. Without objection, it will follow your written statement.

Mr. GUTTMAN-MCCABE. Thank you.

As I noted in my written testimony, in order to maintain our world leadership in wireless broadband, the wireless ecosystem needs access to additional spectrum. Some of what is needed will come from the broadcast incentive auctions that Congress authorized last year, but as both the Federal Communications Commission (FCC), Congress, and the administration have acknowledged, closing this spectrum deficit will require reallocation of spectrum currently held by Federal users.

One frequency band that would be particularly useful to meet rapidly expanding demand is the 1755 to 1780 megahertz band, a subset of what is currently under review by NTIA. In the United States, the band is used by DOD and other Federal agencies, but internationally it is used to support commercial mobile radio services. Reallocation would harmonize U.S. and international use, produce economies of scale and scope, lower costs, speed implementation, and drive advances in our health care, energy, financial, education, and other sectors of the American economy. American consumers and businesses will get the most advanced networks and devices. The economy will benefit significantly as our industry continues to drive tremendous amounts of investment and job creation, and as we heard numerous times on the first panel, the reallocation process can help agencies to replace systems that in some cases are decades old and outdated with state-of-the-art technology.

This can be a win-win-win for the United States. We hope you can help us to move this process forward. Thank you, and I look forward to your questions.

[The prepared statement of Mr. Guttman-McCabe follows:]

PREPARED STATEMENT BY MR. CHRISTOPHER GUTTMAN-MCCABE

INTRODUCTION

Good afternoon, Chairman Udall, Ranking Member Sessions, and members of the subcommittee. My name is Christopher Guttman-McCabe and I am Vice President of Regulatory Affairs at CTIA—The Wireless Association®. CTIA represents the wireless carriers, equipment vendors, and software developers that drive America's leadership in wireless broadband. Since 1984, CTIA has helped coordinate the wireless industry's voluntary efforts to provide consumers with a variety of choices and information regarding their wireless products and services. It also supports numerous industry initiatives to educate consumers and policymakers on such issues as responsible wireless technology use, the industry's eco-friendly initiatives, and accessible wireless products and services. As Vice President of Regulatory Affairs, I work on a wide range of issues involving spectrum, regulatory mandates, and homeland security. Thank you for inviting me to testify today regarding DOD usage of the electromagnetic spectrum.

THE NEED FOR MORE SPECTRUM TO DRIVE ECONOMIC GROWTH

According to a 2012 report by Recon Analytics, the Nation's mobile communications industry is a significant economic engine, directly or indirectly supporting 3.8 million jobs, or 2.6 percent of all U.S. employment, contributing $195.5 billion to the U.S. gross domestic product and driving $33 billion in productivity improvements in 2011. As the FCC noted in its recently released 16th Wireless Competition Report, the 2010 and 2011 CTIA Wireless Indices Reports indicated that incremental capital investment by wireless operators rose to $24.9 billion in 2010, a 22 percent increase from 2009, and then increased again to $25.3 billion in 2011. In fact, in 2012, U.S. wireless carriers invested more than $30 billion—25 percent of the world's total wireless capital investment for the year. As CTIA also recently pointed out to the FCC, a Deloitte study shows that such continued capital investments -specifically in 40 wireless networks—could generate $73 billion to $151 billion in GDP growth, and create 371,000 to 771,000 jobs in America by 2016.

The industry is expected to expand as businesses and consumers increasingly rely on wireless technologies, including bandwidth-intensive smartphones, tablets, and other hand-held devices as well as machine-to-machine communications. CTIA's most recent semi-annual survey revealed that smartphone adoption and tablet use continues to grow at dramatic rates—driving Americans' use of more than 1.1 trillion megabytes of data from July 2011–June 2012, which was an increase of 104 percent over the previous year. A recent report issued by Cis.co indicated that the number of mobile-connected tablets increased 2.5-fold to 36 million in 2012, and the FCC recently recognized in its Competition Report that the adoption of smartphones alone increased at a 50 percent annual growth rate in 2011. Cisco predicts that this growth will continue, with global mobile data traffic predicted to increase 13-fold between 2012 and 2017 at a compound annual growth rate of 66 percent. As the President's Council of Economic Advisers recently reported, this explosion in wireless data usage is not only driving consumer demand for full Internet browsing, media-rich applications, and streaming video content on mobile devices, but also has the potential to facilitate significant productivity improvements in American businesses, including mobile videoconferencing, real-time remote access to inventory and sales data, and other business-to-employee and business-to-customer applications.

In order to keep pace with this growth and continue to fuel the economic engine it represents, the wireless industry needs access to more radiofrequency spectrum—the most critical input for wireless carriers. CTIA first identified a looming spectrum crisis in 2009, when it urged U.S. policymakers to "immediately launch an effort to identify and allocate significant amounts of additional spectrum for commercial wireless services" in order to meet the demands of consumers and businesses that were, and still are, increasingly dependent on "wherever, whenever" access. As FCC Chairman Genachowski more recently noted, spectrum is the "oxygen" of the wireless industry, and "if we don't free up more spectrum, we're going to run into a wall that will stifle mobile innovation, hurting consumers and slowing economic growth." While carriers have responsibly used advanced technologies to get the most out of their existing spectrum and have used unlicensed Wi-Fi spectrum to "offload"

traffic from carrier networks, those efforts are simply not enough. Carriers must have access to additional licensed spectrum in order to keep up with technological developments and consumer demand.

Unfortunately, the sources of additional spectrum are limited to existing non-government users and Federal users. On the nongovernment side, the FCC and Congress have taken aggressive measures to free up additional spectrum. For example, in last year's Middle Class Tax Relief and Job Creation Act, or the Spectrum Act, Congress authorized the FCC to conduct "incentive auctions" that may result in the conversion of some television broadcast spectrum for wireless broadband use. The FCC has already initiated a rulemaking proceeding to begin to implement that legislation.

On the Federal side, Congress has long recognized the importance of converting underused spectrum to commercial use. Twenty years ago, in the Omnibus Budget Reconciliation of 1993, or OBRA–93, Congress required the Secretary of Commerce to identify spectrum that could be used for commercial purposes. The Balanced Budget Act of 1997 also required the Secretary to identify additional spectrum. The Advanced Wireless Service (AWS) spectrum that many carriers use today was made available as a result of OBRA–93. Congress took similar action in last year's Spectrum Act, mandating that the Secretary of Commerce identify 15 megahertz of spectrum that could be converted to commercial use. The 15 megahertz in the 1695–1710 MHz band has recently been designated for such use and FCC Chairman Genachowski has said the spectrum may be auctioned as soon as September 2014. CTIA recently urged the FCC to initiate a process to convert the 2095–2110 MHz band for terrestrial wireless use and to pair it with the 1695–1710 MHz band, pointing out that the 2095–2110 MHz band is ideally suited for mobile broadband.

However, more work is necessary to make additional spectrum available. CTIA recognizes the essential role spectrum plays for government users, just as it does for commercial entities. According to a 2011 GAO study though, the Federal Government operates in approximately 70 percent of the spectrum below 3 GHz—18 percent on an exclusive basis and 52 percent on a shared basis with non-government users. Just as it is appropriate to ensure that spectrum available to the private sector is being used efficiently and for the most highly valued services, the Federal Government must evaluate the use of its spectrum and—when it can be made available for commercial operations—it should be. The President recognized the need to provide additional spectrum for broadband services and to look at Federal spectrum as part of this effort when he issued a Memorandum in June 2010 directing the National Telecommunications and Information Administration (NTIA) to review Federal spectrum use and provide a plan to make 500 megahertz available.

SHARING IS NOT THE LONG-TERM ANSWER

In order to satisfy the need for additional capacity, carriers need to be able to access spectrum on an exclusive basis. Although the wireless industry is examining whether it can share with Federal users on a limited basis and supports continued study of technologies that can facilitate greater and more dynamic spectrum sharing, shared use of spectrum is not a viable long-term solution. The technologies for such real-time, intelligence-based sharing are not available today, have not yet been proven effective, and will not yield the capacity required to satisfy the growing demand for broadband capacity. In addition, except for limited cases, shared spectrum is an inadequate resource because it is available only some of the time in particular places. Sweeping conclusions that shared use is the only future are therefore simply inappropriate. In the early 2000s, the wireless industry faced a similar "solution" to spectrum needs -ultra-wideband. Many people claimed that UWB devices could utilize spectrum more efficiently and that their commercial availability was "right around the corner." Eleven years later, CTIA is glad that policymakers focused on clearing and auctioning several bands of spectrum, driving our world-leading wireless ecosystem, while still allowing the market to go forward to investigate UWB.

Sharing can be a tool to facilitate the transition of government spectrum to commercial use, but the ultimate goal should be reallocation to the extent possible. Indeed, Congress recognized as much when it directed NTIA in the Spectrum Act to "give priority to options involving reallocation of the band for exclusive non-Federal use and [to] choose options involving shared use only when it determines . . . that relocation of a Federal entity from the band is not feasible." This preference for exclusive use has helped foster the U.S. wireless industry's deployment of mobile broadband networks and provided tremendous economic benefits for U.S. consumers and businesses. In short, sharing is one of many available tools, and as technology advances it may provide additional opportunities for maximizing efficient use of the spectrum. Today, shared spectrum can help supplement a provider's exclusive spec-

trum, but it cannot replace it, nor does it provide the incentives or certainty necessary for carriers to make the very substantial investments needed to deliver world-leading, high quality mobile broadband services to American consumers.

THE 1755–1780 MHZ BAND IS UNIQUELY SUITED FOR COMMERCIAL USE

Therefore, additional spectrum that can be used by carriers on an exclusive basis must be identified. One frequency band that would be particularly helpful in allowing wireless companies to meet rapidly expanding demand is the 1755–1780 MHz spectrum. In the United States, the band is currently used by DOD and other Federal agencies. However, the band is identified internationally for commercial mobile services and is used for that purpose throughout most of the world. Reallocation of the band would therefore harmonize U.S. allocation of spectrum with international use. The 1755–1780 MHz band is also immediately adjacent to existing domestic wireless commercial spectrum and would therefore fit seamlessly into the current mobile broadband spectrum portfolio, allowing for more immediate equipment development and deployment and facilitating easy migration of existing and developing technologies to these bands. Creating a domestic allocation that is consistent with international use will produce economies of scale and scope, making for a more robust equipment market for the band, lowering costs, and speeding implementation. International harmonization of this spectrum will also facilitate consumers' use of their wireless devices while traveling to other countries by alleviating compatibility problems.

There is broad support in the wireless industry for pairing the 1755–1780 MHz band with spectrum currently available for licensing at 2155–2180 MHz. The Spectrum Act requires the 2155–2180 MHz band to be licensed by February 2015. The 1755–1780 MHz band should be available in the same timeframe so that the two bands can be made available together. The benefits of pairing 1755–1780 MHz with 2155–2180 MHz, which will permit alignment with existing services, facilitate faster deployment of services, provide consistency with international allocation of the band, and maximize efficient use of the spectrum, are also reflected in how the spectrum is valued. A study by the Brattle Group found that auctioning the 2155–2180 MHz band by itself would yield $3.6 billion—but auctioned together with 1755–1780 MHz band, the pair would generate $12 billion. Auctioning these bands on a paired basis would therefore ensure the best economic return for taxpayers, as well as the most efficient use for broadband services.

CONGRESS HAS PROVIDED PROTECTION FOR RELOCATING FEDERAL USERS

If the 1755–1780 MHz band is reallocated for commercial operations, Federal users of the band would be completely compensated when they are relocated from the spectrum, just as they have been in past reallocation of government spectrum. For example, the wireless industry and Federal users cooperated in the relocation of operations from the 1710–1755 MHz band so that AWS spectrum could be made available. Now, thanks to the Spectrum Act, Federal users are even better protected when their spectrum is reallocated. In that Act, Congress made important changes to the Commercial Spectrum Enhancement Act (CSEA) which provides resources for government agencies to study relocation options and to update equipment to facilitate clearing or shared use of spectrum. In particular, the Spectrum Act allows NTIA to provide Federal agencies with compensation from the Spectrum Relocation Fund for "relocation or sharing costs" associated with the reallocation and auction of spectrum from Federal to non-Federal or shared use prior to auction. Those funds can be used for planning, equipment upgrades, spectrum sharing costs, and pre-auction planning costs associated with relocation or sharing. These changes to the CSEA provide the resources necessary to study and implement relocation or modernization of Federal systems.

These new protections are in addition to other existing provisions which ensure that Federal operations are not harmed as a result of a reallocation of spectrum. First, relocation costs, which now include "the acquisition of state-of-the-art replacement systems" and which are covered by the Spectrum Relocation Fund, would be funded through the proceeds of the auction ofthe band to commercial licensees. Second, the Secretaries of Defense and Commerce and the Chairman of the Joint Chiefs of Staff would have to certify that relocation spectrum identified by NTIA and the FCC "provides comparable technical characteristics to restore essential military capability," as required by the National Defense Authorization Act for Fiscal Year 2000. Finally, Federal agencies would also have the procedural protections of the CSEA, as recently amended, which requires NTIA review and approval of Federal spectrum users' relocation plans.

These protections can result in a win-win-win for the American public, Federal users and wireless carriers. As part of the process of relocating to new systems, Federal systems, many of which are decades-old and outdated, can upgrade to the newest technology—much of which requires less spectrum to perform the same functions as existing, spectrum-intensive equipment. Purchasing state-of-the-art equipment with auction proceeds will reduce ongoing maintenance and procurement costs for Federal agencies, freeing up scare resources under current budget caps. Wireless carriers can then use the relinquished spectrum to provide services and grow the economy. All Americans will benefit in three ways—by having their government use state-of-the-art secure technology to serve the public, by the growth in the economy that more wireless broadband spectrum will produce and by having wireless systems better equipped to meet increasing demand and technological change.

IMPORTANT FIRST STEPS HAVE BEEN TAKEN TO MAKE THE 1755–1780 MHZ BAND AVAILABLE

I am pleased to report that the wireless industry has already been working with NTIA to examine how the 1755–1780 MHz band can be made available for commercial use. First, the FCC has issued an experimental license for the wireless industry to test the suitability of mobile broadband services in the band. As part ofthis effort, carriers have monitored Federal operations in the band and gathered information about the uses of the band. Those monitoring efforts are now complete and the wireless industry was able to learn more about the systems that operate in the band and the spectrum environment generally in which Federal systems operate. Wireless carriers, along with NTIA, are evaluating the information they gathered in order to decide how to proceed. The next step, as far as the wireless industry is concerned, is to conduct laboratory analysis to determine when harmful interference might actually occur. While some within the Federal Government believe that only theoretical analysis is required, the success ofthis endeavor depends in part on the willingness of the wireless industry to invest billions of dollars to put this spectrum to commercial use. Our members would do so more confidently with more real-life tests.

Second, and in conjunction with monitoring in the 1755–1780 MHz band, members of the wireless industry are participating in Working Groups created under the auspices of the NTIA's Commerce Spectrum Management Advisory Committee, or CSMAC. Working Groups have been created to study each of the Federal systems operating in the 1755–1850 MHz band. These groups provide a forum for an exchange of technical information between Federal entities and industry regarding their respective systems and for discussion and exploration of potential solutions for relocation of Federal operations or for sharing.

IMPEDIMENTS TO THE USE OF THE 1755–1780 MHZ BAND REMAIN

While there has been significant discussion and cooperation between industry, DOD and other Federal entities, the current effort is insufficient to make the 1755–1780 MHz band available for commercial operations, consistent with the President's directive, in the timeframe necessary. Among other reasons, current efforts have not moved away from worst-case technical assumptions of sharing with each Federal system to a more realistic analysis and interactive dialogue about what can be done by both industry and Federal agencies to make 1755–1780 MHz available in a meaningful way while meeting the needs of Federal agencies. In light of the upcoming deadline to auction the 2155–2180 MHz band, with which the 1755–1780 MHz band would be best paired, it is critical that these issues be resolved soon.

As an initial matter, tighter processes must be established by which Federal entities are required to cooperate in evaluating spectrum availability. The Spectrum Act contains specific timeframes for Federal entities to act once spectrum is identified for auction. In that case, Congress realized that Federal entities should not unnecessarily delay the clearing of spectrum for commercial use. Unfortunately, there are no timeframes established for cooperation prior to the time that spectrum is identified. In the current evaluation of the 1755–1780 MHz band for example, it took 6 months to execute a memorandum ofunderstanding, or MOU, governing how monitoring should be conducted. Federal agencies are legitimately concerned about the dissemination of confidential information that may be produced during the spectrum evaluation process. However, that concern and the failure to develop a process that allows for productive discussion while protecting legitimately sensitive information has impeded the free flow of information and prevented evaluation or even consideration ofmeaningful solutions. Federal entities must be able to more quickly assess information that requires a high level of protection while not subjecting all information exchange to the same restrictive processes. These and other steps involved in

identifying and making spectrum available should be streamlined, as other aspects of the spectrum reallocation process already are based on Congressionally mandated timetables for action.

Second, Federal entities must engage in more realistic assessments of the impact of reallocation. As I mentioned earlier, in its recent evaluation of the exclusion zones necessary for commercial use of Federal spectrum, DOD has consistently made worst-case assumptions, resulting in a larger-than-necessary area within which commercial operations would be prohibited. While the wireless industry wishes to ensure that Federal operations receive the protection they need, it is not in the public interest for them to receive a level of protection unsupported by sound engineering practices. The worst-case analysis combined with a lack of dialogue regarding operational issues dooms any consideration of sharing options and results in wasted time and effort.

Similarly, NTIA's estimate of the economic impacts ofrelocation must be more realistic. Overstating these costs could lead to a false conclusion that the spectrum should not be reallocated, producing a missed opportunity to deliver the benefits ofbroadband to all Americans. In the experience of the wireless industry during the A WS relocation process, Federal entities often overestimated the time and costs ofrelocation. In fact, in NTIA's Fifth Annual Report on the A WS spectrum relocation process, it reported that the DOD (in particular, the Navy) returned over $51 million dollars back to the Treasury. NTIA's current estimated costs for relocating systems from the entire 1755–1850 MHz band is $18 billion, but DOD earlier estimated that it would cost only $4.6 billion to clear the entire band. There must be a more reliable review of the costs for relocating Federal users.

Finally, NTIA must begin to focus on the 1755–1780 MHz band in particular, not the broader 1755–1850 MHz band. FCC Chairman Genachowski has already announced that the FCC may auction that spectrum as early as September, 2014. However, current efforts to make that spectrum available are at an impasse because of an insistence that a complete solution be developed for the entire 1755–1850 MHz band before any decision is made with respect to the 1755–1780 MHz sub-band. The current course will fail to develop a solution in the time required to auction 1755–1780 MHz paired with 2155–2180 MHz and will result in missed auction revenue and a missed opportunity for Americans to benefit from greater access to broadband. While 1780–1850 MHz is desirable spectrum, there are no immediate plans by industry to make use of the band. In contrast, the 1755–1780 MHz band is uniquely valuable because, among other things, of the pairing opportunity with 2155–2180 MHz. The 1780–1850 MHz portion of the band has no such immediate pairing opportunity. Because 1789–1850 MHz is situated between two uplink bands—bands used for transmitting from user devices to the base station—it would also be most effectively used as additional uplink spectrum. However, it would require a corresponding downlink band—a band used for transmitting from base stations to user devices—to be useful. Because a matching downlink band is not available today, the value and use of 1780–1850 MHz is currently limited.

Additionally, in assuming that the entire 1755–1850 MHz must be relocated now, DOD has focused on the 2025–2110 MHz band as replacement spectrum. That band would be valuable as commercial downlink spectrum, like most of the 1930–2200 MHz band in which it is located. While not the same as paired spectrum, downlink spectrum can be effectively used without a corresponding uplink. It is therefore unlike the 1780–1850 MHz band, for which there is no current need, which is best used for uplink but for which there is no paired spectrum available. Accordingly, it would not be sound spectrum policy to relocate Federal systems out of the 1780–1850 MHz band now to another band like the 2025–2110 MHz band.

Rather than continue down the current course of studying reallocation of the entire 17551850 MHz band, efforts should be focused on reallocation of the 1755–1780 MHz sub-band in the near-term. Sharing or relocation studies for the 1780–1850 MHz band should continue, in aGcordance with Federal requirements and long-term technology upgrades. However, near-term action to auction the 1755–1780 MHz band paired with 2155–2180 MHz will relieve the growing pressure for spectrum, while allowing Federal agencies reliable access to 1780–1850 MHz for at least 10 years.

With a focus on 1755–1780 MHz, additional Federal assignments in that band should not be permitted. In addition, Federal agencies should be required to provide reliable estimates for clearing the 1755–1780 MHz band, not the entire 1755–1850 MHz spectrum. NTIA's Fifth Annual Report, for example, examined the entire 1755–1850 MHz band. NTIA did not provide estimates for relocation ofjust the 1755–1780 MHz band. While reallocation of the entire band may ultimately be desirable, the immediate focus should be on 1755–1780 MHz.

NTIA has consistently asserted that the 1755–1780 MHz band is difficult to reallocate because of the operations located through the entire 1755–1850 MHz band. It should, however, determine the operations that operate uniquely in the 1755–1780 MHz band in order to better assess operations that must be relocated. Systems that operate throughout the 1755–1850 MHz band can use other parts of the spectrum unless NTIA demonstrates why that is not feasible. Relocating those systems from the 1780–1850 MHz band can be part of a longer-term evaluation of spectrum reallocation.

CONCLUSION

CTIA and its members support exploration of spectrum sharing with Federal users but believe that sharing is not the long-term answer. To the contrary, in order to create certainty and to incentivize wireless carriers to make investments that will benefit the American economy and consumers, the ultimate focus should be on reallocation of spectrum to carriers on an exclusive basis. To that end, the 1755–1780 MHz band, coupled with the 2155–2180 MHz band that is already available for licensing, is ideally situated for commercial use. However, cooperation between Federal and non-Federal users is necessary to achieve the benefits that would result from commercial use of these paired bands. Congress has made important changes to Federal law in order to provide economic and procedural protections to Federal users as they are relocated. At the same time, tighter processes must be established to ensure that Federal users do not unnecessarily delay this consideration or otherwise engage in unrealistic assessments that may impede reallocation. This cooperative approach, along with an increased focus on the 1755–1780 MHz band specifically, will allow the wireless industry and Federal users to develop a plan that fully utilizes scarce resources in order to meet the mounting demand for additional wireless broadband capacity.

Thank you again for the opportunity to appear before you today. CTIA appreciates this subcommittee's continued focus on this important issue and looks forward to working with this subcommittee, Congress, NTIA, DOD, and the FCC on these issues.

[The information referred to follows:]

The Honorable Lawrence E. Strickling
Assistant Secretary, Communications and Information
The U.S. Department of Commerce
1401 Constitution Avenue, N.W.
Washington, D.C. 20230

April 24, 2013

Dear Assistant Secretary Strickling:

It has been more than eighteen months since leading Members of the House and Senate wrote to the President, stating that, for the sake of job creation, deficit reduction, and to meet our country's growing broadband needs, the Administration should prioritize re-purposing from federal use internationally-harmonized spectrum below 3 GHz in sufficiently large channel sizes.

We appreciate the steps that you have taken to implement the President's 2010 directive to make 500 MHz of federal and non-federal spectrum available for commercial mobile wireless use, including the study of the 1755-1850 MHz and other bands. We write to you now to emphasize the industry's keen interest in the 1755-1780 MHz portion of this band and the need to finalize relocation plans for this sub-band in time to be paired and auctioned with the 2155-2180 MHz band.

The leading technology around the world for commercial mobile broadband is Long Term Evolution (LTE), standards for which have been defined by the Third Generation Partnership Project (3GPP), an international standards organization. Carriers around the world have plans to deploy LTE consistent with 3GPP band plans. The 1755-1780 MHz band, when paired with the 2155-2180 MHz band, aligns closely with 3GPP Band Class 10. Pairing the 1755–1780 MHz band with the 2155–2180 MHz band would allow this spectrum to be auctioned and licensed by February 2015, as the Chairman of the Federal Communications Commission recently noted.[1]

We recognize that critical federal systems currently occupy the entire 95 MHz of the 1755-1850 MHz band. However, to meet current mobile demand, it is imperative that the government develop relocation plans for the lowest 25 MHz of the band now for an auction in the near-term. These plans should recognize the legitimate requirements of government operations, including long term access to the rest of the band at 1780-1850 MHz, if other spectrum above 3 GHz is not available for relocating those systems deployed on those frequencies.

While the 1755-1780 MHz sub-band is uniquely valuable given international alignment and the spectrum readily available for pairing at 2155-2180 MHz, the remaining 70 MHz—1780-1850 MHz—has significantly less value to the wireless industry as a standalone band. The greatest need for broadband capacity is on the downlink—the link from the base station to user devices. Because the 1780-1850 MHz frequencies are situated between the PCS and AWS

[1] *See* Letter from the Honorable Julius Genachowski, Chairman, Federal Communications Commission to the Honorable Lawrence E. Strickling, Assistant Secretary for Communications and Information, Department of Commerce, March 20, 2013.

uplink bands, it is more suitable for uplink than downlink operations. Without downlink spectrum available to pair with it, the uplink spectrum at 1780–1850 MHz is of significantly less value to industry at this time and would, with today's technology, accordingly raise significantly less in any auction.[2]

Congress has recognized that deploying internationally-harmonized spectrum benefits U.S. citizens through job growth and capital investment. Ensuring spectrum resources are available to mobile carriers will also provide additional auction proceeds to offset deficit reduction and perhaps provide needed offsets to federal agencies.

In addition, more than a year ago, NTIA's report stated that many federal systems could move off the 1755-1780 MHz sub-band within five years. Indeed, a report from the DOD in 2001 contemplated relocation from the sub-band and provided a cost estimate for such an effort.[3] A relocation cost estimate for the sub-band is needed now as well.

In sum, instead of continuing the current course of contemplating reallocating the entire 1755-1850 MHz band at some point in the distant future we strongly urge that NTIA focus the effort on reallocation of the 1755-1780 MHz sub-band as soon as possible. Sharing or relocation studies for the 1780-1850 MHz band should continue in accordance with federal requirements and should take into account the long-term evolution of available technology. However, near-term action to auction the 1755-1780 MHz band paired with 2155-2180 MHz would help relieve the growing pressure for spectrum. At the same time, federal agencies would continue to have access to 1780-1850 MHz for ten years, based on current technology and potential pairing options.

Sincerely,

Kris Rinne
Network Technologies SVP
AT&T Mobility

Chris Pearson
President
4G Americas

Neville Ray
Chief Technology Officer, T-Mobile

Nicola Palmer
Chief Technology Officer, Verizon Wireless

Steve Largent
President and CEO, CTIA
The Wireless Association

[2] The Department of Defense has proposed relocating systems in the 1755-1850 MHz band to the 2025-2110 MHz band. This would be a mistake. Because much of spectrum use in the bandwidth adjacent to 2025-2110 MHz is for commercial mobile downlink, the 2025-2110 MHz band is far more valuable for downlink than the 1780-1850 MHz band is for uplink. Congressional leaders have stated their preference for relocating federal systems off spectrum below 3 GHz. It does not make policy sense to relocate federal systems from one band below 3 GHz to another—particularly when the new proposed spectrum location could be used to meet growing demand for LTE downlink.

[3] *See The Potential for Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band: Federal Operations, Relocation Costs, and Operational Impacts,* Table 5-6, at 5-11, Department of Commerce and Department of Defense (March 2001).

Senator UDALL. Thank you for that summary.

Let me go right to General Wheeler. General Wheeler, it is my understanding that DOD, along with other agencies, resides in the block of spectrum from 1755 to 1850 megahertz. It has been proposed to transition from this spectrum as a part of the President's initiative to free up 500 megahertz for commercial use. But the estimated cost for this block is $18 billion.

How hard is it to remove some elements from the lower 25 megahertz block in that 755 to 780 megahertz band, and how does time play a role in any movements from this block?

General WHEELER. Thank you, Mr. Chairman.

I think the way to think about this is we moved out of the 1710 to the 1755 megahertz band, retuned, as was discussed before in the GAO discussion, into this new band area, the 1755 to 1850. So we have approximately 100 systems in that particular area, most of which range the whole band, not just the lower portion of the band per se. So they go from the bottom of the band to the top part of the band.

That was why the NTIA pushed for us to go ahead and take a study of the whole band and move that to another location, and also because from that particular perspective, giving a larger piece of spectrum—it is easier to do it from an auction perspective. So if you just do that lower portion, since we have to move many of the systems, even though it is just in the 25 megahertz, because they range the whole area, you do not save much cost by virtue of the whole band versus just the 25 megahertz of the band.

That part of the particular band of looking at that study of just 25 megahertz has not been completed because there is no other band for us to go to at this point that has been proposed. So the bottom line to it is we took a look at it from the whole 95 megahertz perspective and looking at going to 2025 to 2110, which is what all of our costs are based on.

Senator UDALL. Let me continue in that vein. I understand that one issue that is hindering communication between DOD and the industry is the sharing of classified information. To work through the problem, it has been proposed that we establish a trusted agent program—I think you are familiar with the concept—someone from industry with the proper clearances who can be trusted by both DOD and industry to relay information back and forth to the parties.

What is the status of the trusted agent, and do you believe having one is a useful step forward?

General WHEELER. Yes, sir. Bottom line is, yes, I think it is a useful tool to have in this. What we have out there is we have working groups that work through the specific issues associated with each of the bands. What comes out of it is a group of analysis methods and some conclusions. That is shared openly between the groups. We have American citizens and non-American citizens on these particular groups.

What industry has asked for is to go into the analysis deeper and to see exactly where all of the issues are associated with that particular analysis. So what we have done is we give the data to, normally, the NTIA and the FCC, and now we are working through the authorization to allow specific people from specific parts of the industry that are representative to have that particular data. That is presently in general counsel right now and it is going through authorization for us to do that.

Senator UDALL. So there might be more than one trusted agent. You might have some trusted agents.

General WHEELER. We are looking at 12 right now, 12 have been set forward that is going through the process right now to have those authorized to do it.

Senator UDALL. So you are implying you think that is a useful step?

General WHEELER. I think that is a useful step in that I think it builds trust. It builds transparency in there. The fact of the matter is we give them all the analysis methods today and we give them all the actual results. It is just how we go through the specific aspect of each part of the analysis. That is closed because of the classification, because it is not just a FOUO, for Official Use Only data, but it is also Secret and Top Secret data, and all of those are mixed. So that is the reason why we have to have the trusted agent aspect.

Senator UDALL. Mr. Goldstein, let me turn to you and ask you how well did DOD estimate the cost of relocating. How hard is it to factor in the time to relocate, given the complexity of many DOD systems?

Mr. GOLDSTEIN. Thank you, Mr. Chairman.

We think DOD did a pretty good job, given that this was really a feasibility study approach that they did in conjunction with other agencies and with NTIA. When we looked at our cost guides, we found that in most of the measures we looked at, they did well.

However, the biggest problem we face is uncertainty. We do not know when an auction would occur. We do not know over what period of time an auction would occur. We do not know at this point in time, as General Wheeler said, where a lot of systems would be relocated to. We do not know inflation factors. There are so many unknowns at this point in time that developing a more robust estimate which, of course, DOD would do down the line, is something that we just cannot work through at this point until we know more from the FCC and ultimately the NTIA.

Senator UDALL. Thank you for that.

Let me turn to Senator Sessions.

Senator SESSIONS. Thank you.

General Wheeler, just fundamentally how would you say DOD looks at this? Positive, negative, neutral?

General WHEELER. I would argue from the senior military side to this, they see that the strength of our Nation rides on the strength of its economy, and I believe that, sir. I think that they want to find a solution to this because they see lighting up this Nation with broadband is a positive economic piece to us. So I would argue that all the workings that I do and all the folks that I talk to in there understand that this problem needs to be from both a military continuing on with our capabilities, because we provide some very unique capabilities, but also the fact of the matter is we have to do this for the economy because it is about real jobs. So we understand that.

Senator SESSIONS. You do not doubt that it can be done without undue risk in the movement.

General WHEELER. I think if we were to move, for example, in the 1755 to 1850, just for an example, the 2025 to 2110, I think our studies show that it is doable. With the proper time and money, we can make this happen and move over to that particular spectrum. The studies that we have done have shown that that is to be true.

Senator SESSIONS. I noted, General Wheeler, the FCC informed the Department of Commerce it intends to commence auction on

the truncated 1755–1780 megahertz band as early as September 2014. Do you think that is premature?

General WHEELER. I think there are a couple of problems with it. Where are we going to go is the real question at that particular point because that is not in the FCC's transmission of their letter. There is no proposal as to, okay, for DOD, you are going to move to this particular band or go over to this part with your systems and move. So for us, it is a difficult aspect as to how do we study this and how do we take a look at it because there is a requirement for us to present a study as to how we would do that. So there is no actual direction for us to go as to what we are supposed to do in the next steps to move into another band.

Senator SESSIONS. Mr. Goldstein, as I understand it, Federal law requires the auction revenue to be at least 110 percent of the cost of relocation for an auction to take place. Is that correct?

Mr. GOLDSTEIN. Yes, Senator, it is.

Senator SESSIONS. Given the Government-wide costs to relocate, there has been an estimate as high as $18 billion?

Mr. GOLDSTEIN. $18 billion, yes, sir. That is the current estimate.

Senator SESSIONS. Is an auction of the entire band likely to reach the 110 percent requirement?

Mr. GOLDSTEIN. Once again, sir, I think it is probably premature to know. There are still so many factors out there because not only do we not know the length and time of the auction, where various systems would end up going, we do not know the price. There is only one study that I am aware of that has been done. It is several years old by an economic consulting group that basically makes assumptions that the price would be essentially the same price it was in the last auction adjusted for inflation. That may or may not be true. So there are still so many variables. It is truly hard to know.

Senator SESSIONS. Mr. Guttman-McCabe, do you have any comment?

Mr. GUTTMAN-MCCABE. I do, Senator. I think it is important maybe just to take a half step back.

So the letter that I asked for consent to enter into the record specifically asks NTIA to focus just on that lower 25 megahertz. The General is right. There really has not been a study on that 25 megahertz, and there has not been a full analysis of the $18 billion for the entirety of the band.

So what we are asking for is a focus on the 25 megahertz because of two important things. One is there is a natural pair for it that our systems can use and that pair is scheduled for auction by congressional mandate, and it has to be actually allocated and assigned by February 2015. So there are 25 megahertz that is about to be auctioned, and we are looking for the pairing for it. The natural pairing is the lower 25 megahertz that General Wheeler referenced.

What we are trying to get a sense of is what needs to happen with that 25 megahertz. Do all the systems need to be relocated? Can some of them be retuned? Can we move forward quicker with that 25 megahertz? The remaining 70 megahertz has no natural pairing to it. So the industry did not say let us look at this 95 megahertz. The industry said, I want to say maybe a half dozen years ago, let us look at the 25 megahertz.

In the interim, Congress has moved forward mandating an auction of a natural pairing for it. So what we are asking is, can we really focus on that 25 megahertz such that it can be auctioned in a way that it is valuable to the industry?

I would love to hear what General Wheeler says, but I also think we have to move a little bit quicker. It took us 6 months to execute a nondisclosure agreement with DOD. So 6 months just to put a nondisclosure agreement together so we can move forward with this analysis.

We do, we need to have a little bit of alacrity here because we have a deadline for the other half of the auction, and that spectrum, if auctioned unpaired, will bring a fraction—and I think Mr. Goldstein might agree with that—as compared to if it were paired with the spectrum that we are looking at.

So right now, you have the uplink spectrum that would be auctioned and it would be auctioned by itself, which is not beneficial to the wireless networks in the United States. So we are looking for a pairing, and that logical pairing is the bottom 25 megahertz of the entire band that the General is looking at.

Senator SESSIONS. Considering the statute, the 110 percent rule, are you concerned that that may not be reached?

Mr. GUTTMAN-MCCABE. I hate to say this because it is almost against interests, but our members seem to pay more and more every time they come to auction, right? So the last two auctions raised $33 billion combined. We have a couple of auctions coming up. We see usage—we call it a hockey stick. The usage rates are just going through the roof. When we began this process in 2009 and said there was a looming spectrum crisis, there were not tablets. There were not what we call verticals. So there was no medical usage, no smart grid, no education. The uses have changed dramatically even since we did a call to arms to say something needs to be done. So, again, I am hesitant to say it but I think it will raise a great deal of money.

I think what we need to do is find out logically what is on the other side of the equation. When we did this 10 years ago when I first started at CTIA, we did it for the advanced wireless service band. The initial DOD estimate ended up being 400 percent above what the final amount was. So what we want to do is take a good, hard look at that $18 billion, but really zero in on the 25 megahertz, what is in there, what needs to be moved or what can be retuned, what can we help to upgrade. In this environment of budget constraints, what can we take this money to legally outside of the sequestration process and outside the budget process? What can we do with this money to help some of these systems upgrade to advanced technologies? It is all incumbent on us zeroing in on that 25 megahertz.

Senator SESSIONS. Thank you. It is a complex and important matter.

Senator UDALL. Thank you very much.

Senator Fischer.

Senator FISCHER. Thank you, Mr. Chairman.

So we have a finite resource, and we have a resource that is very valuable. You said the cost or the value of it is increasing like a

hockey stick, and I see that becoming even more valuable as we see technology advancing.

Focusing on the lower 25 here, General Wheeler, in your prepared statement you said it is important to understand the long-term status of the full band as part of any decision on the lower 25 megahertz. Do you feel that the DOD can consider the lower 25 at this point without having a full plan in place, without looking at what is going to happen to the rest of it? Can you look that far into the future?

General WHEELER. I think the way I would approach it is the fact that—if I could give you an illumination of some of the systems that are in the band. We are looking at airborne platforms that go across the whole United States that actually span that whole band. We actually have satellite control functions that are in the 1755 to 1780 type area. So of those 100 systems, most come across that whole area. That is really the problem. By just going after that 25 megahertz, we really have to redo all of the systems. So where do we put those systems since we retuned out of the 1710 to 1755 and many of these receivers and transmitters no longer have the ability to do that? They are actually at the high end of their capability. So we are going to have to move them to a separate band.

We have not done a specific study, directly to your question, ma'am. So that part of it is definitely something that we can do. We are directed through the Department of Commerce or NTIA to do what we are supposed to look at, and we put all of our assets, if you will, on the movement of us from the 95 megahertz out of that particular band because the other fear we have at this particular point is we only finished moving out of the 1710 to 1755 in March, and we were told to move to the 1755 to 1850 because that was supposed to be where we were going to reside for the future. Then now it has only been a year later and we are told we are going to have to move out of that and just try to push your systems into a different area. We are trying to find a place where we can go actually reside without actually affecting the commercial aspects. We believe that is important for them as well. So we are trying to move out of the whole band.

Senator FISCHER. Did I understand you earlier when you said that this bandwidth that you are currently on now—DOD uses that in the United States, but internationally it is used commercially?

General WHEELER. In different parts of the world, it is used for different parts, but that is true.

Senator FISCHER. How does that play into the usage that DOD has? How does that work when we are overseas? How do we accommodate our system to work on this?

General WHEELER. An interesting question, ma'am, because what happens is our allies do not have enough training frequencies to come to. So they actually come to the United States to do the training with us and use our systems in many cases because we have the airspace, for example, we have the ground ranges, and we have the actual capabilities with that spectrum to train with them. So it is part of the training that we actually do with all of our allies for Afghanistan, Iraq, and all those different locations. So they come back over to our side.

From a satellite perspective, ma'am, when we control a lot of our satellites, that particular realm, they just happen in geographical areas within the United States. It is the downlinks and uplinks.

Senator FISCHER. In another part of your prepared statement, you said that the DOD is evaluating sharing part of the band with the private sector. What is the status of your evaluation of the sharing part? Then I would like to ask Mr. Guttman-McCabe how he feels about sharing.

General WHEELER. Ma'am, there are five separate working groups in that particular area. Some have already brought out their thoughts and some are completing it by the summer. We think there is some value in sharing. It is a way to make the capability for the particular bands available sooner. I would argue that probably a real solution out of this particular arena is going to be a combination of sharing while we vacate. So if you could look at it from that particular perspective, if you pair the different methodologies while you are vacating out of a specific band, you also share. The sharing can be either by time or it can be by geographic. For example, a satellite that is in space—they sometimes maintain 30 years of capability without the ability to change the frequency, but you can do geographic sharing there while you are waiting for the new system to come online.

So we agree that sharing is a methodology for the future, and to be frank, with a finite resource, I think it is going to be the only way that we will finally get to the full solution. But I also believe in the short term that using sharing while we vacate a band is the way to get that spectrum released the quickest.

Senator FISCHER. On average, how long does it take DOD to vacate?

General WHEELER. What they are saying in our studies right now, that we are looking at 10 years approximately for most systems. Now, to be frank, if you share while you are vacating in those areas, you can open up wide areas of the band within 5 years, but just not all of it, obviously, because of the satellites, et cetera.

Senator FISCHER. Thank you.

Do you want to share? Are you going to play nice?

Mr. GUTTMAN-MCCABE. It may be overly simplistic, Senator, but sharing requires two parties. DOD has been good about opening up its information and allowing us to investigate. Aside from the five groups that are working through the NTIA, we also have—three of our carriers through CTIA have what is called an STA, a Special Temporary Authority. They are investigating independently with DOD systems.

Now, the net result has to be that the asset can be used in a meaningful way, and right now what we are finding with some of the analysis is that the folks at DOD are taking a real, absolute worst-case scenario look at the analysis. I will give you an example.

Two of the aerial systems, if you overlay their exclusion zones right now, your State may be one of the few States that actually has any availability in the United States. There is some space in Maine, some in the central United States, but in the majority of the United States, both geographically and population-based, would not be usable. So sharing when the net result is that you actually

do not get access to the asset, whether it is geographic or time-based, temporal, it does not really drive any benefit.

So we are investigating sharing. We have spent a significant amount of money working with and hiring trusted third party agents, Mr. Chairman, that you talked about. We are trying to work through what it would look like ultimately. But both sides need to be willing to take fresh looks at it, to take not aggressive but real-world looks instead of worst case scenario. If we do not do that, then this notion of sharing is almost a lost cause.

Senator FISCHER. Thank you.

Thank you, Mr. Chairman.

Senator UDALL. Thank you, Senator Fischer.

I am going to begin to bring the hearing to a close. Do you have any other questions, Senator Fischer, you wanted to ask?

Senator FISCHER. Could I?

Senator UDALL. Yes, please, yes.

Senator FISCHER. Thank you very much.

I love this stuff. Thank you, guys. [Laughter.]

General Wheeler, how does DOD plan to move forward on this?

General WHEELER. Ma'am, we are continuing to work through the working groups right now. We are pushing hard.

Senator FISCHER. Working group studies. You are including the private sector, I would assume?

General WHEELER. Yes, ma'am. The working groups are part of the Commerce Spectrum Management Advisory Committee groups that is part of Commerce that we are going forward—we are being aggressive in those particular areas. We are working with those carriers that we discussed, bringing them on the various bases, and trying to get an understanding of their expertise versus ours and what we see in the different areas. We brought them across the country, allowed them on the different bases to see if there are some ideas because we think partnering with industry is the way to go.

We have used sharing a lot. If you look above that prime real estate below 3 gigahertz, 54 percent of our spectrum today is shared with Federal and non-Federal entities that we do today. 54 percent of that particular one we share this environment.

There are some systems that are difficult to share. The airborne platforms are one of them, ma'am. That is why we talk about sharing and vacating as a package because there are certain systems that do not lend themselves to easy sharing, whereas a satellite uplink where you have geographic sharing capacity does because the exclusion area is relatively small when you look at it from a geographical perspective from the Nation.

But again, from an airborne platform that rides across the whole Nation and does this, that is an issue. We have over 10,000 flights using one system per year over the United States. It is a 24/7 operation. As an aviator and as someone who flies stealth air assets, it has been one of the edges that we have used in combat. So that is a system I would argue that we would have to move out of the spectrum. The ones for satellite uplinks I would argue is geographical sharing.

So if you start to pair those and come up with that, those are real ideas to move open space and to share at the same time while you are finally going to vacate out there at a future date.

Senator FISCHER. What does the private industry see as a way forward on this?

Mr. GUTTMAN-MCCABE. I think we would agree with the General, realistic sharing with the goal of ultimately clearing. I think when you talk about competitiveness around the world, you could name the top 10 or 15 countries we would want to compare ourselves to, Japan, South Korea, United Kingdom, Italy, Germany, France, Spain, Mexico, Canada. All of these countries have brought hundreds of megahertz of cleared spectrum to market in the last year. They all get it. They are all a fraction of our size, have a fraction of our usage, and they know they want to catch up to us in terms of our leadership in the mobile space.

So for us, sharing can be an on-ramp to clearing, but to the extent that we can get the cleared spectrum that can allow us to continue to maintain the edge, we have. Military is one of them, but there are not a lot of areas in the United States that you can say we have the technological edge. We do in the mobile platform. We really do, and everything gets launched here first, and we want to maintain that. But we need real help. It cannot take 6 months to execute a nondisclosure agreement. That cannot be part of this process when we have a deadline, a clock, established by Congress to auction some of these bands.

Senator FISCHER. Thank you all very much.

Thank you, Mr. Chairman.

Senator UDALL. Thank you, Senator Fischer, for eliciting some passion and helpful responses as we face perhaps having to play King Solomon.

Mr. Guttman-McCabe, I want to give you the final question and then I will make a comment and we will bring the hearing to a close.

Talk about the trusted agent concept. I asked General Wheeler his point of view. Share your thoughts, if you will.

Mr. GUTTMAN-MCCABE. Yes. So I think we would support, we have supported it. As the General suggested, the industry gave DOD a list of 12 names that go across both carrier and manufacturer companies to try to give a broad swath of what we call our ecosystem. It makes sense.

But the entities in the trusted agent environment have to have the requisite knowledge of our systems, of our networks. Our networks move so quickly that if you—and I am going to get myself in trouble, but if you leave it to NTIA or the FCC to be the trusted agents, the reality is they do not have a clear real-time understanding of our networks. We found that with some of the working groups. We went in and said, no, this is not what long-term evolution, our newest technology—this is not the power levels. They are not the outer band of missions. They are here. It changed some of the exclusion zones by up to 80 percent. So we would love a trusted agent as long as those trusted agents have the requisite knowledge of our industry, of our ecosystem, and our networks.

Senator UDALL. I did hear General Wheeler talk about 12 such agents, and what I hear you saying is let us make sure they know in detail. I think the General agrees.

This has been very helpful. Senator Fischer and I come from a part of the country where water is a finite resource. It is the most valuable resource. The Office of Science and Technology Policy convened a group of experts who advocated that since spectrum was a finite resource much like water, we could move towards a scheme of sharing spectrum. In the west, our water law has led to the famous saying that "whiskey is for drinking, water is for fighting over." [Laughter.]

Sometimes Colorado and Nebraska team up against Kansas and sometimes Kansas and Nebraska team up against Colorado. But I would hope we could find a way to share this crucial, valuable finite resource with all the various nuances you all have shared with us.

Thank you again for attending the hearing. We look forward to further commentary and testimony you might want to submit. We will keep the record open to ask any additional questions.

This hearing is adjourned.

[Whereupon, at 4:04 p.m., the subcommittee adjourned.]