

COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS FOR FISCAL YEAR 2014

THURSDAY, APRIL 25, 2013

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 9:30 a.m., in room SD-192, Dirksen Senate Office Building, Hon. Richard C. Shelby presiding.
Present: Senators Mikulski, Shelby, and Cochran.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF HON. CHARLES F. BOLDEN, JR., ADMINISTRATOR

OPENING STATEMENT OF SENATOR RICHARD C. SHELBY

Senator SHELBY. The subcommittee will come to order.

Senator Mikulski, our chairperson, is running a little late. You never know when traffic and other things happen, General Bolden, so she asked me to go ahead and get started. And with your permission, I will.

General Bolden, I'm going to give an opening statement, and then we'll see where we go from there.

The National Aeronautics and Space Administration (NASA) is one of the most publicly-recognized agencies in the Federal Government and an inspiration to young people around the world, motivating them to become scientists, engineers, and explorers. I look forward to hearing from Administrator Bolden about this budget and NASA's plans for the future.

The fiscal year 2014 budget aspires to do many new, innovative, and exciting things, yet it proposes, General Bolden, no additional funding. In essence, NASA is proposing to do more with less.

I strongly believe that this country must continue to push the science and engineering envelope while maintaining focus on current investments in order to realize tangible benefits.

I'm concerned, General Bolden, that the budget before us is an example of chasing the next great idea while sacrificing current investments. This country has finite resources to invest, and while we're committed to NASA's mission, subjecting mission-critical activities to shoestring budgets because a more exciting idea has come along I don't think is wise.

Based on the proposed budget, as well as previous budgets, I have serious doubts about NASA's dedication to truly developing a heavy launch capability. I hope you will dispel that.

While your testimony, Administrator Bolden, points out that NASA is building the world's most powerful rocket, the Space Launch System (SLS), the budget doesn't reflect NASA's commitment to that goal. Instead, it shows cuts to SLS vehicle development as far as we can see.

This budget focuses, I believe, too heavily on maintaining the fiction of privately funded commercial launch vehicles which diverts, I think, critical resources from NASA's goal of developing human space flight capabilities with the SLS.

I've long been a supporter of public-private partnerships that use Federal dollars to leverage private resources in everything. In this case, however, NASA has provided \$1.5 billion to for-profit companies for the development of launch capabilities, but it's my understanding it has no idea how much money these companies are investing themselves. And according to NASA's budget office, it has no authority to ask. That's troubling.

In addition, NASA has no ability to keep the projects on budget or on schedule because of the nature of the contract that was executed.

It's also troubling that NASA paid these companies in spite of delayed milestones, shifting completion dates, and an altered final delivery schedule, and then had to provide additional payments in excess of \$200 million so these projects could be successful. This sounds like a great arrangement for the companies, but I don't believe it's a great arrangement for the taxpayer.

PREPARED STATEMENT

There are many unanswered questions about NASA's vision for the future and how it plans to achieve that vision. With this budget proposal, we have a significant challenge ahead of us, but I believe that with some direction and some accountability, NASA's endeavors can be successful and inspire future generations.

I look forward to working with Chairman Mikulski and with you, Mr. Administrator, in the coming months. And I ask that my full statement be made part of the record.

[The statement follows:]

PREPARED STATEMENT OF SENATOR RICHARD C. SHELBY

Thank you, Madam Chair.

NASA is one of the most publicly-recognized agencies in the Federal Government and an inspiration to young people around the world motivating them to become scientists, engineers, and explorers. I look forward to hearing from Administrator Bolden about this budget and NASA's plans for the future.

The fiscal year 2014 budget aspires to do many new, innovative, and exciting things, yet it proposes no additional funding. In essence, NASA is proposing to do more with less. I strongly believe that this country must continue to push the science and engineering envelope while maintaining focus on current investments in order to reap tangible benefits.

I am concerned that the budget before us however, is an example of chasing the next great idea while sacrificing current investments. This country has finite resources to invest and while we are committed to NASA's mission, subjecting mission critical activities to shoestring budgets because a more exciting idea has come along is not wise.

Based on the proposed budget, as well as previous budgets, I have serious doubts about NASA's dedication to truly developing a heavy launch capability. While your testimony Administrator Bolden, points out that NASA is building the world's most powerful rocket, the Space Launch System, the budget does not reflect NASA's com-

mitment to that goal. Instead, it shows cuts to SLS vehicle development as far as the eye can see.

This budget focuses too heavily on maintaining the fiction of privately funded commercial cargo and crew vehicles which diverts critical resources from NASA's goal of developing human space flight capabilities with the SLS. Administrator Bolden, I have long been a supporter of public-private partnerships that use Federal dollars to leverage private resources. In this case however, NASA has provided \$1.5 billion dollars through Space Act Agreements to for-profit companies to develop low Earth orbit launch capabilities but has no idea how much money these companies are investing themselves, and according to NASA's budget office, has no authority to ask. In addition, NASA has no ability to keep the projects on budget or on schedule because of the nature of the contract that was executed.

It is troubling that NASA paid the companies developing cargo capability in spite of delayed milestones, shifting completion dates, and an altered final delivery schedule and then had to provide additional payments in excess of \$200 million so these projects could be successful. This sounds like a great arrangement for the companies but I don't believe it is a great arrangement for the taxpayer.

There are many unanswered questions about NASA's vision for the future and how it plans to achieve that vision. With this budget proposal, we have a significant challenge ahead of us but I believe that with some direction and greater accountability, NASA's endeavors can be successful and inspire future generations.

I look forward to working with the Chair and you, Mr. Administrator in the coming months.

Senator SHELBY. And I need to mention that the subcommittee has taken Inspector General Paul Martin's testimony for the record already.

Senator Cochran, do you have an opening statement?

STATEMENT OF SENATOR THAD COCHRAN

Senator COCHRAN. Mr. Chairman, I'm pleased to join you in welcoming our distinguished witness to the subcommittee today to review the budget requests for NASA for fiscal year 2014.

I ask unanimous consent that my full statement be printed in the record.

Senator SHELBY. Without objection, so ordered.

[The statement follows:]

PREPARED STATEMENT OF SENATOR THAD COCHRAN

Madam Chairwoman, I join you in welcoming Administrator Bolden to our hearing today on the fiscal year 2014 NASA budget request. I look forward to our work to help ensure appropriate levels of funding for the NASA activities during this budget year.

I am pleased that NASA appears to be moving forward with the development of the Space Launch System. As you know, Stennis Space Center in Mississippi is very important to the people of my State and I am hopeful that we can continue to work together to ensure that we have adequate rocket testing infrastructure at Stennis to support the Space Launch System and our Nation's space exploration goals.

Senator SHELBY. General Bolden, I talked with you a few minutes ago, but we officially welcome you to the subcommittee, and look forward to your testimony and the question-and-answer period, and I'm sure the chairwoman will join us soon.

Mr. BOLDEN. Thank you very much.

Senator SHELBY. Proceed as you wish.

SUMMARY STATEMENT OF HON. CHARLES F. BOLDEN, JR.

Mr. BOLDEN. Thank you, Sir. Mr. Chairman and members of the subcommittee, first of all, I know Chairman Mikulski is not here yet, and I've congratulated both of you in private on your ascension to the chairmanship and ranking membership of the full com-

mittee, and I want to congratulate you again and tell you how much I look forward to working with you in all aspects.

I want to thank this subcommittee for the opportunity to appear today to discuss NASA's fiscal year 2014 budget request. Let me start, again, by thanking this subcommittee for its continued bipartisan support of NASA and the world's second-to-none civil space program. That support is also reflected among the American people and in the White House, as evidenced by the President's \$17.7 billion funding request for NASA.

The budget reflects today's fiscal realities and aligns NASA's full spectrum of activities to meet the President's challenge to send humans to an asteroid in 2025 and to Mars in the 2030s. As part of the agency's overall asteroid strategy, NASA is planning a first-ever mission to identify, capture, and redirect an asteroid into orbit around the Moon. This mission represents an unprecedented technological challenge, raising the bar for human exploration and discovery, while helping protect our home planet and bringing us closer to a human mission to Mars in the 2030s.

This budget also supports NASA's partnerships with American industry partners who are developing new ways to reach space. These partnerships are creating jobs and enabling NASA to focus on new technologies that benefit all of our missions. Industry partner SpaceX has begun resupplying the International Space Station (ISS) with cargo launched from the United States. This past Sunday's successful test launch by Orbital Science of its Antares launch vehicle marks another significant milestone in NASA's plan to rely on American companies to launch supplies and astronauts to the International Space Station. Orbital is now poised for its first demonstration launch and mission to the ISS later this year.

The administration is committed to launching American astronauts from U.S. soil within the next 4 years. This budget provides the necessary resources to achieve that goal. This budget fully funds the ISS that remains the springboard to our next great leap in exploration. It also continues investments that are developing the SLS rocket and Orion crew vehicle that will take astronauts to deep space. And it supports driving the development of space technologies, such as solar electric propulsion, that will power tomorrow's missions and help improve life on Earth.

This budget continues to build on our Nation's record of breathtaking scientific discoveries and achievements in space with science missions that will reach farther into our solar system and provide critical knowledge about our home planet.

Among other science goals, the budget will sustain NASA's vital role in helping us understand Earth's systems and climate, and the dynamics between our planet and our sun. These efforts will provide critical knowledge about our home planet and potential threats. We will continue steady progress toward our next great observatory as we develop the James Webb Space Telescope (JWST), scheduled to launch in 2018.

NASA's programs of innovative aeronautics research are pursuing an ambitious research agenda for substantially reducing aircraft fuel consumption, emissions, and noise. With the fiscal year 2014 request, NASA begins a new \$25 million-a-year advanced

composites project that will focus on innovative composite materials and structures.

PREPARED STATEMENT

Mr. Chairman, we've had to make some tough choices with this budget, as I'm certain we'll discuss today. But I'm committed to making sure that NASA is using its resources strategically for a cohesive exploration program that bolsters our economy, improves life here on Earth, and raises the bar of what humans can achieve.

I look forward to your questions.

[The statements follows:]

PREPARED STATEMENT OF HON. CHARLES F. BOLDEN, JR.

Madam Chairwoman and members of the subcommittee, I am pleased to have this opportunity to discuss NASA's fiscal year 2014 budget request. The requested budget of \$17.715 billion will support continuing progress toward implementing the bipartisan program for NASA agreed to by the President and Congress, which will ensure the United States continues to lead the world in space exploration, technology, innovation, and scientific discovery. A summary of the fiscal year 2014 budget request is appended to this statement.

American astronauts are living and working in space on board the International Space Station (ISS), conducting an expanding research program with an array of partners. By partnering with American companies, we are cost-effectively resupplying the space station from U.S. soil, and we are on track to end our sole reliance on Russia for astronaut transport to and from the Space Station by 2017. NASA is developing spaceflight capabilities to send humans to an asteroid by 2025 and on to Mars in the 2030s. To accomplish these goals, we are building the world's most powerful rocket, the Space Launch System (SLS), and a deep space exploration crew vehicle, the Orion Multi-Purpose Crew Vehicle (MPCV). In critical support of the Agency's broader mission, we are developing and testing space technologies that will enable us to move and operate faster and more efficiently in space, land more mass accurately on another planet, and enable new destinations to be visited. These technologies include solar electric propulsion, learning to store and transfer fuel in orbit, radiation protection, laser communications, high-reliability life support systems, and human and robotic interfaces. Our aeronautics research is making air travel cleaner, safer, and more efficient. With many missions actively observing Earth, the planets, the Sun, and the Universe, we remain the world's premier space science organization and the critical source of information for an understanding of Earth's climate that can only be gained from the global perspective of space. We are extending these cutting-edge capabilities with major new developments, including the James Webb Space Telescope and a new Mars rover. Despite an uncertain budget climate, NASA is delivering the world's preeminent space program, supporting an innovation economy, and broadening our understanding of the universe around us.

As is briefly described below, NASA's resources are directed to accomplish the goals set for the Agency by the Congress and the President. Our improved processes for cost estimating and program management play a critical role in our ability to manage our resources, and we remain on track in our major developments. NASA is confident that we can continue to execute the program described below within the budget levels anticipated in the President's fiscal year 2014 request for NASA. We will attempt to maintain and implement long-term development plans within future budgets as they are appropriated. The Agency stands committed to executing our programs as efficiently as possible.

AN INTEGRATED EXPLORATION MISSION

The President's fiscal year 2014 budget request continues to implement the bipartisan strategy for space exploration approved by Congress in 2010, a plan that advances U.S. preeminence in science and technology, improves life on Earth, and protects our home planet, all while helping create jobs and strengthening the American economy. This budget reflects current fiscal realities by aligning and leveraging relevant portions of NASA's science, space technology, and human exploration capabilities to achieve the President's challenge of sending astronauts to an asteroid by 2025.

As part of the agency's overall asteroid strategy, NASA is planning a first-ever mission to identify, capture, and redirect an asteroid into orbit around the Moon.

The overall mission is composed of three separate and independently compelling elements: the detection and characterization of candidate near-Earth asteroids; the robotic rendezvous, capture, and redirection of a target asteroid to the Earth-Moon system; and the crewed mission to explore and sample the captured asteroid using the Space Launch System (SLS) and the Orion crew capsule. This mission represents an unprecedented technological challenge—raising the bar for human exploration and discovery, while helping protect our home planet and bringing us closer to a human mission to Mars in the 2030s.

Each mission element would heavily leverage ongoing activities across the Human Exploration and Operations, Space Technology, and Science Mission Directorates. We are currently working to align ongoing activities across these directorates to affordably achieve the objectives while we plan this mission. Progress will continue conditional on feasibility and affordability. Funding provided within the President's fiscal year 2014 budget request will augment our existing activities in Space Technology, Science, and Human Exploration and Operations to: enhance our near-Earth asteroid detection and characterization assets; accelerate advanced solar electric propulsion development; and design and test capabilities to capture a small, yet slowly tumbling asteroid in space.

SCIENCE

With 60 missions observing Earth, the Sun, the planets, and the Universe, NASA remains the world's premier space science organization and the critical source of information on the home planet. NASA's budget request for the Science Mission Directorate includes \$5,017.8 million with \$1,846.1 million for Earth Science, \$1,217.5 million for Planetary Science, \$642.3 million for Astrophysics, \$658.2 million for the James Webb Telescope, and \$653.7 million for Heliophysics.

Earth Science

Seventeen NASA Earth Science research missions currently in orbit study the home planet as an integrated system, including the recently launched Landsat Data Continuity Mission (LDCM), which is undergoing on-orbit checkout. NASA is also beginning work on land imaging capabilities beyond LDCM as well as climate sensors that were previously part of the Joint Polar Satellite System (JPSS). NASA missions continue to give us a global perspective on how Earth works as a system and how our climate is changing over time. Few products of NASA's research can be as valuable, in a material sense, as an accurate understanding of the future of our planet's environment—on land, in the oceans, and throughout the atmosphere. The fiscal year 2014 request supports the launch of two new Earth science missions in fiscal year 2014, and final preparations for launch of two more before the end of the calendar year. The Global Precipitation Measurement (GPM) mission, a cooperative mission with the Japan Aerospace Exploration Agency (JAXA), will provide unprecedented global precipitation observations and the Orbiting Carbon Observatory-2 (OCO-2) will provide accurate global measurements of atmospheric carbon dioxide levels. In the fall of 2014, NASA will launch the Soil Moisture Active Passive (SMAP) mission to study the Earth's hydrologic cycle. At the end of the calendar year, in a collaboration among NASA's Science Mission Directorate, Human Exploration and Operations Mission Directorate, and the European Space Agency, NASA will launch and install the Stratospheric Aerosol and Gas Experiment III (SAGE III) on the ISS to continue critical long-term measurements of the vertical structure of aerosols, ozone, water vapor, and other important trace gases in the upper atmosphere.

Astrophysics and James Webb Space Telescope

NASA is on track and making excellent progress on the James Webb Space Telescope, the most powerful space telescope in history. The Webb telescope is the next in a series of astrophysics missions, including the venerable, yet still unrivaled Hubble Space Telescope and the incredibly productive Kepler exoplanet mission, which are revolutionizing our understanding of the universe. After launching in 2018, the Webb telescope will travel 1 million miles from Earth, unfold its sunshield to the size of a tennis court, and keep its instruments cooled to a temperature of 370–387 degrees below zero Fahrenheit (40–50 kelvins). The Webb telescope will allow us to observe objects even fainter than the Hubble Space Telescope can see, which will allow us to study every phase in the history of our universe, ranging from the first luminous glows after the Big Bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own solar system. The fiscal year 2014 request will support work to finish the Webb science instruments, begin their testing as an integrated science payload, and commence construction on the spacecraft that will carry the science instruments and the telescope.

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) airborne observatory is making its second year of science observations. Operating at altitudes of between 39,000 to 45,000 feet (12–14 kilometers) and above 99 percent of the water vapor in the atmosphere, SOFIA makes observations that are unobtainable from telescopes on the ground. In the coming year, SOFIA will begin its next set of science observations. Flying out of Palmdale, California, and Christchurch, New Zealand, SOFIA will observe star-forming regions in our galaxy from its vantage point at the top of the Earth's atmosphere.

Planetary Science

Building on the brilliant success of NASA's new Curiosity rover on Mars, the 2014 request supports plans for a robust multiyear Mars program, including a new robotic science rover based on the Curiosity design set to launch in 2020. The current portfolio includes the Curiosity and Opportunity rovers, the Mars Reconnaissance Orbiter, the Mars Odyssey orbiter, and our collaboration with the European Space Agency Mars Express orbiter. Future missions include the 2013 Mars Atmosphere and Volatile Evolution (MAVEN) orbiter to study the Martian upper atmosphere; the 2016 Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) mission (which will take the first look into the deep interior of Mars); participation in the European Space Agency's 2016 and 2018 ExoMars missions; and the new Mars rover planned for launch in 2020.

Last summer, NASA's Dawn mission completed more than a year in orbit around the asteroid Vesta, and departed for its 2015 rendezvous with Ceres, the largest known asteroid. NASA is developing a robotic asteroid rendezvous and sample return mission, dubbed OSIRIS-REx (for Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer), which is planned to launch in 2016. After traveling 3 years, OSIRIS-REx will approach the Near Earth Asteroid 1999 RQ36, map the asteroid, and collect a sample of up to 2.2 pounds for return to Earth. This mission will provide valuable data and experience in support of NASA's planned human exploration of a Near Earth Asteroid. In addition, the fiscal year 2014 budget request includes enhanced funding for NASA's Near Earth Object survey and characterization activities in support of human exploration and to protect our planet.

Heliophysics

Perhaps even more dynamic than the Earth's climate are the processes taking place within the Earth's nearby star, the Sun. NASA's Heliophysics Program operates nearly 20 spacecraft to expand our understanding of the Sun, its complex interaction with Earth, other planetary systems, the vast space within the solar system, and the interface with interstellar space. Last year saw the successful launch of the Van Allen Probes, which, in a few short months, have already redefined our understanding of the Earth's radiation belts. The fiscal year 2014 request will support final development and launch of the Interface Region Imaging Spectrograph (IRIS), as well as continued development of the Magnetospheric Multiscale (MMS) mission, which is planned for launch in 2015 to investigate how the Sun's and Earth's magnetic fields connect and disconnect. NASA continues to formulate the Solar Probe Plus (SPP) mission and develop its contribution to the European Space Agency's Solar Orbiter mission.

AERONAUTICS RESEARCH

NASA's fiscal year 2014 request includes \$565.7 million for NASA's program of innovative aeronautics research. This research supports the Nation's aviation industry's efforts to maintain competitiveness in the global market, and helps to provide the flying public with an improved flying experience and fewer delays, while also maintaining an outstanding safety level. NASA's breakthrough research into more efficient air traffic management and environmentally friendly aircraft helps U.S. air carriers to operate their fleets more efficiently while reducing operating costs. Today, we are pursuing an ambitious research agenda for substantially reducing fuel consumption, emissions and noise to make the Next Generation Air Transportation System (NextGen) a reality. NASA begins a new \$25 million a year Advanced Composites Project in fiscal year 2014 that will focus on reducing the timeline for development and certification of innovative composite materials and structures. Looking ahead, NASA is paving the way for further industry innovation through demonstration in flight of new aircraft wing technology designed to save fuel by reducing weight and drag, and continued flight research of low-boom technology designed to reduce sonic booms enough to eliminate the barrier to overland civil supersonic flight. By advancing the state of the art in vehicle and air traffic management technology, NASA is directly contributing to the Nation's bottom line.

SPACE TECHNOLOGY

NASA's fiscal year 2014 request includes \$742.6 million for Space Technology. Space Technology enables our future in space by drawing on talent from the NASA workforce, academia, small businesses, and the broader national space enterprise to deliver innovative solutions that dramatically lower costs and improve technological capabilities for NASA and the Nation. In 2012, we successfully fabricated a 2.4 meter composite cryogenic propellant tank. We will scale this design up and test a 5.5-meter diameter tank to enable lower-mass rocket propellant tanks that will meet future SLS needs. The Small Businesses Innovation Research and Small Business Technology Transfer (SBIR and STTR) programs saw six previously funded technologies make their way to Mars last August with the landing of Curiosity and provide the critical detector in the infrared instrument on the LDCM spacecraft. In 2013, we will fly a cluster of eight small satellites that will make coordinated space science observations. We will conduct high-altitude tests of the largest planetary parachute ever developed and drag devices designed to enable precise landing of higher-mass payloads to the surface of planets, with particular focus on infusing advanced capabilities into the Mars 2020 mission. In addition, NASA will launch the Sunjammer Solar Sail, which will demonstrate solar sail propulsion as an enabler for advanced space weather warning systems. Space Technology is also systematically addressing technology barriers in preparation for a future solar electric propulsion demonstration to an asteroid. By the end of fiscal year 2014, NASA will test and deliver two candidates for large deployable solar array systems, power processing units, and advanced thrusters to support this flight demonstration. The Game Changing Program is delivering advanced life-support, robotics, and battery technologies for the system demonstrations planned by the Advanced Exploration Systems Division of NASA's Human Exploration and Operations Mission Directorate.

To meet the challenges that we face in implementing our exploration plans, we are engaging the Nation's brightest and best. Over the past 2 years, Space Technology has engaged over 100 U.S. universities and academic institutions with approximately 350 activities, including fellowships, direct competitive awards, incentive prizes, and through partnerships with NASA Centers, small businesses, and commercial contractors. The fiscal year 2014 request will support our plans to continue releasing a steady stream of new solicitations, tapping into the Nation's talent to ensure the availability of advanced technologies for NASA's missions and ultimately, through technology transfer, for American businesses. Following the National Research Council's review of NASA's Space Technology Roadmaps, the Agency released and is implementing the Strategic Space Technology Investment Plan, which guides technology priorities across the agency's space-technology portfolio across its mission directorates. NASA's community of innovators is applying, testing, and reworking cutting-edge research into potentially "game-changing" solutions that can accelerate a timeline, slash projected costs, or multiply science return. NASA makes progress in essential space technologies daily, enabling more capable and far-reaching space systems for our Nation's future, and we are doing so through lean, agile programs and innovative approaches.

EXPLORATION AND SPACE OPERATIONS

NASA is building the capabilities and knowledge to send humans farther from the home planet than we have ever been before. The fiscal year 2014 budget request for Exploration is \$3,915.5 million with \$2,730 million for Exploration Systems Development, \$821.4 million for Commercial Space Flight, and \$364.2 million for Exploration Research and Development. Space Operations, including the International Space Station and Space Flight Support form a critical component of the agency's exploration plans by enabling us to develop the knowledge, experience, and technology necessary for safely living and working in space. The fiscal year 2014 request for Space Operations is \$3,882.9 million.

Exploration Systems

The fiscal year 2014 request will enable NASA to continue to meet its milestones in the development of the Space Launch System (SLS), a rocket system ultimately capable of bringing an unprecedented 130 metric tons of payload to Earth orbit. The Orion Multi-Purpose Crew Vehicle (MPCV) program continues on schedule for an uncrewed test flight in 2014. This test flight, Exploration Flight Test-1 (EFT-1), will see Orion conduct two orbits of Earth and reenter the atmosphere at a high-speed characteristic of a returning deep space exploration mission. The test will provide valuable data about the spacecraft's systems, most importantly, its heat shield. The flight test article for this mission is already in place at the Kennedy Space Center

and being readied for this test. The fiscal year 2014 request supports progress toward a first uncrewed test of the Orion and the SLS together, known as Exploration Mission-1 (EM-1) in 2017, with the first crewed mission of the two vehicles slated for 2021. These two missions will test and demonstrate these systems. Together, the SLS and Orion MPCV represent a critical step on the path to human deep space exploration. Because our commercial space partners continue to make rapid and cost-effective progress toward meeting the Agency's requirements for access to the ISS and to low Earth orbit, NASA is able to focus its human exploration resources to develop the deep space capabilities represented by the SLS and Orion MPCV.

International Space Station

The fiscal year 2014 request supports the International Space Station (ISS) with its international crew of 6 orbiting Earth every 90 minutes. The Station is making deep space exploration possible, building on the knowledge and experience we are gaining from the astronauts living, working, and conducting research on the ISS. Our plans for the coming year include preparing for an extended duration, year-long human-crewed mission to explore human adaptation to space; continuing to utilize the ISS to improve our ability to live and work in space, including technology demonstrations enabling future exploration; and the addition of three Earth Science instruments that will exploit ISS' capabilities to study winds over the oceans and the movement of dust, smoke, and pollution through the atmosphere. The Center for the Advancement of Science in Space (CASIS) is now managing the National Laboratory research being conducted in the U.S. segment of the ISS by an array of organizations, including commercial researchers interested in taking advantage of this unique, microgravity facility.

Commercial Crew and Cargo

A top priority for NASA and the Nation is to affordably and safely launch American astronauts and their supplies from U.S. soil, ending our reliance on foreign providers and bringing that work back home. Under NASA's Commercial Resupply Services (CRS) contracts, Space Exploration Technologies (SpaceX) was awarded 12 cargo flights to the space station, and Orbital Sciences Corporation (Orbital) was awarded 8. SpaceX executed its first cargo mission to the ISS in October 2012, successfully delivering its cargo and returning scientific samples to Earth. SpaceX successfully completed its second CRS mission and its Dragon spacecraft safely returned to Earth on March 26. Orbital successfully completed the maiden flight of its Antares rocket on April 21 and will conduct a demonstration flight of the Antares with the Cygnus spacecraft this spring under the Commercial Orbital Transportation Services (COTS) effort. Orbital's first contracted cargo resupply mission under CRS is slated for later this year. NASA continues to work with its commercial partners to develop a U.S. commercial capability for human spaceflight. NASA intends to procure commercial crew services to ISS by 2017, and full funding of the fiscal year 2014 request is essential to restore a human spaceflight capability to the United States in this timeframe. Through the successful execution of this partnership, we will return to the United States the vital capability to launch astronauts to the ISS and return them to Earth.

EDUCATION

NASA supports the President's goal to utilize existing resources to achieve improvements in science, technology, engineering, and mathematics, or STEM, education and instruction. The administration is proposing a comprehensive reorganization of STEM education investments. The 2014 budget will enhance the impact of the Federal investment by reorganizing STEM education programs across agencies and redirecting funding in support of a cohesive national STEM strategy focused on four priority areas: K-12 instruction; undergraduate education; graduate fellowships; and informal education activities. Within NASA, STEM education investments previously distributed across the Agency will be consolidated and focused within the Office of Education, the National Science Foundation, and the Smithsonian Institution. During fiscal year 2013 and fiscal year 2014, NASA's education teams will develop transition plans that minimize impacts to students and organizations currently served by NASA. The Agency will also conduct studies to determine which NASA education assets should and can be made available to the new STEM consolidation partners.

The fiscal year 2014 request of \$94.2 million includes education activities in the Office of Education and NASA's mission directorates. The funding request for the Education account includes funding for the National Space Grant College and Fellowship Program, the Experimental Program to Stimulate Competitive Research (EPSCoR), and the Minority University Research and Education Program (MUREP).

These education investments link to NASA's research, engineering, and technology missions. Each of these investments provides unique NASA experiences and resources to students and faculty. Starting in fiscal year 2014, mission-based K-12 education, and engagement activities, traditionally funded within programmatic accounts, will be incorporated into the administration's new STEM education paradigm.

CROSS AGENCY SUPPORT

NASA's Cross Agency Support (CAS) account funds all of the operations and maintenance of NASA's nine Centers, component facilities, and Headquarters, including, the Agency's safety offices, independent technical authority, NASA's engineering safety center, procurement, and others that oversee activities to reduce the risk and loss of life and/or mission in all of NASA's human, satellite, aeronautic, and robotic programs. NASA's fiscal year 2014 request of \$2.85 billion supports critical efforts to modernize NASA's information technology security processes and expanding security operations efforts to provide early warning of cyber vulnerabilities. The request will support the Agency's continuing efforts to reduce its facilities costs by consolidating capabilities and disposing of unneeded assets.

CONCLUSION

NASA thrives on the synergy created by a critical mass of brilliant scientific and engineering talent, supported by a broad range of expert professionals. We work, as an Agency, to send humans to an asteroid and on to orbit Mars. We work, as an Agency, to understand the universe from the beginning of time to the future of Earth's climate. The people working to put the next rover on Mars are refining the systems necessary to put humans there in the future. The people testing advanced ring-sail parachutes for landing payloads on planetary surfaces are also learning how flight through an atmosphere at super-high speeds works. The astronauts running physical science experiments on the ISS are themselves life science experiment subjects, and at the same time, they are demonstrating the science and technology for living and working in space. The Agency is on track and making steady progress executing the space and aeronautical program defined for us by Congress and the President in the 2010 authorization act, and we are confident we can accomplish these programs under that direction. NASA's confidence that we can execute the program described here is based primarily on the demonstrated expertise, flexibility, and dedication of our people. The reason why NASA ranks as the best place to work in the Federal Government may simply be this: we all are contributors to a mission greater than ourselves, extending beyond the current generation. We tackle national and global challenges. We are explorers.

National Aeronautics and Space Administration

FY 2014 PRESIDENT'S BUDGET REQUEST SUMMARY

Budget Authority (\$ in millions)	Fiscal Year						
	Actual 2012 ¹	Estimate 2013 ²	Request 2014	Notional			
	2015	2016	2017	2018			
NASA FY 2014	17,770.0	17,893.4	17,715.4	17,715.4	17,715.4	17,715.4	17,715.4
Science	5,073.7	5,115.9	5,017.8	5,017.8	5,017.8	5,017.8	5,017.8
Earth Science	1,765.7		1,846.1	1,854.6	1,848.9	1,836.9	1,838.1
Planetary Science	1,501.4		1,217.5	1,214.8	1,225.3	1,254.5	1,253.0
Astrophysics	648.4		642.3	670.0	686.8	692.7	727.1
James Webb Space Telescope	518.6		658.2	645.4	620.0	569.4	534.9
Heliophysics	644.9		653.7	633.1	636.8	664.3	664.6
Subtotal, Science	5,079.0	5,121.1	5,017.8	5,017.8	5,017.8	5,017.8	5,017.8
Less Rescissions	(5.3)	(5.3)					
Aeronautics	569.4	572.9	565.7	565.7	565.7	565.7	565.7
Subtotal, Aeronautics	569.9	573.4	565.7	565.7	565.7	565.7	565.7
Less Rescissions	(0.5)	(0.5)					
Space Technology	573.7	577.2	742.6	742.6	742.6	742.6	742.6
Subtotal, Space Technology	575.0	578.5	742.6	742.6	742.6	742.6	742.6
Less Rescissions	(1.3)	(1.3)					
Exploration	3,707.3	3,790.1	3,915.5	3,952.0	3,970.7	3,799.0	3,589.3
Exploration Systems Dev	3,002.0		2,730.0	2,789.8	2,801.5	2,818.3	2,819.5
Commercial Spaceflight	406.0		821.4	821.4	821.4	590.0	371.0
Exploration Research & Dev	303.0		364.2	340.8	347.8	390.7	398.7
Subtotal, Exploration	3,711.0	3,793.9	3,915.5	3,952.0	3,970.7	3,799.0	3,589.3
Less Rescissions	(3.7)	(3.7)					
Space Operations	4,184.0	4,249.1	3,882.9	4,014.9	3,996.2	4,167.9	4,377.6
Space Shuttle	599.3		0.0	0.0	0.0	0.0	0.0
International Space Station	2,789.9		3,049.1	3,169.8	3,182.4	3,389.6	3,598.3
Space & Flight Support	805.2		833.8	845.1	813.8	778.3	779.3
Subtotal, Space Operations	4,194.4	4,259.4	3,882.9	4,014.9	3,996.2	4,167.9	4,377.6
Less Rescissions	(10.4)	(10.4)					
Education	136.1	136.9	94.2	94.2	94.2	94.2	94.2
Subtotal, Education	138.4	139.2	94.2	94.2	94.2	94.2	94.2
Less Rescissions	(2.3)	(2.3)					
Cross Agency Support	2,993.9	3,012.2	2,850.3	2,850.3	2,850.3	2,850.3	2,850.3
Center Management & Ops	2,204.1		2,089.7	2,089.7	2,089.7	2,089.7	2,089.7
Agency Management & Ops	789.9		760.6	760.6	760.6	760.6	760.6
Subtotal, Cross Agency Support	2,994.0	3,012.3	2,850.3	2,850.3	2,850.3	2,850.3	2,850.3
Less Rescissions	(0.1)	(0.1)					

National Aeronautics and Space Administration

FY 2014 PRESIDENT'S BUDGET REQUEST SUMMARY

Budget Authority (\$ in millions)	Fiscal Year						
	Actual 2012 ¹	Estimate 2013 ²	Request 2014	Notional			
	2015	2016	2017	2018			
Construction & Environmental Compliance & Restoration³	494.5	401.9	609.4	440.9	440.9	440.9	440.9
Construction of Facilities	455.0		533.9	365.4	365.4	365.4	365.4
Environmental Compliance & Restoration	45.0		75.5	75.5	75.5	75.5	75.5
Subtotal, Construction & Environmental Compliance & Restoration	500.0	407.4	609.4	440.9	440.9	440.9	440.9
Less Rescissions	(5.5)	(5.5)					
Office of Inspector General⁴	38.3	38.2	37.0	37.0	37.0	37.0	37.0
Subtotal, Inspector General	38.3	38.5	37.0	37.0	37.0	37.0	37.0
Less Rescissions	0.0	(0.3)					
Less Rescission from Prior Appropriation Accounts	(1.0)	(1.0)					
NASA FY 2014	17,770.0	17,893.4	17,715.4	17,715.4	17,715.4	17,715.4	17,715.4

¹FY 2012 rescissions are pursuant to P.L. 112-55, Division B, sec. 528(f).²The FY 2013 appropriation for NASA was not enacted at the time that the FY 2014 Request was prepared; therefore, the amounts in the FY 2013 column reflect the annualized level provided by the Continuing Resolution plus the 0.612 percent across the board increase (pursuant to Section 101(a) and (c) of P.L. 112-175). The FY 2012 and 2013 column also include rescissions to prior-year unobligated balances pursuant to P.L. 112-55, Division B, sec. 528(f).³Construction and Environmental Compliance and Restoration includes \$15 million provided by the Disaster Relief Act, 2013 (P.L. 113-2) for Sandy storm recovery.⁴Rescission of unobligated American Recovery and Reinvestments Act balances in the Office of Inspector General account pursuant to P.L. 111-203, the Dodd-Frank Wall Street Reform and Consumer Protection Act.

PREPARED STATEMENT OF HON. PAUL K. MARTIN, INSPECTOR GENERAL, OFFICE OF
INSPECTOR GENERAL

Chairwoman Mikulski, Ranking Member Shelby, and members of the subcommittee: The Office of Inspector General (OIG) is committed to providing independent, aggressive, and objective oversight of the National Aeronautics and Space Administration (NASA), and we welcome this opportunity to discuss the major challenges facing the Agency in fiscal year 2014 and beyond.

The successful landing of the Curiosity rover on the surface of Mars in August 2012 energized the public about NASA's activities in a way not seen since the final Space Shuttle flight. Similarly, two successful commercial resupply missions to the International Space Station (ISS) by Space Exploration Technologies Corporation (SpaceX) and a successful rocket test flight Sunday by Orbital Sciences Corporation are milestones toward NASA's goal of fostering development of a commercial space transportation capability to low Earth orbit.

The past year was not without its challenges, however, including the need to reprogram funds from several Agency initiatives to accommodate cost overruns in the James Webb Space Telescope (JWST) and other projects. This shift contributed to developmental delays in several ongoing projects and cancellation of others, including a joint project with the European Space Agency for planned missions to Mars in 2016 and 2018.

Moreover, because NASA's commercial crew program received less than one-half its requested budget, the Agency's efforts to obtain commercial transportation for its astronauts to the ISS have been bumped to 2017 at the earliest—uncomfortably close to the Station's currently scheduled 2020 retirement. At the same time, NASA is moving forward with development of a new rocket, capsule, and related launch infrastructure to enable crewed missions to an asteroid and beyond, expensive and technically complex undertakings in an increasingly austere budget environment.

In sum, static budgets and other fiscal uncertainties present the most significant external challenges to NASA's ability to successfully move forward on its many projects and programs. For example, the Agency's fiscal year 2012 appropriation of \$17.8 billion recently was reduced by \$894 million in fiscal year 2013 to reflect its share of the Federal Government-wide sequestration.

Against this rather bleak budgetary backdrop, Agency managers continue to face significant challenges managing NASA's diverse portfolio of science, exploration, and aeronautics projects. Specifically, our most recent report on the top management and performance challenges facing NASA identified five primary issues:

- The Future of U.S. Human Space Flight;
- Project Management;
- Infrastructure and Facilities Management;
- Acquisition and Contract Management; and
- Information Technology Security and Governance.

A detailed description of these challenges and the audit and investigative work conducted by our office in each of these areas is described in the Top Challenges document appended to this statement.

In my testimony this morning, I will highlight three issues: (1) project management, (2) information technology (IT) security, and (3) NASA's aging infrastructure.

PROJECT MANAGEMENT

Over its 50-year history NASA has been at the forefront of science and space exploration that has led to numerous scientific and technological discoveries and innovations. However, in addition to their significant achievements, many NASA projects share another less positive trait—they cost significantly more to complete and take much longer to launch than originally planned.

Last September, the OIG issued a report that examined NASA's project management practices and the primary challenges to achieving the Agency's cost, schedule, and performance goals. Cost and schedule increases on large projects like the JWST can have a cascading effect on NASA's entire portfolio. For example, in fiscal year 2012, NASA moved \$156 million from other Science Mission Directorate projects and its Cross Agency Support account to cover cost increases in the JWST project. In addition, the Wide-Field Infrared Survey Telescope and several other missions have been postponed to make funding available for JWST. Moreover, as previously noted, NASA has pulled out of an agreement with the European Space Agency on two future Mars missions and is re-evaluating its Mars exploration strategy to accommodate a more restricted funding profile.

Our project management review identified four factors that present the greatest challenges to successful project outcomes at NASA: (1) the Agency's culture of optimism, (2) underestimating technical complexity, (3) funding instability, and (4) lim-

ited opportunities for project managers' development. The September audit report and the 2012 Management Challenges document discuss each of these factors in detail.

One of NASA's largest ongoing projects is its new "heavy-lift" rocket known as the Space Launch System (SLS). The NASA Authorization Act of 2010 set a goal for the Agency to achieve operational capability for the SLS and the accompanying Multi-Purpose Crew Vehicle (MPCV) by December 31, 2016. NASA's current plan is to launch an uncrewed test flight of the SLS and MPCV in 2017, followed by the first crewed flight in 2021.

Establishing realistic long-term budgets for the SLS, MPCV, and associated ground support programs is difficult, as illustrated by an August 2011 independent cost assessment for the program, which concluded that NASA's estimates are reasonable for near-term budget planning but do not support establishment of long-term budgets or detailed baselines. Constrained budgets also impact the pace of NASA's development efforts. For example, because the MPCV program is anticipating a "flat" budget profile for at least the next 10 years, NASA has adopted an incremental developmental approach that concentrates on systems needed to meet specific mission objectives for each test flight rather than an approach under which work on all MPCV systems progresses concurrently. The OIG is currently examining NASA's efforts to develop the MPCV and will continue to focus resources on NASA's launch and crew transportation development efforts in the years to come.

INFORMATION TECHNOLOGY SECURITY

At a February 2012 House hearing, I testified about the state of IT security at NASA and highlighted the fact that at the time only 1 percent of NASA's laptop computers were fully encrypted compared to a Government-wide rate of 54 percent. Eight months later, a NASA laptop containing the Social Security numbers and other personally identifiable information (PII) for more than 40,000 individuals was stolen from the vehicle of a headquarters employee. Although the laptop was password protected, neither the laptop itself nor the individual files were encrypted. As a result of this theft, NASA contracted with a company to provide credit monitoring to the affected individuals and the Agency estimates that these services could cost up to \$900,000.

Following this incident, the NASA Administrator accelerated the timetable to encrypt the hard drives of the Agency's laptop computers. As of mid-April, NASA reported that it had encrypted 100 percent of Agency laptops identified as requiring encryption, had exempted 4,247 laptops from the requirement, and was determining whether another 346 laptops required encryption or also would be exempted.

NASA's portfolio of information technology assets includes more than 550 information systems that control spacecraft, collect and process scientific data, and enable NASA personnel to collaborate with colleagues around the world. Hundreds of thousands of NASA personnel, contractors, academics, and members of the public use these IT systems daily and NASA depends on them to carry out its essential operations. Overall, NASA spends more than \$1.5 billion annually on its IT-related activities, \$58 million of that for IT security.

Nonetheless, NASA remains a target of cyber intruders both because of the large size of its networks and because of the technical and scientific information it maintains. Over the years, NASA has increasingly become a target of a sophisticated form of cyber attack known as advanced persistent threats (APTs). The individuals or nations behind these APTs are typically well organized and well-funded.

For example, our investigation of a series of APT attacks at the Jet Propulsion Laboratory (JPL) involving Chinese-based Internet protocol addresses between November 2011 and February 2012 confirmed that cyber attackers were successful in achieving control over much of JPL's network for several weeks and used this access to steal or attempt to steal NASA-funded data. While data theft appears to be the primary motive, the level of access gained by the intruders positioned them to have caused significant operational disruption had that been their goal.

Through our audits and investigations, we have identified systemic and recurring weaknesses in NASA's IT security program that adversely affect the Agency's ability to protect the information and information systems vital to its mission. In particular, the Chief Information Officer's (CIO) inability to ensure that NASA's mission computer networks implement key IT security controls continues to put these critical IT assets at risk of compromise. To illustrate, the Agency has not yet implemented two recommendations from a May 2010 OIG audit report to monitor its mission networks for the presence of critical software patches and technical vulnerabilities.

Achieving the Agency's IT security goals will require sustained improvements in NASA's overarching IT management practices. Effective IT governance is the key to accommodating the myriad interests of internal and external stakeholders and making decisions that balance compliance, cost, risk, and mission success. Effective IT governance also helps ensure that public funds are efficiently spent by coordinating across NASA when purchasing IT products and services.

We are completing a review examining NASA's IT governance structure and anticipate making several recommendations for improvement. This audit is particularly timely given that the NASA CIO position is currently vacant.

NASA'S AGING INFRASTRUCTURE

NASA is the ninth largest Federal Government property holder, controlling approximately 4,900 buildings and structures with an estimated replacement value of more than \$30 billion. In addition, more than 80 percent of the Agency's facilities are 40 or more years old and beyond their design life. Under its current policy, NASA is required to maintain these facilities either in an operational status or, if they are not being used, in sufficient condition that they do not pose a safety hazard. However, NASA has not been able to fully fund required maintenance costs for its facilities and in 2012 estimated its deferred maintenance costs at \$2.3 billion.

One way NASA could reduce its facilities maintenance costs is to reduce the amount of unneeded infrastructure in its inventory. To be successful in this effort, NASA must move beyond its historic "keep it in case we need it" approach of managing its facilities. In an audit issued last month, the OIG identified 33 wind tunnels, test stands, thermal vacuum chambers, airfields, and launch-related facilities that NASA was not fully utilizing or for which Agency managers could not identify a future mission use. These facilities cost the Agency more than \$43 million to maintain in fiscal year 2011 alone.

We found that NASA's efforts to reduce its underutilized facilities have been hindered by several longstanding and interrelated challenges: (1) fluctuating and uncertain strategic requirements, (2) Agency culture and business practices, (3) political pressure, and (4) inadequate funding. To its credit, NASA is undertaking a series of initiatives aimed at "rightsizing" the Agency's real property footprint. However, we noted that many of these efforts are in the early stages and may ultimately be insufficient to overcome the cultural and political obstacles that have impeded past efforts to reduce unneeded infrastructure. Accordingly, an independent outside process similar to the Department of Defense's Base Realignment and Closure Commission may be necessary.

Leasing offers NASA another means to help address maintenance costs associated with its aging and underutilized facilities. However, Federal law and policy prohibit NASA from leasing facilities for which it has no current or future mission-related use. The Agency should consider other options for these facilities such as demolition or reporting the property to the General Services Administration for sale or transfer to another entity. The challenge for NASA is to use leasing when appropriate to generate revenue to offset facilities operations and maintenance costs while not using it as a way to hold on to facilities it does not need.

CONCLUSION

The National Research Council (NRC) concluded in its December 2012 report that there is a "significant mismatch between the programs to which NASA is committed and the budgets that have been provided or anticipated." In other words, too many programs are chasing too few dollars. I am hopeful that the NRC's report, together with the ongoing work of the OIG and Government Accountability Office, will contribute to a dialogue between the administration and the Congress about NASA's future priorities and lead to enactment of a realistic budget that will enable the Agency to accomplish its multifaceted missions.

We look forward to continuing our cooperative working relationship with NASA, this subcommittee, and other congressional committees as we conduct audits and investigations that focus on the Agency's top management and performance challenges.

NASA'S TOP MANAGEMENT AND PERFORMANCE CHALLENGES—NOVEMBER 2012

Introduction

Fiscal year 2012 ended on a high note for NASA with the successful landing of the rover Curiosity on the surface of Mars in August. Over the next several years, Curiosity will explore the Red Planet in an effort to determine if it has ever been

able to support life. Earlier in the year, NASA achieved a major milestone toward its goal of fostering the development of a commercial space transportation capability to low Earth orbit with the successful test flight of the Space Exploration Technologies Corporation's (SpaceX) Dragon spacecraft to the International Space Station (ISS), followed in October by the first actual commercial resupply mission.

The year was not without challenges, however. For example, due to cost overruns in the James Webb Space Telescope and other projects, NASA had to reprogram funds away from several Agency initiatives. This resulted in developmental delays in some ongoing projects and cancellation of other planned projects, including the ExoMars/Trace Gas Orbiter missions to Mars.¹

Moreover, the congressional decision to provide NASA's Commercial Crew Program (CCP) with less than half the funding requested by the President in fiscal year 2012 extended to 2017 the earliest date that NASA expects to obtain commercial crew transportation services to the ISS, which is significant if NASA is unable to maintain and utilize the Station beyond its currently scheduled retirement date of 2020. In addition, as a result of the lower-than-expected funding level, the Agency delayed its planned transition from using Space Act Agreements to using Federal Acquisition Regulation (FAR)-based contracts for developing these systems. This decision heightened concern in some quarters about the ultimate ability of the commercial companies to meet NASA safety requirements.

Finally, declining budgets and fiscal uncertainties remained at the forefront of the Agency's decisionmaking processes this past year. Like the rest of the Federal Government, NASA began fiscal year 2013 under a 6-month continuing resolution that funds the Agency at fiscal year 2012 levels. Overshadowing the effects of the continuing resolution, however, is the possibility of an early January 2013 sequestration that would reduce NASA's anticipated budget by approximately \$1.5 billion. Even if this looming cut is averted, NASA is likely to face constrained budgets for the foreseeable future.

Against this rather bleak budgetary backdrop, we have identified five overarching issues we believe pose the top management and performance challenges to NASA leadership: Future of U.S. Human Space Flight, Project Management, Infrastructure and Facilities Management, Acquisition and Contract Management, and Information Technology Security and Governance.

In deciding whether to identify an issue as a top challenge, we considered the significance of the issue in relation to the Agency's mission; its susceptibility to fraud, waste, and abuse; whether the underlying causes are systemic in nature; and the Agency's progress in addressing the challenge. Several of these challenges—specifically project management, infrastructure and facilities management, and acquisition and contract management—are long-standing concerns likely to remain top challenges for the foreseeable future. However, with focused and sustained efforts we believe that NASA can make significant strides in addressing all of the challenges we have identified.

Future of U.S. Human Space Flight

NASA's Space Shuttle era which began with the maiden voyage of *Columbia* on April 12, 1981, ended after 135 missions when *Atlantis* landed at Kennedy Space Center on July 21, 2011. In the ensuing year, NASA delivered the four retired orbiters to their permanent homes for public display. NASA's current spaceflight activities are focused on maximizing the productivity of the ISS, encouraging development of commercial companies seeking to provide cargo and crew transportation to the ISS, and developing new systems and technologies for exploration beyond low Earth orbit. Moving each of these programs forward in a "flat" or diminishing budget environment will be a significant challenge for the Agency.

International Space Station.—The ISS is currently scheduled to be retired in 2020, although NASA is conducting studies to see if the \$60 billion facility can safely be inhabited and productively utilized until 2028. Whatever its remaining life span, a major focus for the Agency is ensuring the most effective use of the ISS.

One of the most significant factors affecting utilization of the ISS is the amount of time the crew can commit to research. Although NASA has increased average crew research time from 23.9 hours per week in 2010 to 35 hours per week in 2012, the Agency is unlikely to be able to raise that figure given current constraints on crew size.² The ISS was designed to support a seven-member crew. However, be-

¹This joint project between the European Space Agency and NASA consisted of missions scheduled for launch in 2016 and 2018.

²NASA, "Consolidated Operations and Utilization Plan (COUP) 2010, Covering the period 2010–2015" (April 26, 2011). Dan Hartman, Manager, Operations Integration, ISS Program Office, "International Space Station Program Status," July 23, 2012, NASA Advisory Committee,

cause at present the only means of transportation to and from the ISS is the Russian Soyuz, which has a three-person capacity, only six crew members can safely be aboard at one time to allow for evacuation in case of an emergency. This limitation on crew size will exist until at least 2017, the earliest date at which NASA's commercial partners are expected to be ready to fly manned, higher-capacity missions to the ISS.

The other limitation to full utilization is the ability to transport materials and supplies to and from the ISS. SpaceX's Dragon flew a successful demonstration mission to the ISS in May 2012 and began actual resupply missions in October 2012. NASA's other commercial cargo partner, Orbital Sciences Corporation (Orbital), is slated to perform the first demonstration flight of its Antares rocket in December 2012, with a demonstration flight to the ISS with the Cygnus capsule in spring 2013. Although both systems are capable of delivering cargo to the ISS, only Dragon is capable of returning cargo and research experiments to Earth. In fact, other than the very limited capability of Soyuz, Dragon is the only system since the retirement of the Space Shuttles with any "downmass" capability.

In August 2011, NASA entered into a cooperative agreement with the Center for the Advancement of Science in Space (CASIS) initially worth \$15 million per year to manage the non-NASA science activities on the national laboratory portion of the ISS. CASIS, a nonprofit organization, is responsible for ensuring that the laboratory is available to the broadest possible cross section of U.S. scientific, technological, and industrial communities. Part of its job is to select the experiments that will be conducted on the national laboratory.

CASIS issued its first public solicitation in June 2012 with the goal of enabling research in the areas of protein crystallization and the life sciences. However, during its first year of operation CASIS encountered a variety of start-up challenges, including the resignation of its executive director, and as of October 2012, did not have a permanent Board of Directors. In the months and years ahead, NASA must ensure that CASIS forms an effective management team; develops a varied research and development portfolio based on national needs for basic and applied research; establishes a marketplace to help match research with funding; and stimulates interest in using the national laboratory for research and technology demonstrations and as a platform for science, technology, engineering, and mathematics education.

NASA also needs to continue encouraging use of the ISS by other U.S. Government agencies, other nations, and the commercial sector while seeking partnerships and cost-sharing arrangements to supplement Agency funding of ISS research and operations. The Office of Inspector General (OIG) expects to issue a report examining NASA's efforts to ensure full utilization of the ISS early next year.

Commercial Launch Providers.—Beginning in 2006, NASA entered into a series of Space Act Agreements designed to stimulate development by U.S. industry of transportation systems capable of providing safe and reliable cargo and crew services to the ISS and low Earth orbit. NASA initiated two activities to manage its investments in this area: the Commercial Orbital Transportation Services (COTS) Program and the Commercial Crew Program (CCP). Both programs use Space Act Agreements to support the development of commercial transportation capabilities and FAR-based contracts to certify the capabilities and to procure crew and cargo services to and from the ISS. The availability of domestic crew and cargo capability will enable the United States to transport its own astronauts to the ISS rather than relying on Russian vehicles and provide needed redundancy in cargo and crew transportation systems to the ISS.

NASA has invested \$750 million over the past 7 years in its effort to encourage development of cargo transportation by private companies. Two companies, SpaceX and Orbital, are under contract to resupply the ISS through 2016. As noted above, SpaceX flew its first successful demonstration flight in May 2012, during which its Dragon spacecraft berthed with the ISS, and its first resupply mission occurred in October 2012. The first demonstration flight of Orbital's Antares rocket and Cygnus space freighter to the ISS is currently scheduled for late spring 2013, with the company's first resupply mission coming as early as 3 months later.

With respect to the development of commercial crew transportation services, in June 2011 we reported on a series of challenges NASA faces in certifying and acquiring those services from commercial entities: (1) modifying the Agency's existing safety and human-rating requirements for commercially developed systems; (2) managing its acquisition strategy for commercial crew transportation services; (3) implementing the appropriate insight/oversight model for commercial partner vehicle development; (4) relying on an emerging industry and uncertain market conditions to

achieve cost savings; and (5) managing the relationship between commercial partners, the Federal Aviation Administration, and NASA.³

Although challenges remain, NASA has made progress in addressing several of these issues over the past year. For example, in November 2011 NASA updated and published detailed berthing and docking requirements for cargo and crew delivery systems, and in December 2011 the Agency finalized more than 280 specific safety and human-rating requirements for its CCP. With these requirements in hand, the Agency's commercial partners will have greater insight into what will be required of their systems to attain NASA certification. The documents also provide the Agency's methodology for insight and oversight into whether contractors are meeting the program's requirements. Specifically, NASA embedded teams of NASA employees known as "Partner Integration Teams" with the commercial partners to acquire insight into their development efforts while a separate review board will provide more formal guidance, feedback, and an assessment of the partners' activities.

In August 2012, NASA awarded a third round of Space Act Agreements totaling \$1.11 billion to three companies to further the development of their commercial crew systems.⁴ These Commercial Crew Integrated Capability (CCiCap) awards were made to Boeing Corporation (\$460 million); SpaceX (\$440 million); and Sierra Nevada Corporation (\$212.5 million).⁵ These awards deviated from the acquisition strategy the Agency announced in September 2011, whereby NASA planned to enter into firm-fixed-price contracts with one or more companies that would result in a complete end-to-end design compliant with NASA Crew Transportation System requirements. The award was to be followed by a separate solicitation for competitively awarded contracts to develop, test, evaluate, and certify a company's vehicles. However, when Congress appropriated substantially less than the Agency requested for its CCP in fiscal year 2012 (\$406 million versus \$850 million), NASA changed course and decided to award a third round of Space Act Agreements rather than move to a FAR-based fixed-price contract.

Both the Congress and NASA's Aerospace Safety Advisory Panel (ASAP) have voiced concerns about the Agency's continued reliance on Space Act Agreements in connection with its commercial crew efforts.⁶ At a September 2012 congressional hearing, the ASAP Chairman noted that unlike with traditional FAR-based contracts, when using Space Act Agreements NASA cannot dictate specific requirements to the commercial companies, thereby heightening the risk that the companies will ultimately not be able to deliver vehicles that satisfy NASA safety and performance requirements. NASA, however, believes it can ensure that commercial passenger vehicles will meet its requirements by utilizing a two-phase process. In Phase I, currently scheduled for February 2013, NASA plans to award two to four fixed-price contracts worth up to \$10 million for design acceptance and certification plans for the contractors' crew transportation systems. In Phase II, scheduled for May 2014, NASA plans to award one or two fixed-price contracts for the development, test, evaluation, and certification of the contractors' crew transportation system. This strategy anticipates at least one operational crew transportation system would be certified by NASA for crew transportation missions to the ISS by 2017.

Further complicating NASA's commercial crew effort is the uncertainty surrounding the Federal budget in light of the 6-month continuing resolution that essentially holds the Agency to a \$406 million funding level for its CCP. At the September 2012 House hearing, NASA's Associate Administrator for Human Exploration and Operations told the Congress that if the CCP is not funded at approximately \$830 million per year for fiscal years 2014–2017, the Program will face significant schedule delays that will push the first commercial crew launch beyond 2017.

At the same time NASA is fostering the development of commercial cargo and crew capabilities, it has been directed to develop its own launch system and crew vehicle to carry astronauts beyond Earth's orbit. Developing all of these capabilities simultaneously continues to present significant management challenges for NASA leaders.

³NASA OIG, "NASA's Challenges Certifying and Acquiring Commercial Crew Transportation Services" (IG-11-22, June 20, 2011).

⁴The first two rounds of Agreements consisted of \$50 million in Commercial Crew Development 1 (CCDev 1) awards to five commercial partners and \$300 million in CCDev 2 awards to four partners.

⁵Nasa.gov, "NASA's Commercial Crew Program Progressing for Future of U.S. Human Spaceflight," Commercial Space Transportation, August 8, 2012, <http://www.nasa.gov/exploration/commercial/crew/ccicap-announcement.html> (accessed October 8, 2012).

⁶September 14, 2012, hearing before the Committee on Science, Space, and Technology Subcommittee on Space and Aeronautics, U.S. House of Representatives.

NASA Launch System and Crew Vehicle.—The new heavy-lift rocket under development—the Space Launch System (SLS)—will have an initial capacity of 70 metric tons and eventually be capable of lifting 130 metric tons. As such, the rocket will be capable of more than double the lift capacity of any operational launch vehicle that exists today and America’s most powerful since the Saturn V rockets that carried Apollo astronauts to the Moon.

The Multi-Purpose Crew Vehicle (MPCV), which is being developed using an existing contract and is based on design requirements for the canceled Constellation Program’s Orion Crew Exploration Vehicle, will be mounted atop the SLS. The MPCV will serve as the crew vehicle for missions beyond low Earth orbit.

The NASA Authorization Act of 2010 set a goal for NASA to achieve operational capability for the SLS and MPCV by December 31, 2016. In November 2011, NASA reported that the Reference Design Vehicles for the SLS and MPCV would be unable to meet all requirements and schedule goals contained in the authorization act. Instead, NASA expects to launch an uncrewed test flight of SLS and MPCV in 2017 and the first crewed flight in 2021. NASA also reported that it plans to conduct a crewed launch once every 2 years thereafter.⁷ In the decades that follow, NASA plans to undertake crewed and robotic missions to destinations beyond low Earth orbit, such as a near-Earth asteroid, the Moon, or Mars. However, no final decisions have been made concerning specific missions and destinations.

NASA’s management challenge in this area will be to concurrently develop a launch system and crew vehicle and modify the necessary supporting ground systems while meeting the NASA Administrator’s mandate that exploration systems be affordable, sustainable, and realistic. In particular, establishing realistic long-term budgets for the SLS, MPCV, and associated ground support programs will be difficult, as evidenced by an August 2011 independent cost assessment that concluded NASA’s estimates are reasonable for near-term budget planning but do not support establishment of long-term budgets or detailed baselines.⁸

Part of the challenge NASA faces in developing long-term budgets is the relative immaturity of the SLS Program. For example, in September 2012 we reported that although the Agency’s planned modification to adapt the Ares I Mobile Launcher for use on the SLS was technically feasible and the most cost-effective option for the initial versions of the new rocket, NASA will need to continually assess the modifications as the program evolves and the SLS vehicles become larger and more powerful.⁹ We found NASA’s ability to identify the technical risks and accurately estimate future operating costs of modifying the Mobile Launcher throughout the SLS Program life cycle is significantly affected by both the relative immaturity of the SLS Program and the evolvable nature of the SLS vehicles.

NASA’s development efforts have also been impacted by the expectation of continued constrained budgets for the foreseeable future. For example, the MPCV Program is anticipating a “flat” budget profile for at least the next 10 years with no increases for inflation. As a result, NASA has adopted an incremental approach in developing the MPCV under which Program officials will concentrate initially on systems needed to meet the specific mission objectives for each test flight rather than working on all MPCV systems concurrently. The OIG is currently examining NASA’s efforts to develop the MPCV and will continue to examine NASA’s launch and crew transportation development efforts in the years to come.

Project Management

Over its 50 year history, NASA has been at the forefront of science and space exploration and responsible for numerous scientific and technological discoveries and innovations. However, in addition to their significant scientific and technological achievements, many NASA projects share another less positive trait—they cost significantly more to complete and take much longer to launch than originally planned. In this era of constrained Federal budgets, NASA’s ability to deliver projects on time and within budget is more important than ever if the Agency is to maintain a robust portfolio of science and space projects.

Over the past year, the OIG conducted an extensive review examining NASA’s project management practices in an effort to identify the primary challenges to the

⁷NASA, “Final Report Regarding NASA’s Space Launch System and Multi-Purpose Crew Vehicle Pursuant to Section 309 of the NASA Authorization Act of 2010 (Public Law 111–267)” (November 2011).

⁸Booz Allen Hamilton, “Independent Cost Assessment of the Space Launch System, Multi-Purpose Crew Vehicle and 21st Century Ground Systems Programs, Final Report,” August 19, 2011, http://www.nasa.gov/pdf/581582main_BAH_Executive_Summary.pdf (accessed November 5, 2012).

⁹NASA OIG, “NASA’s Plans to Modify the Ares I Mobile Launcher in Support of the Space Launch System” (IG–12–022, September 25, 2012).

Agency achieving its cost, schedule, and performance goals.¹⁰ The core of our fact-finding consisted of interviews of 85 individuals from both inside and outside of the Agency, including the current and former Administrators, Associate Administrators, Center Directors, and project managers and staff.

Key Challenges to Meeting Cost, Schedule, and Performance Goals.—Cost increases and schedule delays on its projects are a long-standing issue for NASA. A 2004 Congressional Budget Office study that compared the initial and revised budgets of 72 Agency projects between 1977 and 2000 reported a 61 percent increase between the projects' initial and revised budgets.¹¹ Similarly, the Government Accountability Office (GAO) has consistently reported on cost growth and schedule delays in NASA's major projects. For example, in its 2012 assessment of 21 large-scale projects, GAO reported an average development cost growth of 47 percent or \$315 million, much of which was attributable to the James Webb Space Telescope (JWST). The current "poster child" for NASA's persistent difficulties in controlling cost and schedule growth, JWST has gone from an original life-cycle cost baseline estimate of \$5 billion and a launch date of June 2014 to a projected cost of \$8.8 billion and a launch date of October 2018.¹²

As GAO noted, cost and schedule increases on large projects like JWST can have a cascading effect on NASA's entire portfolio. To illustrate, in fiscal year 2012 NASA moved \$156 million from other Science Mission Directorate projects and the Cross Agency Support account to cover cost increases in the JWST Project.¹³ In addition, several other missions including the Wide-Field Infrared Survey Telescope have been postponed to make funding available for JWST.¹⁴ Moreover, NASA announced in February 2012 that it was pulling out of an agreement with the European Space Agency on two future Mars missions and planned to reevaluate its Mars exploration strategy to accommodate a more restricted funding profile.

In our September 2012 report, we identified four factors that appear to present the greatest challenges to successful project outcomes at NASA:

NASA's Culture of Optimism.—Permeating all levels of NASA from senior management to frontline engineers, a culture of optimism is essential to overcoming the extraordinary technical challenges inherent in the development of unique, first-of-their-kind space systems. However, this same optimism can sometimes prevent managers and leaders from making critical assessments of requirements, budgets, and schedules to determine what a project can realistically accomplish within a set budget and timetable.

Underestimating Technical Complexity.—Project managers we interviewed cited the technical complexity inherent in NASA projects as a major challenge to achieving cost and schedule goals. In our judgment, five factors explain the inherently uncertain nature of estimating costs for the type of space technologies NASA develops: (1) unique, first-of-their-kind technologies; (2) interdependent technologies and complex integration issues; (3) increased testing needs; (4) limited quantities; and (5) shrinking industrial base and reduced quality of parts.

Funding Instability.—Funding instability includes situations in which a project receives less money than planned or where funds are disbursed on a schedule different than planned. Such instability may result from presidential, congressional, or Agency-directed actions and can cause work to be delayed and development risks to be identified late in the project life cycle, which in turn can lead to cost increases and schedule delays.

Limited Opportunities for Project Managers' Development.—Interviewees stated that the limited number of small and mid-size projects in NASA's current portfolio allows too few opportunities for Agency personnel to gain experience managing a project's cost, schedule, and technical performance efforts. In addition, they expressed concern that an increased reliance on contractors to design and build projects has led to a decline in Agency personnel with development experience. Finally, they stated that NASA engineers are primarily operating as overseers of work

¹⁰NASA OIG, "NASA's Challenges to Meeting Cost, Schedule, and Performance Goals" (IG-12-021, September 27, 2012).

¹¹A Congressional Budget Office Study, "A Budgetary Analysis of NASA's New Vision for Space Exploration," September 2004.

¹²GAO "NASA: Assessments of Selected Large-Scale Projects" (GAO-12-207SP, March 1, 2012).

¹³NASA's Cross-Agency Support account funds support activities necessary to ensure the operation and administration of the Agency such as human capital management, security, and maintenance of real property assets that cannot be directly aligned to a specific program or project requirement.

¹⁴The Wide-Field Infrared Survey Telescope is a NASA observatory designed to settle essential questions in both exoplanet and dark energy research.

performed by contractors rather than gaining experience with in-house builds of instruments and spacecraft.

Given the anticipated funding challenges for all Federal agencies in the years ahead, changes to the way NASA develops and manages its projects are imperative. At the same time, the Agency is undergoing considerable changes in mission focus, with the end of the Space Shuttle Program and the first steps on a new path toward human space exploration. Collectively, these factors both necessitate and provide an opportunity for the Agency to reset itself and take steps toward meaningful change in the way its projects are developed and managed.

Project Management Principles and Tools.—To execute projects within established cost and schedule estimates, NASA needs to maximize the use of sound project management principles and tools in projects both large and small. To its credit, NASA has taken several steps in the last few years aimed at curbing cost growth and schedule delays. For example, in response to a 2007 GAO report highlighting NASA's lack of emphasis on cost controls and program outcomes, the Agency issued a Corrective Action Plan that established a definition of success that includes completing all development projects within 110 percent of cost and schedule baselines and meeting Level 1 requirements for 90 percent of the major development projects in its portfolio.¹⁵ NASA hopes to achieve the Corrective Action Plan's criteria for success by fiscal year 2013, implementing the policies and processes on new projects while tracking and reporting the measures for existing projects.¹⁶

The Agency also has implemented a cost and schedule analysis methodology that produces what is known as the Joint Cost and Schedule Confidence Level to assist managers with cost and schedule estimating while enabling the Agency to evaluate more accurately whether projects have an executable plan as they proceed into implementation. NASA believes that this analysis has helped projects such as the Gravity Recovery and Interior Laboratory, Juno, and the Mars Atmosphere and Volatile Evolution meet cost and schedule goals.¹⁷

Moreover, NASA's new program and project management policy requires that project plans document decisions to either build or procure items based on NASA's in-house capabilities, maintenance of core competencies, cost, and best overall value to NASA. Project plans must also include baseline and threshold values for the performance metrics to be achieved at each Key Decision Point and mission success criteria associated with the program-level requirements that, if not met, trigger consideration of a Termination Review.¹⁸ Furthermore, project plans are required to document how the project will periodically report cost and schedule performance and provide a mitigation and corrective action plan in the event the project exceeds development cost estimates. More recently, NASA appears to be holding project managers more accountable for meeting cost cap agreements as evidenced by its decision in May 2012 to terminate the Gravity and Extreme Magnetism Small Explorer mission because development costs were likely to exceed the agreed-upon budget.

Apart from those positive actions, NASA was not fully utilizing at least one important tool in its arsenal—its Lessons Learned Information System (LLIS). Since 1994, LLIS has been NASA's principal mechanism for collecting and sharing lessons learned from Agency programs and projects.¹⁹ The information in LLIS is drawn from individuals, directorates, programs, projects, and supporting organizations and personnel across NASA and is one component of NASA's larger knowledge management and sharing system. Sharing lessons learned can reduce risk, improve efficiency, promote validated processes, and improve performance in ongoing and future NASA projects. In a March 2012 OIG report, we documented that NASA's project managers did not routinely use LLIS to search for lessons identified by other projects or routinely contribute new information to LLIS. Specifically, we found in-

¹⁵“NASA Plan for Improvement in the GAO High-Risk Area of Contract Management,” dated October 31, 2007, and updated through January 31, 2008. A Level 1 requirement is a project's fundamental and basic set of requirements levied by the Program or Headquarters.

¹⁶NASA's current set of major development projects were all underway prior to implementation of the Corrective Action Plan. These projects will gradually be completed (NASA's typical timeline for development is 4 years) and replaced with projects that will be fully subject to the Plan.

¹⁷The Gravity Recovery and Interior Laboratory mission launched on September 10, 2011, to study the Moon's interior. Juno launched on August 5, 2011, to investigate the origin and evolution of Jupiter and is scheduled to arrive at the planet in July 2016. The Mars Atmosphere and Volatile Evolution mission is scheduled to launch in late 2013 to investigate the Martian atmosphere.

¹⁸NASA Procedural Requirements (NPR) 7120.5E, “NASA Space Flight Program and Project Management Requirements,” August 14, 2012.

¹⁹LLIS is an online, automated database. The public can access LLIS at <http://llis.nasa.gov/llis/search/home.jsp> (accessed October 8, 2012).

consistent policy direction and implementation for the Agency's overall lessons learned program; disparate levels of funding for LLIS activities across NASA Centers; deficient monitoring of critical Center-based LLIS activities; and lack of definition in NASA's overall strategy for knowledge management, lessons learned, and LLIS. Consequently, LLIS had been underutilized by project managers and marginalized in favor of other NASA knowledge sharing system components.

Infrastructure and Facilities Management

NASA is the ninth largest Federal Government property holder, controlling a network of approximately 4,900 buildings and structures that support Agency research, development, and flight activities. In total, the assets occupy 46 million square feet and their current replacement value is estimated at more than \$30.8 billion. The 2010 authorization act requires NASA to develop a strategy for the most efficient retention, sizing, and distribution of facilities and other infrastructure consistent with the Agency's mission. In a time of constrained Federal budgets and transition from the Space Shuttle era, successfully implementing this directive is among the most pressing challenges facing Agency management.

Maintenance, Repair, and Use of Aging Facilities.—NASA officials report that more than 80 percent of the Agency's facilities are 40 or more years old and beyond their design life. Under its current policy, NASA is required to maintain these facilities either in an operational status or, if they are not being used, in sufficient condition that they do not pose a safety hazard. However, NASA has not been able to fully fund required maintenance costs for these facilities and in 2011 estimated its deferred maintenance costs at \$2.47 billion.²⁰

NASA has struggled for years with managing its backlog of deferred maintenance projects. The Aerospace Safety Advisory Panel cited the condition of NASA's facilities and infrastructure as an area of concern in its 2011 annual report, and in 2010 the National Research Council cited a "steady and significant decrease in NASA's laboratory capabilities, including equipment, maintenance, and facility upgrades" that require more maintenance than funding permits.

The challenge for NASA leadership in this area is to address the backlog of essential maintenance projects so that facilities will be available when needed to support future missions. Continuing to delay essential maintenance projects poses a threat to the safety of personnel and equipment and likely will result in higher repair costs in the future.

Reducing Unneeded and Duplicative Infrastructure.—One way NASA could reduce its facilities maintenance costs is to reduce the amount of underutilized and duplicative infrastructure in its inventory. In the 1990s, GAO issued several reports on NASA's infrastructure challenges and noted that the Agency was building new facilities faster than it was consolidating or closing older ones, resulting in duplication of capabilities. More recently, GAO reported that over 10 percent of NASA's real property assets were either underutilized or not being used at all.²¹ In 2008, NASA's own Program Analysis and Evaluation Office identified 203 facilities that had no future mission requirement yet were still listed in the NASA inventory.

Finally, an August 2011 OIG audit found numerous NASA facilities that had not been utilized, some for as long as 10 years.²²

The challenge for NASA leadership in this area is to reduce unneeded and duplicative property in light of the key missions, technologies, and programs the Agency intends to pursue over the next 20 to 30 years and the facilities it will need for those pursuits. In this effort, NASA must move beyond its traditionally conservative approach of "keep it in case we need it" in managing its facilities. Fundamental to the success of any such effort will be improving the quality of the Agency's data regarding its real property assets. To this point, our August 2011 OIG report found that the data in NASA's primary system for compiling and analyzing its real property assets were unreliable metrics for evaluating utilization, mission dependency, and condition of the Agency's real property assets largely because NASA Centers used inadequate processes to gather and update this information.

To its credit, NASA has begun to take positive steps toward addressing its infrastructure challenges. For example, in 2011 NASA developed its first integrated, Agency-wide real property master plan, which it intends to use to coordinate resources across the Agency by linking real property needs with projected funding.

²⁰ NASA, "Deferred Maintenance Assessment Report: FY11 NASA-Wide Standardized Deferred Maintenance Parametric Estimate (Full Assessment)," October 1, 2011.

²¹ GAO, "Federal Real Property: Progress Made Toward Addressing Problems, but Underlying Obstacles Continue to Hamper Reform" (GAO-07-349, April 13, 2007).

²² NASA OIG, "NASA Infrastructure and Facilities: Assessment of Data Used to Manage Real Property Assets" (IG-11-024, August 4, 2011).

However, in December 2011 we reported that the Center master plans the Agency was using to develop this integrated plan contained deficiencies that may limit the plan's usefulness in making strategic real property decisions.²³ Developing an integrated Agency master plan in an uncertain budget environment is a significant challenge for NASA. Nonetheless, as noted in our report, better Center master plans will help NASA develop a more comprehensive Agency master plan, which in turn will enable the Agency to make better strategic decisions regarding its real property assets.

In addition to its Agency-wide master planning effort, NASA is taking further action to better identify and assess the Agency's strategic capabilities and the real property assets that will be needed to support those capabilities.²⁴ For example, the Agency has strengthened central authority over infrastructure decisions and initiated efforts to improve data management and better assess technical capability needs across the Agency to assist in the Agency's efforts to reduce its real property, the OIG is conducting an audit examining NASA's efforts to identify and reduce unneeded and duplicative test stands, wind tunnels, vacuum chambers, airfields, and Space Shuttle-related infrastructure.

Leased Space at NASA Centers.—Leasing offers the Agency another means to help address the maintenance costs of its aging and underutilized facilities. However, Federal law and policy prohibits NASA (and other Government agencies) from leasing facilities for which it has no current or future mission-related use. For these facilities, NASA should consider other options, such as demolition or transferring the property to the General Services Administration for sale or transfer to another entity. The challenge for NASA is to use leasing when appropriate to generate revenue to offset facilities operations and maintenance costs while not using it as a way to hold on to facilities the Agency does not need. Leasing property under the latter scenario frustrates the Agency's efforts to reduce its real property footprint and can divert effort and resources from its core missions.

An August 2012 OIG review found that NASA lacks clear guidance to ensure that property identified for leasing was not excess to the Agency's needs.²⁵ We also determined that NASA lacked a complete inventory of space available for lease as well as an effective marketing program to attract potential tenants. In addition, we found internal control weaknesses that limit NASA's ability to ensure that leases provide the best value to the Agency and are fair to its partners and potential partners. Absent better controls and improved guidance, NASA will be hard-pressed to maximize the potential of its leasing program to help reduce the cost of maintaining underutilized facilities while meeting its obligation to ensure that leasing does not become a substitute for disposing of excess property.

One tool available to NASA is Enhanced-Use Leasing (EUL), which allows the Agency to retain the proceeds it derives from leasing underutilized real property rather than turning them over to the U.S. Treasury. In fiscal year 2003, Congress granted EUL authority to Ames Research Center and Kennedy Space Center. Using this authority, Kennedy entered into an EUL with a Florida utility for a 60-acre site that supports a solar farm that generates 1 percent of the Center's power needs. Under subsequent legislation, all Centers may enter into EULs in which they receive either cash payments or in-kind consideration related to the development of renewable energy production facilities.

Acquisition and Contract Management

Approximately 81 percent of NASA's \$18.5 billion fiscal year 2011 budget was spent on contracts to procure goods and services and provide funding to grant and award recipients. As the President and Congress work to reduce Federal spending and the country's budget deficit, NASA is likely to face constrained funding levels for the foreseeable future. Accordingly, it is critical that NASA work to ensure that the billions of dollars of taxpayer funds entrusted to it are spent wisely. However, systemic weaknesses in NASA's internal controls related to acquisition and contracting continue to create challenges for the Agency. The OIG will continue to focus resources on this issue to identify fraud, waste, and abuse by contractors and awardees as well as weaknesses in the Agency's system of internal controls.

Contract Management.—Given the large amount of taxpayer funds NASA spends on contract awards, managers are constantly challenged to ensure that the Agency

²³ NASA OIG, "NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Master Planning" (IG-12-008, December 19, 2011).

²⁴ NASA defines a capability as the necessary infrastructure, equipment, workforce and other direct costs required to accomplish a given mission requirement.

²⁵ NASA OIG, "NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Leasing Practices" (IG-12-020, August 9, 2012).

pays contractors in accordance with contract terms and receives fair value for its money. During the past year, the OIG continued to uncover fraud and overcharging by NASA contractors. Specifically, as a result of our investigative work in the past year:

- A Government contractor and its parent company agreed to pay \$3.3 million to settle allegations that they included unallowable costs in calculating overhead rates for NASA and national defense-related contracts.
- Another Government contractor agreed to pay \$617,789 to settle allegations that it submitted inflated invoices for engineering and technical services it provided to Dryden Flight Research Center.
- A Texas business owner pleaded guilty and was sentenced to 3 years' probation for making a false statement concerning space vehicle parts his business supplied to NASA for use on the ISS. The investigation found that the business owner had certified that ratchets his company produced met contract specifications when he knew they did not.

The OIG's audit work during the past year also identified weaknesses in NASA contract management. For example, we examined whether research funded by NASA Research Announcements (NRAs) advanced the Agency's aeronautics research goals and whether award costs were allowable and properly supported.²⁶ Although we found that these NRA awards advanced the Agency's aeronautics research goals, we also found that 18 of the 43 awards we reviewed (42 percent) contained approximately \$2.4 million in questioned costs: \$22,114 in unallowable fees, and \$2,405,635 in unsupported costs.²⁷ Based on our sample results, we estimated that the NRA awards made by the Aeronautics Research Mission Directorate from May 2006 through January 2011 contained \$25.2 million in unallowable or unsupported costs.

In another audit, we reviewed NASA's compliance with the Duncan Hunter National Defense Authorization Act of 2009 and found contract files lacking documentation related to acquisition plans and rationales supporting the type of contracts selected.²⁸ We also identified several instances where the contracting officer's technical representative was not timely assigned and cases where NASA had not validated the adequacy of the contractor's accounting system—both critical to management and oversight of contractor performance. Recently, we initiated an audit of NASA's Strategic Sourcing Program to determine whether the Program has been effectively implemented and whether it has resulted in cost savings for NASA.

One area in which NASA continues to be particularly challenged with regard to safeguarding against fraud is its Small Business Innovation Research (SBIR) program. NASA awarded approximately \$190 million to small businesses under this program during fiscal year 2011 to stimulate technological innovation, increase participation by small businesses in federally funded research and development, and increase private sector commercialization of innovations derived from federally funded research and development efforts. In multiple investigations and audits over the years, the OIG has identified significant fraud, waste, and abuse in NASA's SBIR program. For example, this past year an OIG investigation resulted in the suspension of a technology firm and two of its principals from participation in Federal procurements for failing to disclose that the principals were primarily employed by a university when they submitted proposals to participate in the NASA and Navy SBIR programs.

Moving forward, the OIG will continue to closely monitor the Agency's SBIR activities and work collaboratively with the Agency to improve performance in this area.

Grant Management.—NASA faces the ongoing challenge of ensuring that the approximately \$500 million in grants it awards annually are administered appropriately and that recipients are accomplishing stated goals. The Agency makes these awards to facilitate research and development projects; to fund scholarships, fellowships, or stipends to students and teachers; and to fund educational research performed by educational institutions or other nonprofit organizations.

²⁶ NRAs are solicitations that announce research opportunities and provide a formal mechanism for corporations, universities, and research institutions to submit project ideas. From 2006 to 2010, NASA spent approximately \$1.3 billion on NRA awards, of which approximately \$435 million was spent by the Aeronautics Research Mission Directorate.

²⁷ NASA OIG, "NASA's Use of Research Announcement Awards for Aeronautics Research" (IG-12-011, April 30, 2012).

²⁸ The act requires OIGs to report on their agencies use of cost-reimbursement contracts and level of compliance with applicable FAR rules related to the appropriate documentation for the award, use, and management of those contracts. See NASA OIG, "Final Memorandum on NASA's Compliance with Provisions of the Duncan Hunter National Defense Authorization Act of 2009—Management of Cost-Reimbursement Contracts" (IG-12-014, March 14, 2012).

Over the past 5 years, the OIG conducted 40 grant fraud investigations resulting in three prosecutions and \$12.5 million in restitution and recoveries. As a result of one recent investigation, the Department of Justice filed a civil complaint under the False Claims Act alleging that a NASA grant recipient improperly spent more than \$3.75 million in grant funds intended for research purposes on construction of a building.

In September 2011, the OIG reported that NASA did not have an adequate system of controls in place to ensure proper administration and management of its grant program and that as a result some grant funds were not being used for their intended purposes.²⁹ Following this report, we conducted three audits examining whether specific NASA grants are being used for their intended purpose and whether associated costs are allowable, reasonable, and in accordance with applicable laws, regulations, guidelines, and terms of the grants.³⁰ Although we did not find any evidence of fraud or abuse in these audits, we did identify a number of internal control deficiencies and improvements needed in NASA's grant oversight and management. For example, we determined that the Philadelphia College Opportunity Resources for Education, a not-for-profit organization that provides college scholarships to high school seniors, had charged \$60,511 in unallocable or unallowable expenditures and failed to maintain appropriate time and attendance documentation to support personnel charges totaling \$156,409.

NASA is faced with the challenge of conducting active oversight of grant recipients within resource and staffing limitations. Consequently, we will continue to focus resources in this area as the Agency works to enhance its grant management processes.

Information Technology Security and Governance

NASA's portfolio of information technology (IT) assets includes more than 550 information systems that control spacecraft, collect and process scientific data, and enable NASA personnel to collaborate with colleagues around the world. Hundreds of thousands of NASA personnel, contractors, academics, and members of the public use these IT systems daily and NASA depends on them to carry out its essential operations. Overall, NASA spends more than \$1.5 billion annually on its IT-related activities, \$58 million of that for IT security. Although many NASA IT systems contain data that may be widely shared, some systems house sensitive information which, if lost or stolen, could result in significant financial loss, adversely affect national security, or significantly impair our Nation's competitive technological advantage.

Over the past 5 years, we have issued 21 audit reports containing 69 IT-related recommendations. In addition, OIG investigators have conducted more than 16 separate investigations of breaches of NASA networks, several of which have resulted in the arrests or convictions of foreign nationals in China, Great Britain, Italy, Nigeria, Portugal, Romania, Turkey, and Estonia.

IT Security Weaknesses.—Through our audits and investigations, we have identified systemic and recurring weaknesses in NASA's IT security program that adversely affect the Agency's ability to protect the information and information systems vital to its mission. For example, NASA has been slow to implement full-disk encryption on notebook computers and other mobile computing devices it provides to its employees, potentially exposing sensitive information to unauthorized disclosure when such devices are lost or stolen. Between April 2009 and April 2011, NASA reported the loss or theft of 48 Agency mobile computing devices, which resulted in the unauthorized release of sensitive information including Social Security numbers, export-controlled data on NASA's Constellation and Orion programs, and third-party intellectual property. Although NASA has selected an enterprise solution for encrypting data on its mobile computing devices and hopes to complete implementation by March 31, 2013, until this process is complete, sensitive data on the Agency's mobile computing and portable data storage devices will remain at high risk for loss or theft.

We also found that NASA continues to experience challenges as it moves from a compliance-focused "snapshot" approach for measuring the security of its IT systems to using tools and techniques to perform real-time security control monitoring. Although NASA has made progress implementing such a continuous monitoring pro-

²⁹NASA OIG, "NASA's Grant Administration and Management" (IG-11-026, September 12, 2011).

³⁰NASA OIG, "Audit of NASA Grants Awarded to the Alabama Space Science Exhibit Commission's U.S. Space and Rocket Center" (IG-12-016, June 22, 2012); NASA OIG, "Audit of NASA Grants Awarded to the Philadelphia College Opportunity Resources for Education" (IG-12-018, July 26, 2012); and NASA OIG, "Audit of NASA Grant Awarded to HudsonAlpha Institute for Biotechnology" (IG-12-019, August 3, 2012).

gram, the Agency needs to: (1) create and maintain a complete, up-to-date record of IT components connected to Agency networks; (2) define the security configuration baselines that are required for its system components and develop an effective means of assessing compliance with those baselines; and (3) use best practices for vulnerability management on all its IT systems. Only by making improvements in each of these areas can NASA ensure that its continuous monitoring program will adequately protect Agency IT assets.

The CIOs inability to ensure that NASA's mission computer networks implement key IT security controls continues to put these critical IT assets at risk of compromise. Through our work we have found that Agency mission networks do not consistently implement key IT security controls. For example, the Agency has not yet implemented two recommendations from a May 2010 OIG audit report to monitor its mission networks for the presence of critical software patches and technical vulnerabilities.³¹ Moreover, our detailed control tests of mission networks in 2010 and 2011 identified several high-risk technical vulnerabilities on systems that provide mission support to spacecraft. Until NASA implements measures to better protect its mission networks, they will remain at risk of compromise, which could have a severe adverse effect on NASA operations, assets, or personnel.

Attacks on Information Technology Infrastructure.—In 2010 and 2011, NASA reported 5,408 computer security incidents resulting in the installation of malicious software on or unauthorized access to its computers. Such incidents disrupt Agency operations and can result in the loss or theft of sensitive data from NASA systems. NASA remains a target both because of the large size of its networks and because its information is highly sought after by criminals attempting to steal technical data or further other criminal activities. Moreover, NASA has increasingly become a target of a sophisticated form of cyber attack known as advanced persistent threats (APTs). The individuals or nations behind these APTs are typically well organized and well funded and often target high-profile organizations like NASA. Our investigation of a recent APT attack at the Jet Propulsion Laboratory (JPL) involving Chinese-based Internet protocol addresses has confirmed that the intruders gained full system access to numerous JPL systems and sensitive user accounts. With full system access the intruders could: (1) modify, copy, or delete sensitive files; (2) add, modify, or delete user accounts for mission-critical JPL systems; (3) upload hacking tools to steal user credentials and compromise other NASA systems; and (4) modify system logs to conceal their actions.

In an effort to improve the Agency's capability to detect and respond to these evolving threats, in November 2008 NASA consolidated its Center-based computer security incident detection and response programs into a single, Agency-wide computer security incident handling capability called the Security Operations Center (SOC). In an August 2012 audit, we found that establishment of the SOC had improved NASA's computer security incident handling capability by providing continuous incident detection coverage for all NASA Centers.³² Moreover, the SOC's communication processes, including weekly conference calls and security bulletins, were effective for sharing security incident and threat information with responders across the Agency. Finally, we found that NASA implemented an effective information system that enables Agency-wide management and reporting of IT security incidents.

However, we also found that NASA's computer systems and networks remain at high risk for loss of sensitive data because the Agency's network firewalls and the SOC's intrusion detection capability are ineffective for either detecting or preventing APTs from bypassing the Agency's firewalls and perimeter defenses. Moreover, even after NASA fixes the vulnerability that permitted the attack to succeed, the attacker may covertly maintain a foothold inside NASA's system for future exploits. The increasing frequency of APTs heightens the risk that key Agency networks may be breached and sensitive data stolen. We made three recommendations in our report for enhancing the Agency's capability to detect and prevent these types of sophisticated cyber attacks and to improve overall SOC availability. The Agency is in the process of implementing these recommendations.

NASA Information Technology Governance.—Achieving the Agency's IT security goals will require sustained improvements in NASA's overarching IT management practices and governance. Effective IT governance is the key to accommodating the myriad interests of internal and external stakeholders and making decisions that balance compliance, cost, risks, and mission success. Effective IT governance also

³¹NASA OIG, "Review of the Information Technology Security of [a NASA Computer Network]" (IG-10-013, May 13, 2010).

³²NASA OIG, "Review of NASA's Computer Security Incident Detection and Handling Capability" (IG-12-017, August 7, 2012).

helps ensure that public funds are efficiently spent by coordinating spending across NASA when purchasing IT products and services.

Federal law and NASA policy designate the Agency Chief Information Officer (CIO) as the official responsible for developing IT security policies and procedures and implementing an Agency-wide IT security program. However, we have found that the CIO has limited ability to direct NASA's Mission Directorates to fully implement CIO-recommended or mandated IT security programs.

NASA's IT assets generally fall into two categories: (1) the "institutional" systems and networks the Agency uses to support such administrative functions as budgeting and human resources; and (2) the "mission" systems and networks that support the Agency's aeronautics, science, and space programs such as the Mission Operations Directorate at Johnson Space Center, the Huntsville Operations Center at Marshall Space Flight Center, and the Deep Space Network at JPL. While the CIO has a complete inventory of and the authority to implement the Agency's IT security program for NASA's institutional IT assets, the CIO cannot fully account for or ensure that NASA's mission IT assets comply with applicable IT security policies and procedures.

IT assets on NASA's mission computer networks are funded by the related Mission Directorate, which is responsible for IT security, including the authority for risk determination and risk acceptance. Moreover, IT staff responsible for implementing security controls on mission IT assets report to officials in the Mission Directorate, not the NASA CIO. Thus, the CIO does not have the authority to ensure that NASA's IT security policies are consistently followed across the Agency.

We are currently conducting a review examining NASA's IT governance structure and anticipate making recommendations for improvement.

NASA PRIORITIES

Senator SHELBY. Thank you, Administrator Bolden. It's hard not to call you General Bolden, because we go back a while.

Administrator Bolden, over the past 2 years, in testimony before this and other committees, you stated that NASA's top priorities are SLS, Orion, JWST, and the ISS. In your testimony today, you do not take, I believe, a similar position. In fact, you're specifically talking about commercial crew being NASA's top priority.

This statement is reflective of this budget with respect to commercial crew. But I'm interested to learn why NASA no longer counts these other programs as top priorities and how our long-standing investments in these other programs will be impacted by NASA's changing priorities.

Could you explain that to the subcommittee?

Mr. BOLDEN. Mr. Chairman, I hope this will not be considered a disagreement with the chairman, because that's not healthy, but NASA's priorities are the Nation's priorities, and they remain SLS, multi-purpose crew vehicle (MPCV), JWST, and the ISS, shored up by a vigorous technology development program and commercial crew and cargo.

The reason I emphasized commercial crew in my opening statement is because this is a year of decision. We promised that we would have a commercial crew capability for the Nation by 2015, if funded at the President's requested level back in 2011, and that funding did not come. We now find ourselves targeting 2017 for the first availability of a U.S. capability to launch American astronauts to space.

If we do not get \$822 million in the fiscal year 2014 budget as requested by the President, it will be my unfortunate duty to advise the Congress and the President that we probably will not make 2017 for the availability of an American capability to get our astronauts to space. I will have to tell you that I'm going to have

to come back and ask for authorization to once again pay the Russians to take our crews to space.

We just renewed a contract for another year, because we weren't able to have our own capability in 2015. It is not my desire to come back to this subcommittee and to the Congress and the President and ask for more money to pay the Russians.

Senator SHELBY. We're joined by the chairwoman, and I'll yield back the gavel.

Mr. BOLDEN. Welcome, Madam Chair.

Chairwoman MIKULSKI [presiding]. Good morning, Mr. Bolden. First of all, let me apologize. It took 2 hours to get here from Baltimore this morning. I needed one of your rocket ships or something.

Mr. BOLDEN. I needed one coming from Mount Vernon. I, too, was late.

Chairwoman MIKULSKI. Well, you're coming from the other side of the Potomac, but I'm beginning to think this—anyway, so I really apologize for being late. But it shows the bipartisan nature of this subcommittee and this Committee, with my vice chairman, Senator Shelby. I had absolute confidence that he could take this over, because we're going in the same direction with the Committee, and we're going in the same direction with the space program.

We do want to welcome you. And today is a very compressed day. The hearing must end no later than 10:30 a.m.

Just know that, first of all, as we review the President's budget, and the fact that we're facing sequester, and then the usual challenges of NASA, where we ask you to do more than less, there are many things that we would like to discuss with you.

But I believe that our overall thrust is that we are looking on a bipartisan basis to be an advocate for a balanced space program. And a balanced space program to us means all of the groundwork for continued human space exploration; reliable space transportation mechanisms, both to carry our astronauts and then also to be able to service the ISS; to continue America's exceptionalism in space science; and to continue our work in aeronautics.

We believe that NASA is an economic engine, and we want to continue out-innovating the rest of the world. But at the same time, we have to be stewards of the taxpayer's dollar with oversight and accountability.

So having looked at that, Senator Shelby, did you ask any questions yet?

Senator SHELBY. Just one.

Chairwoman MIKULSKI. What was—may I ask—

Senator SHELBY. We were just getting into the priorities of NASA.

Chairwoman MIKULSKI. Well, you know, Mr. Chairman, while I go over mine, why don't you continue your line of questioning? But I just wanted to welcome Administrator Bolden and apologize for the delay. Why don't you do that?

SPACE LAUNCH SYSTEM BUDGET ESTIMATES

Senator SHELBY. Thank you. Thank you, Madam Chairman.

I have a couple more areas, General Bolden, I'd like to get into.

In August 2011, an independent cost assessment determined that NASA's budget estimates for SLS were reasonable through 2015. These budget numbers assume that costs for SLS rocket development in the year 2014 would be \$1.61 billion. But NASA's budget request, I understand, is \$1.38 billion. That's \$227 million less than was expected to be needed. That's a large swing in the cost model that raises questions, I think, whether the difference is attributed to cost savings or is it a lack of commitment to the mission?

Could you explain what that is, General, and why?

Mr. BOLDEN. Mr. Chairman, first of all, the independent cost assessment was requested, as we have done for JWST, for SLS, for MPCV, and most recently for the commercial crew program. It is not surprising that every time we get an independent cost assessment, one of their first determinations is that we don't have enough money.

So while we accept the assessment of the independent cost assessment that they would like to see more—they consider it reserve. We acknowledge the fact that we did not have the amount of reserve that we would like to have, but that we were confident that we could carry out this program with a budget that we requested.

As Mr. Gerstenmaier has testified before this and other committees in the past, we are running all of our programs to include commercial cargo and crew at the lowest level that we feel confident we can deliver them on time.

So that's the difference between what the independent cost assessment said they thought we should have to provide adequate reserves and what we think we can do the program with.

Senator SHELBY. Well, some of us are concerned about the funding necessary for the SLS rocket development and, of course, the other components. But, you know, we're talking about SLS rocket.

And if there's truly cost savings being realized, could you detail these actions to us, to the subcommittee, and an understanding of how similar measures are being applied across NASA's programs to achieve similar savings?

Mr. BOLDEN. I can say that—

Senator SHELBY. In other words, we're concerned, and I hope there's not a lot of ground for it, about SLS, the rocket itself, not the component.

Mr. BOLDEN. I could stand corrected by somebody in my organization, but we don't advertise that we have realized cost savings on the SLS program. What we have done is we've exercised efficient management of the program.

Senator SHELBY. We like that.

Mr. BOLDEN. And when we talk about the SLS program, I do want to be careful that I include everything that's involved in that program. So we have completed significant upgrades to Launch Complex 39B that is being prepared for SLS. The B-2 Test Stand at Stennis is being prepared for main propulsion test, which is a critical part of the preparation of SLS for its 2017 launch.

The J-2X engine has undergone numerous, very successful tests at Stennis. We've run it 500-plus seconds more than one time, and that puts us ahead of the game. I will say, we don't need to be

ahead of the game with the J-2X, but because we've committed that we would do that, we did.

We recently completed the very first test of a major engine component at Marshall in firing the gas generator for a rebuilt F-1 engine with Dynetics. Those are all examples of the progress that we continue to make with the SLS program.

Senator SHELBY. But, General, my emphasis is on the rocket itself, specifically, not all the ancillary things, the components.

Mr. BOLDEN. Yes.

Senator SHELBY. Because you've got to have that.

Mr. BOLDEN. Yes. I had a conversation with J.R. Thompson, who I know you know very well. He cautioned me this Sunday or last week, when we were waiting for Orbital to launch, not to become overly aggressive with the rocket and forget that the rocket is built to support an entire program. I could very easily find myself just like we were with Constellation. We need a 70-metric-ton vehicle, and we are on schedule, on target, on cost to provide that 70-metric-ton vehicle. I will need a 105-metric-ton vehicle probably in 2023. I think we're on target, on cost, on schedule in the development of that. It's an evolving system, and we'll get there.

Senator SHELBY. But you agree that you've got to have the engine—that's the rocket—to move and go anywhere? And just like you've got to have an engine in a car, you can have the finest components in the world and a beautiful seat and a good radio and good tires, but no engine, you're going nowhere.

Mr. BOLDEN. Senator Shelby, you and I agree completely. I think it's said that all roads to space lead through Huntsville, Alabama.

Senator SHELBY. I want to work with you on that.

Mr. BOLDEN. And Stennis. And that's very true.

And we are on schedule for having a 70-metric-ton vehicle at the level of spending that we—

Senator SHELBY. Will you furnish some details on all this to the subcommittee?

Mr. BOLDEN. We will do that, sir. I'll take that.

Senator SHELBY. Okay.

[The information follows:]

NASA is committed to developing the SLS for missions of deep space exploration. The fiscal year 2014 President's budget request, balancing the Nation's goals for space exploration with the current fiscal climate, provides the necessary funding profile required to keep SLS, Orion, and EGS moving forward to achieve EFT-1 in 2014, EM-1 in 2017, and EM-2 in 2021. The Agency plans to evolve SLS to achieve the 105 metric ton (mT) capability, and NASA believes the out-year resources envisioned in the fiscal year 2014 budget request will be sufficient to meet that goal in the 2023 timeframe. The 130 mT upgrade of SLS is planned for Mars-class missions in the 2030s.

COMMERCIAL SPACE ACT AGREEMENTS

Madam Chairman, I have one last area to get into, if I could, and that's commercial space.

Chairwoman MIKULSKI. Please, go right ahead, because your questions are actually identical, Sir, to what I was going to ask.

Senator SHELBY. Thank you.

I alluded to Commercial Space Act Agreements in my opening statement. NASA has used Space Act Agreements rather than traditional Federal Government contracts to execute the commercial

cargo and crew programs. These agreements lack transparency and incorporate significant schedule leniency.

Traditional Government contracts provide full insight and control over the contractor and the product throughout the process to protect the Government's investment, and ultimately the taxpayer.

With respect to the Space Act Agreements, it's my understanding that NASA has no authority to review the work of the contractors, audit their programs, or investigate in the event of an accident. Is that true?

Mr. BOLDEN. Mr. Chairman, that is a misconception of the capability of Space Act Agreements. We have had satisfactory insight and oversight on both commercial crew and cargo. We have embedded teams in the factories of our commercial crew partners, and we're still working fully on Space Act Agreements. They are an integral part, so we have sufficient insight for me.

Senator SHELBY. Do you have to ask the contractor to give you access to the Space Act Agreements that would give you some absolute authority over the contractor? And why does NASA prefer that approach, as opposed to the other government contracts?

Mr. BOLDEN. The reason we'd prefer—

Senator SHELBY. This is a deviation from the Government contracts.

Mr. BOLDEN. Yes, the reason we'd prefer Space Act Agreements at this stage of the game for commercial crew is the same reason we did it for commercial cargo. We wanted to give American industry as much leeway as possible to produce a vehicle that fulfilled the requirements that we set. It has worked very well for us, as demonstrated by the success of both Orbital and SpaceX, when we got to the point where we entered into a Federal Acquisition Regulation (FAR)-based contract.

Senator SHELBY. Well, if you're the one that's paying the bill and they're doing it, it looks to me like you should be in control of the destiny of that to a point, through the contract system.

Mr. BOLDEN. Sir, again, it's a misconception that we don't know what they're paying into it.

Senator SHELBY. Okay.

Mr. BOLDEN. We are a partner. When we did the independent cost assessment, then Booz Allen was able to go into the company, and granted, it's proprietary information.

Senator SHELBY. Sure.

Mr. BOLDEN. Without revealing what they had put into it, because that's competitive sensitive for them, we know about what each company has put into it.

Senator SHELBY. Okay. We don't want you to be in the dark anywhere, because it's taxpayers' money.

Mr. BOLDEN. I don't feel that we're in the dark with any of the contractors either in commercial crew or cargo. We feel very confident that we know about what level they're paying. We don't know the precise amount, because we don't get fiscal accounting the way that would be required if we were working under a FAR-based contract, but they are now working under FAR-based contracts in the Commercial Crew Integrated Capability (CCiCap) program, which is—not the CCiCap, but the requirements definition program. That's a FAR-based contract. We have total insight into

everything that they're doing. So when we get ready to roll out the request for proposals here this summer, we'll be confident that we know what they're doing.

Senator SHELBY. We just know that this is a deviation from the regular government contracts. We want to make sure——

Mr. BOLDEN. Most agencies don't have the——

Senator SHELBY [continuing]. That NASA spends our money wisely. That's all.

Mr. BOLDEN. Yes, Sir. NASA uses Space Act Agreements judiciously, but we use them widely, because it enables us to do much more than any other agency and the government can do for the budget that we have. We use it as a budget tool.

Senator SHELBY. Thank you.

Thank you, Madam Chairman.

BALANCED SPACE PROGRAM

Chairwoman MIKULSKI. I really truly appreciate Senator Shelby's line of questioning, because this goes to the balanced space program, and actually, his questions were very much along the line that I was going to ask.

I was troubled by the fact that there were decreases in the SLS rocket and Orion capsule program by \$184 million.

As the chair of the subcommittee, working with Senator Shelby, I'm worried. So let me tell you what I'm worried about.

I believe that NASA has been constrained over several years now with staying roughly in this \$17 to \$18 billion range. We ask you to make estimates, and there's been a pattern not only in NASA, but across all agencies, to low-ball estimates. Then those low-balling of estimates tend to be inaccurate, and then along comes something like sequester, which has a tremendous impact on employees, both our civilian Federal employees, our contractors, because NASA is truly a work-with-contractor agency and has a fairly good track record on that.

We're going to get to the end of the day with a fiscal quagmire unresolved, the space agency and other agencies—Department of Defense (DOD) is the same way and others—underestimating what it's going to take.

And then we end up with programs that falter or sputter. And in NASA's mission, faltering or sputtering really can blow the whole program.

So you see where I am.

Mr. BOLDEN. Yes, ma'am.

Chairwoman MIKULSKI. One set of dynamics, our fiscal quagmire, was shutdown, slam-down politics that are not characteristic of this subcommittee—in fact, just the opposite—that we have to resolve.

And so my question to you, as we look at this, is that facing sequester and facing the estimates in the President's budget, do you think you can keep these NASA missions on track and online?

Or are we really asking for an almost impossible task of you, Director Bolden?

And I mean it very sincerely. You are a very dedicated person. You were heading in a whole different life before President Obama asked you to take this job.

Mr. BOLDEN. I was.

Chairwoman MIKULSKI. Yes, I know. You were going to start a foundation oriented to sickle-cell anemia. I mean, you were going to devote your life to inspirational motivation of young people and cracking a biomedical problem facing Americans. Now you're staying on for yet another tour of duty.

So, please, let's get realistic estimates, so we know what we're really facing and what we should really be doing to maintain a balanced space program.

Mr. BOLDEN. Madam Chairman, I agree with you. Let me say, my assumption in recommending this budget to the President and the President's assumption in sending it to the Congress was that, between him and all of you, the 100 Senators and 400-plus Members of Congress, we are going to solve the sequester problem in this budget coming out.

If that is not done, then I will tell you right now, what I'm telling you about today, I can't do. So you're going to see us come in and tell you that it will impact the priorities that NASA and the Congress agreed to. It will potentially impact JWST. It will definitely impact SLS, MPCV. It will devastate commercial crew and cargo. We have contracts now for commercial cargo. I'll have to renegotiate those contracts. We won't fly the number of missions that we have. Right now, we're flying 20 commercial cargo missions to the ISS over the next 5 years for \$3-point-some-odd billion dollars, an incredible value to the Nation. I can't carry that out under sequester.

I will, in all probability, have to furlough civil servants, and we have avoided that.

So the sequester is not good. And I'm not telling anybody I can work a miracle. If we cannot get out from under the sequester, all bets are off. And you are absolutely right, I'm going to come to you and tell you things that we're dropping off the plate.

Chairwoman MIKULSKI. But this is the time to tell us. In other words, this is not in the future. The sequester is here now.

So this is not, again, meant to be in any way pugnacious.

So let's look at the sequester issue. And if we do not cancel or find a way to cancel the sequester, what would be the consequences? Would it be simply delays to these projects?

Let's take three things. Let's take the JWST. Let's take the SLS Orion. And let's take other important scientific programs.

Mr. BOLDEN. Let me just say one quick thing. We are under the sequester now, and so we're operating under fiscal year 2013 budget sequestered.

We have made adjustments such that it has not impacted our programs, nor our people just yet. But we cannot do that in fiscal year 2014. So you're absolutely right.

Chairwoman MIKULSKI. When will it actually affect you? In other words, everybody says the sequester is a made-up crisis and—

Mr. BOLDEN. No, it's not a made-up crisis.

Chairwoman MIKULSKI. In other words, if you have to furlough people, when will you start doing it?

Mr. BOLDEN. If we do not come out from under the sequester for the fiscal year 2014 budget, we'll start furloughing people when the fiscal year 2014 budget becomes effective.

Chairwoman MIKULSKI. That would be October 1.

Mr. BOLDEN. That would be October 1. We'll have to start looking at——

Chairwoman MIKULSKI. So we have some elasticity of time, but not an open-ended situation.

Mr. BOLDEN. Time is not my ally, but time is my friend right now when it comes to the workforce.

Chairwoman MIKULSKI. Well, we are your friend, but anyway, let me go then to the next question.

Many of our colleagues have said, oh, give the agencies flexibility. If you have flexibility, which I wanted to do, and many on the other side of the aisle wanted. There were higher powers that didn't. I wanted to give agencies a 1 percent transfer, reprogramming authority so we could keep our constitutional prerogatives and that of this subcommittee across programs, not across agencies. Like you couldn't go to the FBI, and they couldn't come to you, but across programs.

Would transfer authority solve your problem? Or is it truly the whole NASA that you would be still too constrained?

Mr. BOLDEN. Transfer authority, as you describe it, would always be helpful, and that's what we've requested or we have said——

Chairwoman MIKULSKI. But would it solve your problem?

Mr. BOLDEN. Under the sequester, transfer authority, even as you describe it, would not solve the problem.

Chairwoman MIKULSKI. Why not?

Mr. BOLDEN. We still will have to drop something from our portfolio. We would become a \$16.2 billion agency, and, you know, we're down almost \$1 billion this year. We're managing to do that. The sequester would take us down another huge notch, and then——

Chairwoman MIKULSKI. What is the number attached to a huge notch?

Mr. BOLDEN. I think right now, we're operating at \$16.8 billion, and we would go down to \$16.1 billion in fiscal year 2014, I think is the right number, but I'll get back to you.

[The information follows:]

In fiscal year 2014, under current law and assuming a continuing resolution, NASA expects to be subject to a sequester of approximately 7.8 percent from the \$17.492 billion enacted level in the fiscal year 2013 CJS appropriation. This equates to a total of \$16.159 billion and approximates the \$16.1 billion level I referred to in my testimony. As we have discovered in the past few months, the application of the sequester is not entirely straightforward and we have not received any guidance on the process for fiscal year 2014, so please view this as an estimate.

Chairwoman MIKULSKI. Mr. Administrator, my time is moving along, and I want to be sure that Senator Cochran has an opportunity.

What I would appreciate, and I think members of the subcommittee, is what would be—you've sent me a letter, I believe, on the consequences of that.

Mr. BOLDEN. We did. Yes, ma'am.

Chairwoman MIKULSKI. Does that outline it pretty well?

Mr. BOLDEN. That outlines pretty well what the effect would be. At that time, we gave you what we knew, and things have probably gotten more dire since then.

Chairwoman MIKULSKI. Well, then if you have an update or an annex, we would like to see it.

Mr. BOLDEN. Yes, ma'am. We will do that.

[The information follows:]

NASA has subsequently submitted the fiscal year 2013 operating plan, which serves as an update to the original letter to the Senator regarding effects of sequestration.

JAMES WEBB SPACE TELESCOPE STATUS

Chairwoman MIKULSKI. Now let me go right to one of our biggest scientific endeavors, the JWST. And if we don't keep that on track, where we've already had overruns I'm very concerned about, but if we don't keep the JWST within making sure we maintained all standards and practices of accountability, I'm afraid that the JWST overruns could begin to eat NASA alive.

And you know I'm a big supporter of the JWST. I believe it will keep America's exceptionalism in astronomy going beyond the Hubble Space Telescope (HST), with not only the power of the HST, but would keep us as premier space astronomers for the next 50 years.

So here is my question about that. Looking at the JWST and the fact that there are now additional Government Accountability Office (GAO) reports that say there continue to be flashing yellow lights, could you give us the status of the JWST? Is it online? How are we doing on maintaining the fiscal accountability that both you and Northrop Grumman promised me, and yet address the issues around the GAO?

And then I'd like to turn to Senator Cochran.

Mr. BOLDEN. Yes. Madam Chairman, as I mentioned to you the first time I called, nobody was as devastated as I was to find out the situation that James Webb was in. But as I promised you, when we restructured the program, we changed the management both in Northrop Grumman and NASA. We developed a new cost and schedule timeline. We are on schedule for a launch in 2018. We have a 14-month pad in the critical path for the telescope.

The reference that you make to the GAO report refers to two instruments, Near Infrared Spectrograph (NIRSpec) and Near Infrared Camera (NIRCam), we saw that the vendors were not going to be able to deliver on time, so we modified the schedule such that they could fit in, because it's critical that they be integrated into the telescope by the time it goes into the large test cell at the Johnson Space Center in the next few months. They are now on schedule to be delivered and will be there.

So we are on budget. We are on schedule. I look at JWST, post-your conversation with me, as I do Mars Atmosphere and Volatile Evolution (MAVEN) and Landsat Data Continuity Mission (LDCM) and some other missions, that by doing things differently than we always did them, we now are bringing in missions on cost, on schedule. We have done that for most of the missions that we have launched in the last couple of years. I'm very proud of that. We have a tremendous team that's really focused on the things that you asked us to focus on.

Chairwoman MIKULSKI. Well, thank you very much.

Senator Cochran, thank you for your patience, Sir.

B-2 TEST STAND

Senator COCHRAN. Madam Chairman, thank you for allowing me to join your subcommittee for this hearing. It's a pleasure to serve as a member of the subcommittee with such distinguished Senators as you and Senator Shelby.

Mr. Administrator, one of the facilities that NASA administers is the Stennis Space Center down the Mississippi gulf coast, as you well know.

Funding is needed from time to time to maintain its capabilities, and I'm here to see if the funding levels that are in the budget are sufficient to maintain the integrity of the test stand, where you will test the engines before you actually commit them to a launch.

And if there are deficiencies, I hope you will advise us what they are and your suggestions for dealing with them.

Mr. BOLDEN. Sir, it is my opinion that we have sufficient funds to continue the work that we're doing with Stennis. We're progressing well on the upgrades to the B-2 Test Stand, which, as I mentioned before, will be critical for main propulsion tests for SLS. Their record of performance in meeting test schedules not only for the J-2X, but for even our commercial partners' rockets, is phenomenal. We have days that we run two or three engine tests, and that's unprecedented.

So I think we're doing very well. It will be a challenge of them, and I'll go back to what Senator Mikulski said. Sequester is serious, and the sequester is real. All the progress that we made at Stennis will come to a screeching slow, if not a halt, if we have to live under sequester.

By the way, Sir, I want to thank you for all you did when you were ranking member of the Committee and your hospitality when I come to Mississippi.

Senator COCHRAN. Well, thank you very much.

Well, you know, the President proposes and the Congress disposes.

Mr. BOLDEN. Yes, Sir.

Senator COCHRAN. And that's something that reflects the responsibilities of our body in participating in the decisions regarding funding and the expenditure of taxpayer dollars on Federal programs. So your advice and your observations about the needs for funding are considered very important, because we know that you're familiar with the test stand and how it is producing some additional resources for NASA. And we want to be sure that we do our part here to maintain the integrity of that facility.

Mr. BOLDEN. Yes, Sir.

Senator COCHRAN. Thank you.

Chairwoman MIKULSKI. Mr. Administrator, there are many questions we'd like to continue to pursue. But there's been a special briefing called for Senators on both North Korea and Syria, and as the vice chairman of the Defense Committee and we who are the appropriators, we need to attend that briefing.

We want to thank you for your ongoing service, sir. And it is really noted and appreciated.

You have a big job. We have a big job.

And Senator Shelby and I were just talking about the fact that we want to return to a regular order of this committee, where we would take bills one at a time. But in order to do that, we have to meet our—I have to give allocations between May 15 and May 20.

There's a discrepancy. The American Taxpayer Relief Act of 2012 tells us to mark up our bills at a 302(a) level of \$1.058 trillion. Mr. Ryan has passed a budget at \$966 billion and taken all of the cuts out of discretionary spending.

So we've got that fiscal quagmire that I've talked about. But we're going to work together on a bipartisan basis, and we hope that the President, through his outreach to others, and the House would cooperate, and Mr. Ryan would appoint conferees, that there could be a reconciliation.

I think people don't quite yet grasp the significance of the sequester, because this is what the discrepancy is. We're set to go. And I've instructed my clerks and subcommittee chairmen—and I know Senator Shelby—we're not only spenders on this Committee, we also have a sense of frugality and wise spending. We're concerned that if we have sequester, we could end up by being penny-wise and pound foolish, by ending up with boondoggles because of delay in schedules, et cetera.

So we've got a big job ahead, but so do you.

Mr. BOLDEN. Yes, ma'am.

Chairwoman MIKULSKI. So please keep in touch with us. And we want to thank you for your cooperation at this abbreviated hearing.

As we go forward with the markup on our bill, both Senator Shelby and I and other members, along with our key staff, will be in touch with you.

Mr. BOLDEN. Yes, ma'am.

Chairwoman MIKULSKI. So for you, it's not keep the eye on the ball. Keep your eye on those rockets and telescopes, and let's keep America flying.

Mr. BOLDEN. Thank you very much, Madam Chairman.

ADDITIONAL COMMITTEE QUESTIONS

Chairwoman MIKULSKI. If there are no further questions this morning, Senators may submit official questions for the subcommittee's hearing record.

We ask NASA to respond within 30 days.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED TO HON. CHARLES F. BOLDEN, JR.

QUESTIONS SUBMITTED BY SENATOR DIANNE FEINSTEIN

MARS EXPLORATION

Question. The Curiosity Rover landing and the astonishing images coming back from Mars have generated enormous public support for Mars exploration. The scientific community broadly supports the next Mars mission as well, as demonstrated by its top ranking in the National Research Council's Decadal Survey. Moreover, Congress gave clear direction to prioritize this program in fiscal year 2013, reversing the severe cuts proposed in the President's budget. Despite congressional, scientific, and public support, the budget proposal for Planetary Science and Mars this

year looks remarkably similar to last year. Why has the administration chosen to scale back this critical funding so significantly?

Answer. The Mars 2020 rover mission continues the pursuit of the Mars Exploration Program's science theme of "Seeking the Signs of Life." The mission objectives are to explore an astrobiologically relevant ancient environment on Mars and to search for potential biosignatures within that geological environment. This mission will enable concrete progress toward eventual return to Earth of carefully selected materials, thereby satisfying NRC Planetary Decadal Survey science recommendations, and it will provide opportunities for accommodation of contributed Human Exploration & Operations Mission Directorate (HEOMD) payload element(s), technology infusion, and international participation.

Currently, a Science Definition Team is working to outline the science measurements required to meet the above objectives for Mars 2020, and the project team is assessing the engineering requirements and defining the overall mission concept, including the use of residual flight hardware and expertise from the Mars Science Laboratory (MSL) mission. As the mission concept is further developed, we will proceed to a Mission Concept Review in the fall of 2013, which will be followed by an openly competed payload Announcement of Opportunity.

At the time of the fiscal year 2014 budget formulation, NASA was in the early stages of defining the 2020 mission, and significant uncertainties remain as to the phasing of the mission's overall budget pending the results of the Science Definition Team and the upcoming Mission Concept Review later this year. The fiscal year 2015 budget formulation process will provide the opportunity to assess the budget profile for the Mars 2020 mission based on this better understanding of mission requirements.

Question. The Mars Program funding profile in the budget recommends funding increases in fiscal years 2017 and 2018. But the increases would only occur after severe lean years in fiscal years 2014, 2015 and 2016. How will NASA maintain its experienced and successful "entry, descent and landing" team in the coming years with this budget?

Answer. NASA's Science Mission Directorate recognizes that making steady progress towards the Mars 2020 mission launch will be critical to retaining the core capabilities in MSL-based Sky-Crane entry, descent and landing and Curiosity-class rover engineering systems. Currently, members of the Curiosity Entry, Descent, and Landing (EDL) team are engaged in reconstruction and analysis of data taken during Curiosity's landing to provide critical information for future Mars landers and rovers. Some members of the team are also supporting other Agency efforts in the immediate term. The ongoing concept definition for Mars 2020 will provide input to the fiscal year 2015 budget process, including the workforce requirements.

Question. In an effort to save money, the re-scoped Mars mission for 2020 called for a rover that has a virtually identical design as Curiosity, but carries different scientific instruments. This was done to streamline costs and maintain an early launch date within a limited budget. But, it is my understanding that the budget will not allow the suppliers and staff who worked on Curiosity to begin work on the new vehicle for several years. Why have you chosen to delay rover construction even though the staff and suppliers are available to do the work today?

Answer. At the time of the fiscal year 2014 budget formulation, NASA was in the early stages of defining the 2020 mission, and significant uncertainties remain as to the phasing of the mission's overall budget pending the results of the Science Definition Team and the upcoming Mission Concept Review this year. Currently, the team is preparing for acquisition of key long-lead parts. The fiscal year 2015 budget formulation process will provide the opportunity to assess the budget profile for the Mars 2020 mission based on this better understanding of mission requirements.

COMMERCIAL CREW

Question. The President's budget proposes a significant increase for the Commercial Crew Program—a 36 percent increase over the level provided in the fiscal year 2013 Omnibus. Can you explain why the budget proposal includes this increase? Will it allow for a meaningful competition to occur among private entities seeking to enter the space launch business?

Answer. The President's fiscal year 2014 budget request would restore the Commercial Crew Program funding to the level requested in previous budgets to bring an American commercial system to operational use as quickly as possible (NASA is estimating by 2017, though the companies have indicated that they could do it sooner). Through the Commercial Crew Integrated Capability (CCiCap) effort, NASA is funding three companies in an attempt to promote meaningful competition in the

development of their crew transportation systems, and reduce the eventual per-seat price of commercial crew transportation and rescue services.

SPACE LAUNCH PROCUREMENT

Question. Both NASA and the Department of Defense (DOD) require affordable access to space, but the agencies have taken different approaches on how to achieve that goal. NASA has effectively used competition and fixed price contracts to drive down costs, while the DOD is primarily relying on buying in bulk, what they call a “block-buy” strategy. From your experience, how has competition and fixed-price contracting benefited the Agency in its space launch procurement, both in terms of cost savings and mission success?

Answer. When appropriate, NASA has successfully utilized competition and fixed price contracting to drive down costs without compromising mission success. Specific examples include NASA Launch Service (NLS) and the Tracking and Data Relay Satellite System (TDRSS) contracts.

NASA pursues a “mixed fleet” approach to assure its access to space by using a competitive strategy across a variety of commercial launch services to support the small, medium and intermediate range. Historically, NASA has benefited significantly from competition and fixed-price contracting in the intermediate class launch services. However, one must be flexible and adjust the strategy to fit market conditions. In the past, we have also benefitted from a large block buy in the medium class when no competition existed or was forecasted. More recently, NASA was able to achieve good pricing for its medium class missions by utilizing competition. With the recent success of emerging launch service providers, NASA can regain the benefit from competition in the intermediate class and maintain competition in the medium class. The small class has only witnessed minimal competitive scenarios so far; however the fixed-price contracting has helped keep costs in check. As to mission success, a technical evaluation of capabilities and past performance of the commercial providers is evaluated as part of any competition, along with cost and other variables in order to determine a “best value” selection to meet NASA’s needs and the mission’s risk posture. Since NASA’s Launch Services Program creation in 1998, mission success in the medium and intermediate class launch services has thus far been 100 percent successful. Up until the two Taurus XL launch failures in 2009 and 2011, mission success in the small class had also been 100 percent successful. Launch is still a very challenging engineering endeavor, and no system will be able to maintain a 100 percent success record. Maintaining competition and using the NASA Launch Service Firm Fixed Priced contract structure and terms is critical to ensuring that NASA receives the best value for its launch services.

In addition to these programs, NASA believes that maintaining competition for the Commercial Crew Program is critical to ensuring that NASA and the Nation receive the best value for future U.S.-based crew transportation to the International Space Station (ISS). Competition also incentivizes the companies to invest their own funds and share in the development costs of their Crew Transportation System. Having industry share in the cost of development and selling seats to other customers in addition to NASA will likely decrease NASA’s costs for crew transportation services in both the short- and long-term. The competitive environment provides strong incentive for the companies to align with NASA’s certification requirements in order to remain competitive in the future certification and services phases. Having multiple companies competing against each other will help ensure the safest and most cost effective system possible for the Government.

SPACE TECHNOLOGY

Question. The budget proposes creating a new Space Technology Directorate, and funding it at \$742 million in fiscal year 2014. Can you explain how the program and the new structure will improve our ability to protect astronauts on long-term deep-space missions? How will the work being done interact with the ongoing work within the Science Mission Directorate?

Answer. The Space Technology Mission Directorate (STMD) was formally established in February 2013 to bring about innovative solutions that dramatically improve technological capabilities for NASA and the Nation. This new mission directorate has management and budget authority of the Space Technology programs, which are performed by all 10 NASA Centers. It focuses on project execution and technology infusion into the Agency’s exploration and science mission needs, taking a customer driven approach to prove capabilities needed for future NASA missions and the national aerospace community.

Using a broad investment strategy, NASA’s Space Technology investments address the identified range of technology areas found in NASA’s Space Technology

Roadmaps as prioritized by the National Research Council. The Space Technology portfolio supports a combination of early stage conceptual studies, discovering entirely new technologies; determining technology feasibility through rapid competitive development and ground-based testing; and flight demonstrations in relevant environments, completing the final step to mission infusion.

To achieve our human spaceflight goals, there are many technological barriers that must be overcome to allow humans to travel further from Earth. HEOMD conducts architecture studies (e.g. Human Exploration Framework Team (HEFT), Human Spaceflight Architecture Team (HAT)), which identifies needed technologies, as well as their timeline to perform future deep space human exploration missions. Exploration Technology Development (ETD) within the Space Technology budget is targeted specifically at human exploration technology needs. This includes the development and demonstration of high power solar electric propulsion (SEP) capabilities, scalable to handle power and thrust levels needed for deep space human exploration missions. High power SEP is considered essential to affordably performing human exploration missions to distant destinations such as Mars. In addition, NASA is investing in technologies that will allow for the in-space storage and transfer of cryogenic fuels to meet the needs for future propulsion stages to move crew from low Earth orbit to a variety of destinations. Providing such long duration storage and transfer of propellants is considered essential for any human exploration missions beyond the earth-moon system. Finally, Space Technology within the ETD program area is maturing a suite of critical technologies identified by the HEFT, HAT and other human exploration studies. Technologies within the portfolio include: life support components for next generation space suits and habitats, in-situ resource utilization components to detect water and produce oxygen from carbon dioxide (considered essential to produce ascent vehicle propellants for a human Mars mission), advanced batteries to support long spacewalks, high efficiency fuel cells that require no consumables and can be recharged for reuse during long duration missions, radiation modeling methods to improve the lead time for solar events, autonomous systems that will permit astronauts to efficiently operate independent of ground controllers, and robotic systems that can work in close proximity to humans, off-loading maintenance and operational tasks from astronaut duty cycles.

For science, this includes developing technologies that can increase communications bandwidth so NASA is able to receive more data from spacecraft studying the far corners of our solar system. In addition, we are developing technologies to improve accuracy of navigation systems and improve the longevity and efficiency of spacecraft power systems. Space technology is developing and will demonstrate a solar sail seven times larger than any solar sail tested in space to date, which has tremendous potential for future heliophysics missions. STMD also continues to support future planetary science missions through investments in advanced entry descent and landing (EDL) technologies, such as a new 33 meter ring sail parachute and supersonic inflatable aerodynamic decelerators to improve upon the landed mass and landing accuracy demonstrated by Curiosity. These new chutes and other supersonic decelerator technologies such as STMD investments in supersonic retro propulsion are necessary for human missions to the Mars surface. EDL technology investments also include inflatable and mechanical deployable heat shields applicable for robotic missions to multiple planets, as well as human missions to Mars. STMD is also investing in a new class of woven-carbon thermal protection materials permitting new missions to Venus as well as the other planets. The STMD is working with SMD to coordinate technology investments in nuclear systems and chronographs/starshades needed for next generation astrophysics observatories, with a goal of a space asset capable of detecting the atmospheric content and potential presence of life of Earth-like planets orbiting distant stars. In addition, STMD conducts annual small spacecraft demonstrations which tests subsystems that enable small spacecraft as well providing for an affordable test platform for future larger systems.

QUESTIONS SUBMITTED BY SENATOR RICHARD C. SHELBY

SPACE ACT AGREEMENTS/FEDERAL ACQUISITION REGULATION (FAR) CONTRACTS

Question. Please provide a detailed list of NASA authorities granted by the Space Act Agreements for the Commercial Crew Program. In particular, what unilateral authority to investigate participants, their activities and their books (specifically related to commercial crew activities) does the agreement grant NASA and what must NASA have permission from the contractor to access?

Answer. Under the Commercial Crew Integrated Capability (CCiCap) Space Act Agreements (SAAs), NASA has the authority to request any data first produced by the partner under the agreement for the purpose of evaluating the partner's performance of its milestones. NASA has the authority to review the partner's records to determine if any inventions were made under the agreement and whether the partner has complied with the requirements of the agreement relative to reporting of inventions. The partner is also required to report any mishap, and NASA has the authority to request any reports and data resulting from the partner's mishap investigation.

Question. Does NASA have the authority to investigate the Commercial Resupply Service flights, which to date, have had multiple incidents on ascent and at least once at landing, and if not, what is required for NASA to gain insight into these and any future mission irregularities?

Answer. The Commercial Resupply Services (CRS) contractor has the lead for anomaly resolution for phases of the mission during which they have responsibility (as was the case for the recent Dragon thruster anomaly which was successfully resolved). However, under the terms of the CRS contract, NASA officials are kept well apprised of the nature and progress of these activities, and NASA technical personnel may participate in the contractor's investigation and resolution of anomalies. SpaceX provided all relevant data necessary, including anomaly resolution information, to perform the rendezvous and berthing of the Dragon to the International Space Station (ISS).

Question. Can NASA provide the timing for conversion to FAR-based contracts for the certification of commercial capabilities and procurement of crew transportation services? Does NASA intend to sign further Space Act Agreements, or modifications to current agreements that are currently signed, for commercial crew prior to implementing FAR-based contracts?

Answer. NASA's contracting effort for the certification of commercial crew transportation services began with the first contract phase, the Certification Products Contracts (CPC). CPC was awarded to three companies on December 19, 2012. Under these FAR-based contracts, the selected contractors are developing products that will lead to the certification of their integrated commercial crew transportation systems. Advances made by these American companies during CPC are advancing the process of ensuring integrated crew transportation systems that will meet Agency safety requirements and standards to launch American astronauts to the International Space Station from the United States, ending the Agency's reliance on Russia for these transportation services.

The CPC contractors are:

- The Boeing Company, Houston, Texas;
- Sierra Nevada Corporation Space System, Louisville, Colorado; and
- Space Exploration Technologies Corp., Hawthorne, California.

The procurement planning for the second phase of the FAR-based certification contracts, known as the Commercial Crew Transportation Capability (CCtCap) procurement, has begun and will result in a separate competition. CCtCap award(s) are planned for the summer of 2014.

NASA does not currently intend to conduct additional competitions for Space Act Agreements to support commercial crew development. As companies mature their designs, NASA will determine whether exercising optional milestones is in the best interest of the Government.

COTS PROGRAM

Question. During the Commercial Orbital Transportation Services (COTS) program, the Space Act Agreements frontloaded the funding milestones so that nearly 90 percent of the funds were provided to companies before a single launch occurred in order to ensure the capability was developed and available when needed.

Given that significant Federal investment has already been made in a commercial capability which is a "launching point" for much of the commercial crew capability, has NASA considered backloaded payments for commercial crew in an effort to push for a greater private investment in the capability and greater accountability with respect to achieving milestones, imbedding safety tests and meeting schedule requirements?

Answer. NASA performs a full and comprehensive analysis of the milestones, deliverables, and payment options for all procurements and/or agreements. All types of payment options are considered and the specific type is chosen to best meet the objectives of the activity.

With respect to the COTS and Commercial Crew funded Space Act Agreements, the milestones and the amount of the milestones were proposed by industry and

NASA reviewed them for appropriateness and the extent to which they met the objectives of the Announcement for Proposals.

COMPETITION

Question. The Commercial Crew Program has been characterized as a competition. However, NASA has provided \$1.5 billion in incentivized grants to three companies for the development of crew launch vehicles. This does not sound like a traditional competition where multiple companies compete and one wins. This sounds like a grant program that makes everyone a winner—except perhaps the taxpayer who is paying multiple times for the same product.

Could you explain why NASA is calling the Commercial Crew Program a competition and how this approach will save taxpayer dollars if NASA is paying to develop multiple launch vehicles?

Answer. NASA characterizes the Commercial Crew Program as competitive because industry competes for awards under the program. Multiple companies competed for funded Commercial Crew Development (CCDev) and Commercial Crew Integrated Capability (CCiCap) awards and did not receive them, so the characterization of everyone being a winner is incorrect. NASA has leveraged the benefits of competition among companies for awards through the conduct of multiple competitions thereby requiring the companies to provide best value during each phase of the activity.

Maintaining a competitive environment for the Commercial Crew Program is critical to ensuring that NASA and the nation receive the best value for future U.S.-based crew transportation to ISS. In addition, continued competition among providers incentivizes the companies to expand their commercial market base by selling services to any other customers to maintain reasonable prices. Continued competition among providers also incentivizes the companies to invest their own funds and share in the development costs of their systems. Competition is also the fundamental basis for establishing fair and reasonable pricing for all requirements. Having industry share in the cost of development and selling seats to other customers in addition to NASA will likely decrease NASA's costs for crew transportation services in both the short- and long-term.

The establishment of this competitive environment provides strong incentive for the companies to align with NASA's certification requirements in order to remain competitive in the future certification and services phases. Having multiple companies competing against each other will help ensure the safest and most cost effective system possible for the Government.

NASA is not paying multiple times for the same product. Each commercial crew industry participant is proposing a unique crew transportation system (even when using the same launch vehicle) and NASA's investments are helping to develop those unique systems. The benefits of this approach can be seen in the Commercial Cargo Program which should soon have demonstrated two different U.S. cargo systems for ISS logistics. NASA refers to this as "dissimilar redundancy" and it allows NASA to be able to absorb a failure of any one system without a major impact to on-orbit operations. Additionally, the technology development that has been achieved by all the commercial crew companies will benefit other space based activities and expand the U.S. space industrial base.

Question. Please elaborate how the timing of NASA investment in commercial crew, and the spreading of that investment across multiple companies results in efficient use of Federal funding and optimizes private investment. Also provide any studies either done independently or by NASA that support the implementation of commercial crew.

Answer. The President's fiscal year 2014 budget request will enable the re-establishment of U.S. human access to space by 2017. Through the Commercial Crew Program, NASA is funding multiple industry concepts in an attempt to promote meaningful competition among providers in the development of their crew transportation systems, and reduce the eventual per-seat price of commercial crew transportation and rescue services. Please see response to question above.

The most prominent study supporting the implementation of commercial crew is the "Final Report of the Review of U.S. Human Spaceflight Plans Committee" published in 2009 and available online at http://www.nasa.gov/pdf/396093main_HSF_Cmte_FinalReport.pdf.

Question. If none of the current contractors for commercial crew vehicle development are able to meet NASA's requirements for safely delivering crew to the international space station, will NASA choose to continue the program, as they did with COTS, at whatever the cost or delays in schedule may be?

Answer. It is NASA's intention to use U.S. commercial industry to provide crew transportation and rescue services to the International Space Station (ISS). The Agency has made its crew safety requirements available, and is confident that one or more potential vendors will be able to develop safe crew transportation services by 2017, contingent upon the availability of appropriated funds and technical progress.

Question. Have any of the commercial crew participants shown to NASA that their business will go forward, regardless of receiving NASA funding or guaranteed flights to the international space station?

Answer. NASA has not requested a guarantee from our industry partners for their businesses to go forward without NASA funding. However, each company has a unique view of the market for human space transportation and unique business cases for completing the development of their systems.

As part of the Commercial Crew Program Industry Touchpoint held in April 2013 in Colorado Springs, NASA did request industry input regarding post-certification missions to the ISS. This information is being used by the NASA in the preparation of the Request for Proposals for the Phase 2 Certification contract.

COMMERCIAL CREW VERSUS INTERNATIONAL PARTNERS

Question. Will NASA continue payments to the Russians as a back-up to commercial crew services and for how many months, or years after commercial crew services become regularly available?

Answer. NASA recently signed a modification to its contract with the Russian Federal Space Agency (Roscosmos) for full crew transportation services to the ISS in 2016 with return and rescue services extending through June 2017. NASA is facilitating development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable and cost-effective access to and from the space station and low Earth orbit beginning in 2017. NASA is committed to launching U.S. astronauts aboard domestic spacecraft as soon as possible.

Question. NASA's Commercial Crew Program projects that a vehicle will be ready to launch in 2017. However, given the schedule delays in the Commercial Cargo Program, it is likely that the Crew Program will experience delays as well. If that is the case, I question the value of moving forward with an extremely costly Commercial Crew Program when the Space Station is currently slated for decommissioning in 2020.

Has NASA done a cost-benefit analysis comparing the cost of developing a commercial crew capability with the cost of using our international partners to provide those same flights given that there will likely be a limited number of flights to the Space Station?

Answer. NASA has not performed a cost-benefit analysis comparing the cost of developing a commercial crew capability with the cost of using foreign systems. NASA's commercial crew partners have not formally established final pricing for ISS services missions. In keeping with the 2010 NASA Authorization Act, NASA believes U.S. human access to space is a critical capability for the nation and that commercial crew capabilities are a key means to achieve this goal. The lifetime extension data that NASA and the ISS partnership have reviewed to date indicates that the ISS could operate until at least 2028.

Question. Is this the best way for NASA to spend scarce taxpayer dollars when the capability already exists and there are so many other endeavors in which to invest?

Answer. Yes. The capability does not already exist within the United States and NASA is committed to launching U.S. astronauts aboard domestic spacecraft as soon as possible. Like the COTS program, the Commercial Crew Program appears to date to be a cost-effective means of developing U.S. space capabilities. Full funding of the Administration's fiscal year 2014 budget request is critical to making these domestic capabilities possible by 2017. The commercial crew industry partners have indicated that they believe they could be ready prior to that date. But, NASA has included some schedule margin because human spaceflight development efforts have historically been challenging. Thus, NASA believes 2017 is a reasonable estimate for the availability of U.S. commercial crew services, pending adequate funding and technical progress.

Question. At what point in the development of U.S.-based crew vehicles will NASA stop negotiating future flights with the Russians and is there a planned overlap in case the commercial vehicles are not ready in time?

Answer. NASA will monitor the development of commercial crew vehicles closely. It is important to note that the Russians require approximately 3 years of lead time

to manufacture a new Soyuz spacecraft, so the Agency has to enter negotiations with that timeframe in mind.

COMMERCIAL CARGO/RESUPPLY

Question. What are NASA's plans with regard to future commercial cargo deliveries to the ISS, after 2015? Will the current contracts be extended or will there be a new competition?

Answer. NASA can continue to award some additional flights under the current CRS contracts. Beyond that, future competitions for cargo servicing will be awarded using competitive FAR-based contracts. See the answer to question #13.

Question. For the Commercial Resupply Services Program, will both of the cargo providers meet their obligations to supply the ISS by the dates originally agreed to by NASA? If not, why not, and will NASA have to renegotiate existing contracts in order to accomplish the programs purpose?

Answer. The CRS contract is a firm-fixed price, Indefinite Delivery Indefinite Quantity procurement with a period of performance from January 1, 2009, through December 30, 2016. The CRS contractors are not anticipated to complete on their original contract schedule, due in large part to the technical challenges of bringing new spacecraft and launch vehicles to operational status. However, NASA may elect to modify the current contracts to enable the completion of the flights. It is important to recall that the Agency only pays the contractors for milestones achieved.

ASTEROID

Question. The asteroid retrieval strategy outlined in the budget request proposes to augment existing activities in order to facilitate a potential mission in the future. Provide the changes in budget profile and timing if this augmentation is not provided.

Answer. NASA is pursuing ways to align key activities in Science, Space Technology, and Human Exploration and Operations Mission Directorates to improve detection and characterization of near-Earth asteroids (NEAs); including asteroids that could be potentially hazardous to the Earth; demonstrate advanced solar electric propulsion; and capture and redirect a small NEA to a stable orbit in the lunar vicinity. We would then use the Orion and Space Launch System assets to launch astronauts to the asteroid, perform rendezvous operations and return samples from it.

Changes in the budget have been requested for fiscal year 2014 to accelerate the development of key technologies and capabilities for NASA, as well as enable the asteroid redirect mission. These capabilities are important in their own right independent of the proposed asteroid strategy. For example, the Space Technology Mission Directorate (STMD) had planned to perform a high-powered Solar Electric Propulsion demonstration to support the needs of future human exploration as well as the commercial satellite sector. The fiscal year 2014 budget request will allow NASA to accelerate the development and demonstration of these capabilities and define a mission concept to leverage existing efforts. The asteroid mission strategy, including the crewed segment using the Space Launch System (SLS) and Orion, would provide a compelling near term mission and destination for exploration system capabilities. The asteroid mission fits well with the current development timelines for SLS and Orion and it would not require substantial added deep space architecture components implying an affordable near term destination. If the augmentation is not provided, a significant delay will occur in the advancement and demonstration of these critical technologies and capabilities. Further development of this compelling mission concept will be impaired or halted, depending on the magnitude of the cut to the request. In addition, momentum gained in human spaceflight for enhancing the objectives of initial missions of Orion and SLS toward this integrated opportunity will be at risk.

Question. Please explain the timing and chain of events that changed NASA's planning from sending astronauts to visit an asteroid to the currently proposed capture of an asteroid and bringing it back for examination?

Answer. As NASA planners worked different scenarios for the Agency's next human missions of exploration beyond low Earth orbit, they found that the potential mission to capture and redirect an asteroid into a stable lunar orbit for in situ study by astronauts had a number of advantages. First, it is a comparatively near-term goal (NASA is considering flying such a mission by the 2025 timeframe), which would enable the Agency to test out its initial deep-space architecture elements—the Space Launch System (SLS) and Orion Multi-Purpose Crew Vehicle (MPCV)—without the need for the immediate development of other components needed for other destinations. Second, this proposal draws on work already underway in the

Agency, including asteroid detection and tracking efforts, advanced solar-electric propulsion (SEP) development, and the development and initial flights of the SLS and Orion vehicles.

NASA has also spent significant time examining the potential for sending astronauts directly to a near earth asteroid. Such a mission includes several additional challenges. First, identifying a target NEA that is worthy of a visit in terms of science and exploration value, while keeping trip times and propellant requirements reasonable is challenging. Most identified NEA targets of significant value will require greater than 6-month round trip times. Such a mission will also require the development of additional exploration assets/capabilities such as a deep space habitat, space exploration vehicle (something with an airlock, manipulator arms as well as power and propulsion), long duration cryogenic storage, more reliable life support systems and a strategy for radiation protection. These capability requirements imply that the cost and schedule for a direct asteroid exploration mission is more challenging than the asteroid redirect mission. The Asteroid Redirect Mission would affordably support and leverage multiple efforts across the Agency as it paves the way for journeys to other destinations by helping NASA prove out its new heavy-lift launch vehicle and exploration spacecraft in a near-term mission.

Question. What is the technology readiness level of the propulsion and capture mechanisms intended to be used for a future asteroid retrieval mission and does NASA anticipate some technology demonstrations prior to the mission to reduce risk?

Answer. The Asteroid Redirect Mission will serve as a technology demonstration mission to validate the utility of high-powered solar electric propulsion and robotic capture mechanisms. Since this is a technology demonstration effort, the goal of this mission will be to mature these technologies for infusion into future NASA science and exploration missions.

The technology development to support a high-powered solar electric propulsion demonstration has been underway for the last 2 years through Space Technology's Game Changing Development Program. The main technology components under development include:

- Solar Array Systems: These deployable high-power arrays feature twice the power for the same mass and three times the packaging efficiency relative to current array technologies. STMD selected two solar array system contractors (ATK and Deployable Space Systems) to develop advanced deployable arrays systems that can support the 30 kW to 50 kW required for the Asteroid Redirect Mission and that can scale to over 300 kW for future human exploration missions. This technology will reach TRL 5 by the middle of fiscal year 2014. Space Technology will then be prepared to down-select one of the two vendors for inclusion into the SEP system for the flight demonstration.
- Electric Propulsion Thrusters: These magnetically shielded, high thrust Hall thrusters feature higher thrust levels (10 to 15 kW vs. 5 kW), higher specific impulse (3000 sec vs. 2000 sec) and magnetic shielding to significantly increase long duration operations. These thrusters will reach TRL 5 by mid fiscal year 2014, with the potential for the procurement of engineering development units to support the asteroid redirect mission before the end of fiscal year 2014. Alternate electric propulsion thruster solutions (besides magnetically shield Hall thrusters) are possible for the Asteroid Redirect Mission but will need to prove competitive in terms of mass, efficiency, specific impulse and technical maturity.
- Power processing units (PPUs) and power management and distribution (PMAD) systems: Multiple options for PPUs and the PMAD approach have been under development that can support the Asteroid Redirect Mission. These technologies will reach TRL 6 by the end of fiscal year 2014.

Currently, with all technology components expected to complete development and testing during fiscal year 2014, the Solar Electric Propulsion (SEP) system will be ready for the procurement of hardware supporting the flight demonstration by fiscal year 2015. Currently, STMD is considering whether any precursor demonstration, to test the highest risk items, is warranted prior to the asteroid mission. In addition to the current baseline Hall-thruster SEP concept, STMD will study and consider other high-powered SEP concepts such as gridded ion and magneto-plasma systems to power the robotic spacecraft.

SUBCOMMITTEE RECESS

Chairwoman MIKULSKI. This subcommittee stands in recess until Thursday, May 9, when we're going to take the testimony of the FBI Director, Mr. Mueller.

[Whereupon, at 10:15 a.m., Thursday, April 25, the subcommittee was recessed, to reconvene subject to the call of the Chair.]