NASA's Top Management and Performance Challenges, November 2014

NASA's ability to sustain its ambitious exploration, science, and aeronautics programs will be driven in large measure by whether the Agency is able to adequately fund such high-profile initiatives as its commercial cargo and crew programs, the Space Launch System (SLS) rocket and Orion capsule, James Webb Space Telescope, Mars 2020 Rover, and the personnel and infrastructure associated with these and other missions. Over the past year, the Office of Inspector General (OIG) voiced concerns on a variety of issues that could affect the sustainability of NASA's varied missions. For example:

- Because of budget reductions and the loss of other expected revenue, NASA's Space Network – part of the Agency's Space Communications and Navigation Program that provides connectivity with NASA spacecraft operating in low Earth orbit – will not have sufficient funding beginning in fiscal year (FY) 2016 to meet all planned service commitments.[1]
- Since 2006, NASA has spent or budgeted an average of $62 million annually to address an estimated $1.1 billion in unfunded environmental liabilities. Soil and groundwater cleanup costs for one project alone – the Santa Susana Field Laboratory outside Los Angeles, California – could easily consume NASA's entire environmental restoration budget.[2]

The Government Accountability Office (GAO) echoed concerns about sustainability in its July 2014 audit of the SLS Program in which it found that although NASA is making "solid progress" on the rocket's design, it has not developed "an executable business case . . . that matches resources to requirements."[3] Similarly, during its July 2014 meeting several NASA Advisory Council (NAC) members raised concerns that the Agency's human spaceflight program, including the Asteroid Redirect Mission and a human visit to Mars, is not executable within the Agency's anticipated funding levels: "the mismatch between NASA's aspirations for human spaceflight and its budget for human spaceflight is the most serious problem facing the agency."[4] Finally, a National Research Council committee examining how NASA can develop a sustainable program of human deep space exploration noted in its June 2014 report that "progress in human space exploration beyond low Earth orbit will be measured in decades and hundreds of billions of dollars" and concluded that "any human exploration program will only succeed if it is appropriately funded and receives a sustained commitment on the part of those who govern our nation."[5]

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[1] NASA OIG, "Space Communications and Navigation: NASA's Management of the Space Network" (IG-14-018, April 29, 2014).

[2] NASA OIG, "Audit of NASA's Environmental Restoration Efforts" (IG-14-021, July 2, 2014).

[3] GAO, "Space Launch System: Resources Need to be Matched to Requirements to Decrease Risk and Support Long Term Affordability" (GAO-14-631, July 23, 2014).

[4] Dr. Steven W. Squyres, Chair, NAC, letter to Charles F. Bolden Jr., Administrator, NASA, August 4, 2014, http://www.nasa.gov/sites/default/files/files/SquyresLetterToBolden_tagged.pdf (accessed September 15, 2014). The NAC is an outside group of experts that advises the NASA Administrator on major issues affecting the Agency.

[5] National Research Council, "Pathways to Exploration – Rationales and Approaches for a U.S. Program of Human Space Exploration," Washington, D.C., National Academies Press (2014).

NASA began the new fiscal year without a full-year appropriation and faces significant budgetary challenges given that its "top-line" funding level is likely to remain relatively flat for at least the next several years. Accordingly, we believe the principal challenge facing NASA leaders in FY 2015 will be to effectively manage the Agency's varied programs in an uncertain budget environment. In addition to this overarching challenge, NASA managers must address a myriad of individual Agency-, project-, and facility-related challenges. This report provides our views of the seven top management and performance challenges facing the Agency:

- Managing NASA's Human Space Exploration Programs: the International Space Station, Commercial Crew Transportation, and the Space Launch System
- Managing NASA's Science Portfolio
- Ensuring the Continued Efficacy of the Space Communications Networks
- Overhauling NASA's Information Technology Governance
- Ensuring the Security of NASA's Information Technology Systems
- Managing NASA's Infrastructure and Facilities
- Ensuring the Integrity of the Contracting and Grants Processes and Proper Use of Space Act Agreements

In deciding whether to identify an issue as a top challenge, we considered the significance of the challenge in relation to NASA's mission; whether its underlying causes are systemic in nature; the challenge's susceptibility to fraud, waste, and abuse; and the Agency's progress in addressing the challenge. We have not listed the challenges in priority order.

Managing NASA's Human Space Exploration Programs

NASA is simultaneously managing three large-scale, long-term human exploration programs – the International Space Station (ISS or Station); development of a capability through private, domestic spaceflight companies to transport astronauts to the ISS in an effort known as the Commercial Crew Program; and the SLS, Orion, and Ground Systems Development and Operations (GSDO) Programs. Looming over the daunting technical and schedule challenges associated with these Programs is a constrained budget and evolving political environment.

Extending the International Space Station

In November 2013, the ISS completed 15 years of continuous operation in low Earth orbit, marking a significant achievement in the history of human spaceflight. Two months later, the Administration announced its intent to extend Station operations from the current target of 2020 to 2024. As a result, a spacecraft originally designed and tested for a 15-year life span may now operate for 26 years. (See Figure 1.)

Figure 1: International Space Station

Source: NASA.

Since 1994, the United States has invested almost $75 billion in the ISS for construction, operating costs, and transportation, and NASA will continue to spend at least $3 to $4 billion per year to maintain and operate the Station going forward.[6] Historically, the Agency's international partners – the European Space Agency, Canada, Japan, and Russia – have contributed to ISS operations and helped share associated expenses by providing astronauts, ground facilities, launch vehicles, and other items and services, but the level of international participation beyond 2020 is uncertain.[7]

In the meantime, NASA continues to utilize the ISS as a research platform to study and mitigate a variety of human health risks that must be addressed to enable long-term human exploration missions. However, a major portion of the Station's success as a research platform hinges on the ability of NASA's partner – the Center for the Advancement of Science in Space (CASIS) – to attract sufficient interest and funding from private users and investors.

In a September 2014 report assessing NASA's examination of the issues related to extending the ISS to 2024, we found that while NASA has identified no major obstacles, it must address several areas of risk.[8] First, the ISS may experience insufficient power generation due, in part, to faster-than-expected degradation of its solar arrays. Second, sporadic failures of key hardware have required unplanned spacewalks for repairs. Finally, NASA has a limited ability to transport large replacement parts to the ISS should they be needed.

NASA officials have indicated they intend to maintain the ISS budget between $3 and $4 billion per year through 2024. In our judgment, this estimate is based on overly optimistic assumptions and we believe the cost to NASA will likely be higher. First, much of the projected cost increase is attributable to increased transportation costs, but we found NASA's estimate for transportation costs unrealistic. Specifically, NASA's estimates for the cost of the commercial crew transportation services are based on the cost of a Soyuz seat in FY 2016 – $70.7 million per seat for a total cost of $283 million per mission for

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[6] This figure does not include development costs incurred under the cancelled Space Station Freedom program.

[7] NASA expects each Partner to make a decision about their continued participation and role in ISS by the end of 2016.

[8] NASA OIG, "Extending the Operational Life of the International Space Station Until 2024" (IG-14-031, September 18, 2014).

four astronauts. However, the Program's independent Government cost estimates project significantly higher costs when NASA purchases flights from commercial companies rather than from Russia. Second, the Agency's international partners have yet to commit to participating in Station operations beyond 2020. Should one or more decide not to, NASA and any remaining partners will likely face higher costs. While ISS Program officials said they are seeking to reduce costs, it is unclear whether these efforts will be sufficient to address anticipated cost increases.

Given the high cost and extraordinary effort to build the ISS, national leaders have emphasized the importance of maximizing its scientific research capabilities. However, we found that while utilization of the ISS for research is increasing, NASA and CASIS continue to face challenges. A significant amount of research aboard the ISS is related to the risks associated with long-term human presence in space; however, by 2024 NASA expects research aboard the Station to result in mitigation strategies for only 12 of the 23 human health risks for which the ISS is an appropriate research platform. Although ground-based methods could be used to develop risk-mitigation procedures, such methods are not ideal. Therefore, NASA needs to prioritize research aboard the ISS to address the most important risks before Station operations end. In April 2014, we opened an audit to examine NASA's efforts to manage health and human performance risks associated with long-duration space exploration more closely.

In August 2011, NASA signed a cooperative agreement with CASIS to manage non-NASA research aboard the ISS. Pursuant to the agreement, NASA provides CASIS with $15 million annually to fund non-NASA research proposals. Further progress on expanding ISS research depends on CASIS's ability to attract private funding and encourage companies and other organizations to conduct self-funded research. Moreover, our September 2014 ISS audit found that attracting more commercial researchers would require gaining legislative approval for them to retain intellectual property rights in the research.

Another key facet to maximizing research on the Station is providing a U.S. capability to transport cargo and crew. Two commercial providers – Space Exploration Technologies Corporation (SpaceX) and Orbital Sciences Corporation (Orbital) – are scheduled to continue making cargo deliveries to the ISS through 2017, and competition will soon begin for a new cargo resupply contract. NASA's challenge will be procuring enough flights to the Station at an affordable price to support ISS research.

In late October 2014, Orbital's third resupply mission failed shortly after launch from NASA's Wallops Flight Facility in Virginia, destroying an Antares rocket and Cygnus spacecraft loaded with 4,800 pounds of science and research, crew supplies, and vehicle hardware bound for the ISS. As a result, NASA will need to reexamine its cargo manifest and make any necessary adjustments to upcoming SpaceX resupply missions and work with Orbital to repair the Wallops facility and identify a root case of the mishap to ensure a safe return-to-flight for the company's vehicles.

Securing Commercial Transportation for Astronauts to Low Earth Orbit

Since the end of the Space Shuttle Program in 2011, the United States has lacked a domestic capability to transport astronauts to the ISS. Between 2012 and 2017, NASA will pay Russia $1.7 billion to ferry 30 NASA astronauts and international partners to and from the Station at prices ranging from $47 million to more than $70 million per round trip. To address this lack of U.S. capacity, NASA has provided approximately $1.6 billion in funding since 2010 to U.S. commercial spaceflight companies to spur development of a crew transportation capability. NASA originally hoped commercial flights would be operating by 2016, but due to funding constraints, the Agency adjusted this goal to late 2017.

NASA is closing out the third phase of the Commercial Crew Program's development in which it worked with three companies – The Boeing Company (Boeing), SpaceX, and Sierra Nevada Corporation (Sierra Nevada) – using a combination of funded Space Act Agreements and more traditional contracts to develop commercial crew transportation capabilities. Boeing completed its Critical Design Review for its system in August 2014, while the remaining two companies expect to complete their reviews by March 2015.[9] A fourth company, Blue Origin, is also conducting developmental work under an unfunded Space Act Agreement.

The fourth and final phase of NASA's Commercial Crew Program began in September 2014 with the award of $6.8 billion in firm-fixed-price contracts to Boeing ($4.2 billion) and SpaceX ($2.6 billion), to complete development of and certification for operation of their spaceflight systems and for up to six flights to the Station.[10] In these contracts, NASA will provide Boeing and SpaceX with specific requirements for launch systems, spacecraft, and related ground support. The contracts include at least one crewed flight test with a NASA astronaut to verify that the fully integrated rocket and spacecraft system can launch, maneuver in orbit, and dock to the ISS, as well as validate that all systems are performing as expected. Once each company's test program has been successfully completed and its system certified, they will conduct at least two, and as many as six, crewed missions to the Station. The spacecraft also will serve as a lifeboat for astronauts aboard the Station.

In 2012, NASA planned to transition from Space Act Agreements to firm-fixed-price contracts governed by the Federal Acquisition Regulation (FAR) for final design work, testing, evaluation, and certification of crew transportation systems. Thereafter, NASA planned to enter into individual FAR-based contracts to acquire specific transportation services. However, in FY 2012 NASA received only $397 million for its Commercial Crew Program, less than half of its $850 million request. As a result, NASA revised its acquisition strategy and continued to rely on funded Space Act Agreements for the integrated design phase of the Commercial Crew Program rather than FAR-based contracts. This situation was further exacerbated in 2013 when the Program again received significantly less than requested – $525 million compared to the $830 million requested. Although the Commercial Crew Program received $696 million out of $821 million requested in FY 2014, funding shortfalls in previous years contributed to delaying the expected completion date of the Program's development phase from 2016 to 2017.

NASA's use of funded Space Act Agreements rather than FAR-based contracts to develop new crew and cargo transportation capabilities has had several benefits.[11] First, because the partners share development costs and Space Act Agreements involve fewer regulations and require less oversight by NASA, the Agency spent less to develop these capabilities. For example, in the cargo development program, NASA estimated it saved between $1.4 and $4 billion in connection with SpaceX's efforts, with similar savings for the transportation obtained from Orbital. Second, because NASA does not impose

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[9] Each company defined its own requirements for achieving Preliminary and Critical Design Reviews that were negotiated with NASA before the Space Act Agreements were awarded. NASA defines a Preliminary Design Review as establishing the basis for proceeding with detailed design and demonstrating that the correct design option was selected, interfaces have been identified, and verification methods have been described. The Critical Design Review determines if the integrated design is appropriately mature to continue with final design and fabrication. Both reviews are important to demonstrate that a system meets all requirements with acceptable risk and within cost and schedule constraints. NASA funded Boeing and SpaceX to achieve Critical Design Review, but due to the Agency's limited budget did not fund Sierra Nevada's completion of that milestone.

[10] One bidder NASA did not select for a contract award, Sierra Nevada, filed a protest with the GAO in September 2014. Although the protest had not been resolved at the time this report was issued, NASA invoked an exception to the automatic stay that generally follows such a protest and directed Boeing and SpaceX to begin work on the contracts.

[11] NASA, "Commercial Orbital Transportation Services: A New Era in Spaceflight" (NASA/SP-2014-617, February 2014).

specific requirements on the companies as part of the Space Act Agreements, the commercial partners are free to develop spacecraft designs that will support the needs of both NASA and other customers. Finally, NASA officials said they believe the greater flexibility offered by the Space Act Agreements promotes creativity and innovation.

However, NASA's decision to limit specific design and safety requirements during the development process also poses risks and makes it harder to ensure the companies will ultimately produce spaceflight systems that can safely carry humans to and from the ISS. To mitigate these concerns, in December 2011 NASA published documents identifying the requirements and certification process for commercial transportation systems. A year later, NASA began the certification process by awarding Boeing, SpaceX, and Sierra Nevada FAR-based contracts that require them to submit key documents for NASA's review and approval. However, because they had completed much of their spacecraft design work prior to award of these contracts, Boeing, SpaceX, and Sierra Nevada expressed concern that NASA's feedback may not be timely and could cause schedule delays or increased costs if design changes are required to meet Agency requirements. Although the use of Space Act Agreements in the Commercial Crew Program is ending, we concluded in a June 2014 audit that NASA may have more flexibility than the Agency originally thought in defining requirements.[12] Specifically, allowing program managers to describe detailed program objectives and key safety elements would help ensure the money NASA invests in these development projects produces technology that will meet Agency needs.

In a November 2013 audit report, we identified four challenges to NASA's Commercial Crew Program: (1) unstable funding, (2) integration of cost estimates with the Program schedule, (3) providing timely requirement and certification guidance, and (4) spaceflight coordination issues with other Federal agencies.[13] Since that time, the Agency has made some progress in these areas and expects to complete corrective actions by mid-2015.

Developing the Space Launch System, Orion, and Ground Systems Development and Operations Programs

NASA continues to describe its long-term human exploration goal as sending humans to Mars and is planning for a precursor mission to identify, capture, and relocate an asteroid. However, some members of the Agency's congressional oversight committees are advocating for a Moon landing mission to prepare for a trip to Mars. Whatever the destination, successful development of NASA's new heavy lift rocket, the SLS; the accompanying Orion crew capsule; and related launch infrastructure remain critical to the overall success of NASA's human exploration goals.

The NASA Authorization Act of 2010 set a goal for NASA to achieve operational capability for the SLS and Orion by December 31, 2016; however, NASA has reported that it will not meet this timetable.[14] Initially, the Agency scheduled an un-crewed test flight for December 2017, and is still working toward that goal; however, noting technical and funding uncertainties during a recent SLS design review, NASA adjusted its planning schedule to reflect a launch readiness date of no later than November 2018.

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[12] NASA OIG, "NASA's Use of Space Act Agreements" (IG-14-020, June 5, 2014).

[13] NASA OIG, "NASA's Management of the Commercial Crew Program" (IG-14-001, November 13, 2013).

[14] The National Aeronautics and Space Administration Authorization Act of 2010, Pub. L. No. 111-267, 124 Stat. 2805.

Figure 2: Artist Concept of Space Launch System

Source: NASA.

NASA is using the Space Shuttle's main engine, the RS-25, on the SLS and designing the vehicle with an evolvable architecture that can be tailored to accommodate longer and more ambitious missions. Initial versions of the SLS will be capable of lifting 70-metric tons and use an interim cryogenic propulsion stage to propel Orion around the Moon on its first exploration mission. Later versions will be designed to lift 130-metric tons and incorporate an upper stage to travel to deep space. Orion will be mounted atop the SLS and serve as the crew vehicle for up to six astronauts. NASA is developing the capsule using an existing contract with Lockheed Martin Corporation and is basing its design on requirements for the crew exploration vehicle that was part of NASA's now defunct Constellation Program. (See Figure 2.)

In addition to the SLS and Orion, NASA's GSDO Program is modifying launch infrastructure at Kennedy Space Center that was formerly used for the Space Shuttle. To support the SLS, the GSDO Program is refurbishing the crawler-transporter that will transport the SLS from the Center's Vehicle Assembly Building to the launch pad and modifying the mobile launcher and tower (originally built for the Constellation Program's Ares I rocket), the Vehicle Assembly Building, and Launch Pad 39B. We are in the final stages of an audit of the GSDO Program.

NASA's challenge in this area continues to be managing the concurrent development of a launch system and crew vehicle and modifying the necessary supporting ground systems while also meeting the Administrator's mandate that exploration systems be affordable, sustainable, and realistic. Integrating hardware and supporting equipment from other programs, specifically the Space Shuttle and Constellation Programs, may prove challenging since each piece of equipment was designed and tested for a different launch vehicle. For example, the GAO reported in July 2014 that the SLS's solid rocket boosters, originally designed for Constellation, must include a new nonasbestos insulating material in order to comply with environmental regulations.[15] Integrating the new material has already required changes to the manufacturing process and may have significant impact on meeting scheduled milestones. Moreover, achieving successful integration will require effective management of all three Programs – SLS, Orion, and GSDO.

[15] "Space Launch System," GAO-14-631.

Similar to the ISS extension and commercial crew development, the SLS and its associated Programs continue to face challenging future budgets. For example, the Orion Program anticipates receiving a flat budget of approximately $1 billion per year into the 2020s. Given this budget profile, NASA is using an incremental development approach under which it allocates funding to the most critical systems necessary to achieve the next development milestone, rather than developing multiple systems simultaneously as is common in major spacecraft programs. Prior work by the OIG has shown that delaying critical development tasks increases the risk of future cost and schedule problems.[16] Moreover, NASA Program officials admit that this incremental development approach is not ideal, but contend that it is the only feasible option given current funding levels.

In its 2014 report, GAO also noted that the SLS Program is carrying a $400 million risk to account for uncertainties in funding projections that, if unmitigated, could impact the hoped for December 2017 launch. Moreover, NASA has not developed complete life-cycle cost estimates for SLS launch vehicles once nominal operations begin and the Program has yet to solidify specific human rating and long-term mission requirements.

As we reported in August 2013, even after the SLS and Orion are fully developed and ready to transport crew, NASA will continue to face significant challenges concerning the long-term sustainability of its human exploration program.[17] For example, unless NASA begins a program to develop landers and surface systems, NASA astronauts will be limited to orbital missions.[18] In the current budget environment, however, it appears unlikely that NASA will obtain significant funding to begin development of this additional exploration hardware anytime soon, effectively delaying such development into the 2020s. Given the time and money necessary to develop landers and associated systems, it is unlikely that NASA would be able to conduct any manned surface exploration missions until the late 2030s at the earliest.

Managing NASA's Science Portfolio

With a relatively constant annual budget of approximately $5 billion since FY 2009, NASA's Science Mission Directorate oversees more than 100 projects and programs in various phases of development and operation. Many of them have cost more and taken longer to deliver than predicted and experienced funding instability, and some have received inconsistent direction from Congress and the Administration. For example, in September 2011 NASA rebaselined the James Webb Space Telescope (JWST), increasing its life-cycle budget from $4.96 billion to $8.84 billion and delaying its launch 4 years from June 2014 to October 2018.[19] These cost overruns and schedule delays affected other projects in NASA's science portfolio as Agency managers needed to identify additional money to support JWST. Moreover, in its FY 2015 budget proposal the Administration called for phasing out NASA's airborne observatory – the Stratospheric Observatory for Infrared Astronomy (SOFIA) – although the SOFIA Program's fate remains uncertain in light of congressional action to continue its funding. In addition to

[16] NASA OIG, "NASA's Challenges to Meeting Cost, Schedule, and Performance Goals" (IG-12-021, September 27, 2012), and "Status of NASA's Development of the Multi-Purpose Crew Vehicle" (IG-13-022, August 15, 2013).

[17] "Status of NASA's Development of the Multi-Purpose Crew Vehicle," IG-13-022.

[18] In July 2014, NASA OIG announced its audit examining space technology projects.

[19] A baseline defines the requirements, costs, schedule, and performance parameters of an acquisition program, and identifies milestones for measuring the program's progress.

its portfolio of projects in development and primary operations, in September 2014 NASA's Senior Review found that all seven planetary science missions eligible for extension were worthy of continued funding, including the Mars Opportunity rover and the Lunar Reconnaissance Orbiter, both of which many observers thought the Agency would opt not to fund.

Managing this extensive portfolio in the current budget and political environment poses significant challenges to NASA. With the prospect of static budgets for the foreseeable future, it is imperative NASA work to keep projects on cost and schedule and, when necessary, make difficult choices between competing priorities.

James Webb Space Telescope

The JWST – the scientific successor to the Hubble Space Telescope – is expected to be the premier space-based observatory of the next decade when it is launched aboard a European Space Agency Ariane 5 in October 2018. (See Figure 3.) The observatory is designed to help understand the origin of the first stars and galaxies in the universe, the evolution of stars, and the formation of stellar systems and nature of objects in our own solar system. JWST consists of a 25-square-meter mirror composed of 18 smaller mirrors, an integrated science instrument module that houses the telescope's four instruments, and a tennis-court size sunshield. JWST's instruments are designed to work primarily in the infrared range of the electromagnetic spectrum, allowing for unprecedented observing capability.[20]

Figure 3: Artist Concept of James Webb Space Telescope

Source: NASA.

Like many NASA projects, JWST has faced significant challenges meeting cost, schedule, and performance goals. Program cost estimates in the late 1990s and early 2000s ranged from $1 billion to $3.5 billion, with an expected launch date between 2007 and 2011. However, following a change in the launch vehicle and revisions to other requirements, in 2005 NASA estimated life-cycle costs at $4.5 billion with a launch date in 2013. A year later, an independent review team reported that although the Program was technically sound, funding reserves were too low, phased too late in development, and insufficient to support such a complex Program. The review team also reported that a 2013 launch date was not achievable. In 2009, NASA rebaselined JWST with a life-cycle cost estimate of $4.9 billion and a June 2014 launch date.

[20] The electromagnetic spectrum is the full range of frequencies from radio waves to gamma rays.

Unfortunately, it soon became clear that neither this cost estimate nor the 2014 launch date were attainable. At the request of Congress, NASA commissioned another independent review, and in October 2010, this panel reported that while JWST's technical performance was "commendable and often excellent," the Program's budget and contingency funding reserve was severely understated and improperly phased, Program management was ineffective, and the Program could not meet its cost and schedule commitments.[21] Subsequently, NASA restructured the JWST Program, and in September 2011 established a revised baseline life-cycle cost estimate of $8.84 billion and an October 2018 launch date.

Although JWST Program management has made significant progress in the past 3 years – including completing all 18 primary mirror segments and the telescope structure, testing of all science instruments and a full-scale test of the sunshield, and addressing technical challenges such as inadequate spacecraft mass margin – significant challenges remain. For example, in spring 2014 the aft unitized pallet structure used to support the sunshield was found to have manufacturing deficiencies due to moisture from tooling equipment. This issue has eroded about 2 months of schedule reserve as corrective actions were evaluated. In addition, development of a device to cool one of JWST's science instruments (the "cryocooler") continues to slip from its cost plan and use a disproportionate share of the Program's unallocated future expenses and schedule reserve.[22] Adding to these individual challenges is an overall concern about the relatively low level of unallocated future expenses available to the Program for FY 2015.

As we stated in a September 2012 report, historically NASA has taken funds from other programs when highly visible flagship missions experience significant cost growth.[23] Although Congress has explicitly cost-capped JWST at its current baseline, because it is the largest science project in NASA's portfolio any future budgetary and programmatic challenges could negatively affect other projects in the Agency's science portfolio.

SOFIA – Stratospheric Observatory for Infrared Astronomy

The SOFIA Program – the second most expensive operating mission in NASA's astrophysics portfolio – uses a heavily modified Boeing 747SP fitted with a 2.7-meter telescope to study the universe. SOFIA can observe both infrared and visible wavelengths and is particularly well suited for investigating the formation of massive stars and planets. The Program, which in 2014 reached full operational capability after 23 years of formulation and development at a cost of nearly $1.1 billion, more than 300 percent over original estimates and 13 years behind schedule, faces an uncertain future. The Administration's FY 2015 budget proposed placing SOFIA in storage unless NASA could identify partners to subsidize its $80 million annual operating costs; however, as of September 2014 NASA had not identified additional partners to assist with funding. At the same time, FY 2015 appropriations legislation in both the U.S. Senate and House of Representatives contain funding to continue the Program.

[21] Independent Comprehensive Review Panel, "James Webb Space Telescope (JWST) Independent Comprehensive Review Panel (ICRP): Final Report" (October 29, 2010).

[22] Unallocated future expenses are costs expected to be incurred but not yet allocated to a specific task.

[23] "NASA's Challenges to Meeting Cost, Schedule, and Performance Goals," IG-12-021.

In a July 2014 report, we examined the long-term demand and viability of SOFIA over its planned 20-year operational life.[24] We found the Program faces immediate challenges as a result of the Administration's proposal to cease funding, including possible delay of planned aircraft maintenance and possible loss of key personnel while Congress debates whether to continue the Program. We also identified several challenges NASA managers need to address to ensure the best possible return on investment if the decision is made to continue the Program.

Specifically, the SOFIA Program must take steps to maintain demand for the observatory over the next 2 decades. For example, we found NASA's plans to introduce new technology every 4 years may be too infrequent. We also found grants provided to many researchers are insufficient for them to complete projects and publish results. In addition, we found SOFIA's current requirement to fly 960 annual research hours may not be optimal and the Program lacks procedures to assess its scientific "return on investment." Finally, we determined the Program's proposed organizational structure for SOFIA's operational phase does not provide adequate oversight of mission critical functions. Failure by NASA to address these issues could reduce demand for SOFIA and affect the quality of its science.

Ice, Cloud, and land Elevation Satellite-2

Using space-borne laser altimetry, the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) is designed to measure mass changes in the polar ice sheet in an effort to understand the mechanism driving the changes and the impact those changes will have on global sea levels. Following a challenging formulation phase that began in December 2009 and included multiple schedule delays and revised plans and cost growth, in December 2012 NASA established an $860.2 million life-cycle cost baseline for ICESat-2 and a May 2017 launch date. However, in January 2014 NASA reported to Congress that challenges developing the laser instrument would cause ICESat-2 to exceed its budget and face launch delays.[25]

In May 2014, NASA approved a revised plan and rebaseline under which life-cycle costs rose to $1.06 billion and the launch date delayed until June 2018. Implications of these delays reverberate across other NASA science platforms – specifically, NASA aircraft that will need to continue flying missions to observe the polar ice sheet until ICESat-2 is operational. Although the Earth Science Division Director stated additional funding for the Project would be found within the Earth Science Division, he could not rule out delays to future projects as a result.

Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer

The $1.1 billion Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx) mission is a sample return mission that will study a near-Earth asteroid. The spacecraft is scheduled to launch in October 2016, rendezvous with asteroid Bennu (formerly 1999 RQ36) in 2018, and return samples to Earth in 2023. In November 2013, we concluded a preliminary review of OSIRIS-REx after finding Project management has been controlling costs, meeting milestones, and

[24] NASA OIG, "SOFIA: NASA's Stratospheric Observatory for Infrared Astronomy" (IG-14-022, July 9, 2014).

[25] In August 2014, we concluded a preliminary review of ICESat-2 and found Project management was challenged by the inexperience of the small business contractor responsible for designing and developing the altimeter's laser.

achieving technical objectives. We also found that OSIRIS-REx appears to be positioned to meet its launch window – an opportunity that may not be available again for approximately 6 years given alignment issues between Earth and the target asteroid.[26]

However, a July 2014 fire at a contractor facility destroyed a component that was designed to house the OSIRIS-REx Visible-Infrared Spectrometer instrument and its associated hardware. The contractor was the only qualified source for performing the coating work that needed to be done on the component. OSIRIS-REx management is evaluating using a flight-ready spare while also constructing an additional spare unit. Although management believes there is sufficient time in the schedule to accomplish the extra work, the schedule margin for the instrument has been reduced and is likely to cost an additional $400,000 or more.

Solar Probe Plus

The Solar Probe Plus mission is designed to be the first spacecraft to fly within the sun's atmosphere, or corona, to investigate coronal heating and the origin and evolution of solar wind. In 2009, while the mission was still in early formulation, NASA recognized that higher budget priorities did not leave sufficient funding to support a launch in 2015 and determined that the next feasible launch window would be 2018. In January 2012, NASA established a preliminary life-cycle cost estimate range of $1.23 billion to $1.44 billion and a July 2018 launch date. In March 2014, the Agency established a baseline life-cycle cost of $1.55 billion and a launch date of July 2018. Project management also determined that risk could be reduced by utilizing a heavy-class launch vehicle. While NASA had already spent approximately $16 million designing and developing a high performance upper stage for use on a modified Atlas V launch vehicle, the switch to the heavy-class vehicle allowed NASA to cease development of the custom stage without increasing the Launch System budget. Unfortunately, by using a heavy-class launch vehicle, NASA could end up paying substantially more – potentially $200 million – than was originally budgeted for the modified Atlas V.

Near-Earth Objects Observation Program

In 2005, Congress tasked NASA with implementing a program to find and track comets and asteroids known as near-Earth objects (NEO) greater than 140 meters in diameter (460 feet) to assess their threat to Earth and set a goal that NASA catalogue 90 percent of NEOs by 2020. Although NASA's NEO Program budget has increased 10-fold from FY 2009 to FY 2014 ($4 million to $40 million), the Agency will not be able to meet its goal. In a September 2014 report, we found that despite this large funding increase and expanded responsibilities, the NEO Program's management structure remains organized under a single Program Executive who manages a loosely structured conglomerate of research activities that are not well integrated and lack a Program oversight framework, objectives, and established milestones to track progress.[27] We believe the Program would be more efficient, effective, and transparent were it managed in accordance with standard NASA research program requirements. We made five recommendations to NASA, including that the Agency perform an analysis to determine the number of staff required to administer the Program; NASA agreed to take corrective action.

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[26] There is a possible launch opportunity in September 2017, but launching in that timeframe is not currently part of the Project plan.

[27] NASA OIG, "NASA's Efforts to Identify Near-Earth Objects and Mitigate Hazards" (IG-14-030, September 15, 2014).

Ensuring the Continued Efficacy of the Space Communications Network

NASA's Space Communications and Navigation (SCaN) Program is responsible for providing communications, navigation, and transmission of scientific data to spaceflight missions. SCaN is comprised of three networks: (1) the Near Earth Network, which covers low Earth orbit and portions of geosynchronous and lunar orbit; (2) the Space Network, which controls the Tracking and Data Relay Satellites (TDRS) through a network of geographically diverse ground systems; and (3) the Deep Space Network, which covers NASA communications beyond low Earth orbit, including planetary exploration missions to Mars and beyond. SCaN operates its three Networks as part of a unified Network to meet mission needs. Without SCaN services, NASA could not receive data transmissions from its satellites and robotic missions or control such missions from Earth, and space hardware worth tens of billions of dollars would be little more than orbital debris. While NASA has provided these services for over 30 years, many of its current satellite communications systems are aging and increasingly difficult to repair.

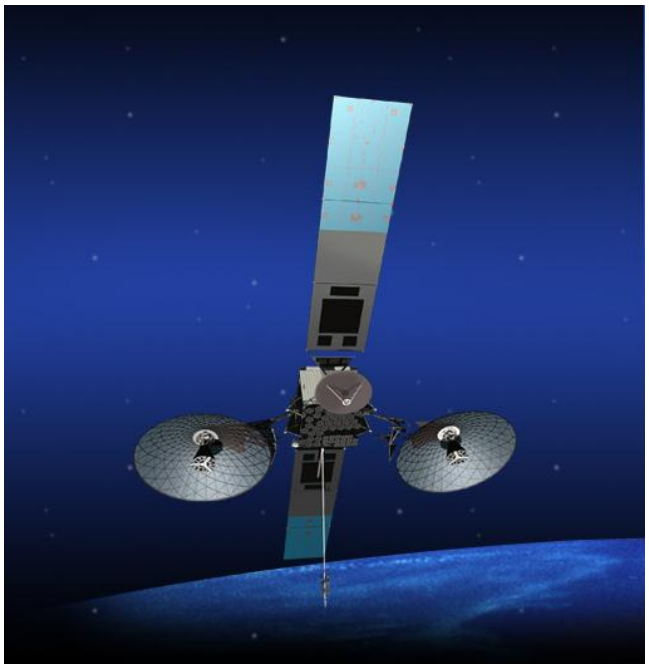
In 2006, NASA initiated the SCaN Program to create an integrated Agency-wide space communications and navigation architecture. The evolution of the integrated system will take place in phases. With a planned FY 2014 budget of $554 million, the Near Earth, Space, and Deep Space Networks initially will remain independent. In the interim, SCaN is adding new capabilities that extend the functionality of the Networks and will be incorporated into the integrated architecture. SCaN also manages the Spectrum Program for NASA and is deeply involved in this issue with other space-faring nations. The Spectrum Program ensures all NASA activities comply with national and international laws applicable to the use of the electromagnetic spectrum. Nearly every endeavor NASA undertakes requires communications or data transfer via the electromagnetic spectrum.

We are examining the SCaN Program through a series of audits, the first of which focused on the Space Network and issued in April 2014.[28] In that report, we found key components of the Space Network are not meeting planned cost, schedule, and performance goals. Taken together, the delays and cost growth increase the risk the Space Network will be unable to continue to provide adequate communication services to NASA missions and its customers.

NASA plans to upgrade the Space Network through an $860 million Space Network Ground Segment Sustainment (SGSS) Project. The purpose of the SGSS Project is to implement a modern ground system that will enable delivery of high quality services to the Space Network community while significantly reducing operations and maintenance costs. Without the upgrades, the ground system will become increasingly unreliable and more expensive to maintain.

[28] "Space Communications and Navigation: NASA's Management of the Space Network," IG-14-018.

Figure 4: Artist Concept of Tracking and Data Relay Satellite



Source: NASA.

To complement the ground system, NASA maintains the TDRS fleet of satellites that transmit the tracking, data, voice, and video services from the ground station to the ISS, NASA's space and Earth science missions, other Federal agencies, and commercial users. The Space Network is in the process of upgrading and replenishing failing satellites, many of which are operating well beyond their planned lives. The TDRS replenishment efforts are major components of maintaining Space Network capabilities. By 2016, four of the nine TDRSs will reach the end of their expected operational lives. Moreover, a NASA study indicates that one of the spare satellites the Agency has in on-orbit storage is already operating 15 years past its design life and could fail as soon as 2014. However, NASA currently has only two new third-generation satellites in orbit to replace four aging satellites. Although NASA had planned to launch another TDRS as early as December 2015, the Agency now expects to delay that launch by as many as 6 years because it lacks funding for a launch vehicle. Further, the Agency's decision in 2013 not to exercise the option to purchase a fourth satellite at a favorable price will result in NASA paying considerably more for a replacement satellite in the future. (See Figure 4.)

We found that the SGSS Project may cost $329 million more than NASA's baseline commitment agreement of $862 million and the schedule for completion likely delayed more than 1.5 years. The cost overrun will require SGSS Project managers to reassess their original requirements and the schedule slip means Space Network officials will have to reprioritize and mitigate the Network's obsolescence risks longer than planned – tasks that will require additional funding. Moreover, any operations and maintenance savings NASA expected to achieve through implementation of the SGSS Project will be delayed for several years.

Further, because of budget reductions and the loss of other expected revenue, in FY 2016 the Space Network will not have sufficient funding to meet all planned service commitments. Although NASA agreed to provide free access to Space Network services for some customers beginning in FY 2014 in exchange for their contributions to the development of two satellites several years earlier, the Agency failed to adequately plan for the resulting loss of approximately $70 million per year in revenue. Consequently, the Space Network has a projected $63 million budget shortfall in FY 2016 and even larger estimated shortfalls in subsequent years. Finally, as we had reported in a prior audit, we found that NASA has not kept current the rate it charges customers for use of the Space Network and, as a result, may be absorbing costs for services used by other Federal agencies and commercial customers.[29]

[29] NASA OIG, "Review of NASA's Tracking and Data Relay Satellite System" (IG-10-023, September 21, 2010).

In our April 2014 report, we recommended the Agency (1) require the SGSS Project Office to revise its cost estimate and, based on those results, adjust the Project baseline and Agency baseline commitment as necessary; (2) report the appropriate baseline commitment and/or status to Congress; (3) ensure the SGSS Project passes a termination review prior to any rebaselining; and (4) examine options to increase funding for the Space Network. We also recommended NASA document the cost factors and formulas used for reimbursable rates and ensure those rates are reevaluated and new rates set on an annual basis. NASA concurred or partially concurred with our recommendations.

NASA is also upgrading its Deep Space Network. Established in 1963 to provide communications for NASA robotic missions operating outside of Earth orbit, the Deep Space Network provides communication for international spacecraft and facilitates scientific investigations through radio astronomy, radio science, and radar activities. NASA runs the Deep Space Network from three ground-based sites (Goldstone, California; Madrid, Spain; and Canberra, Australia), with one 70-meter antenna and multiple 34-meter antennas at each location for around-the-clock coverage. As part of the upgrade, NASA will enhance antenna assets by adding new 34-meter antennas by 2025 at a cost of $393 million. The upgrades will support a greater number of missions and spacecraft as well as the increasingly complex data transfer requirements of those missions. For example, NASA projects future deep space missions will require faster data transmission than the current system can provide and future robotic missions more precise spacecraft navigation for entry, descent, landing, and outer planet explorations. The improved Network will also support manned missions to Mars.

We initiated our audit of the Deep Space Network in May 2014 to assess how NASA is identifying and adjusting capabilities to meet mission requirements; managing program, cost, schedule, and performance; and addressing key risks.

Overhauling NASA's Information Technology Governance

NASA spends more than $1.5 billion annually on a portfolio of information technology (IT) assets that includes approximately 500 information systems the Agency uses to control spacecraft, collect and process scientific data, and enable its personnel to collaborate with colleagues around the world. IT plays an integral role in every facet of Agency operations, and hundreds of thousands of individuals, including NASA personnel, contractors, members of academia, and the public, rely on NASA IT systems daily.

IT governance is a process for designing, procuring, and protecting IT resources. Because IT is intrinsic and pervasive throughout NASA, the Agency's IT governance structure directly affects its ability to attain its strategic goals. For this reason, effective IT governance must balance compliance, cost, risk, security, and mission success to meet the needs of internal and external stakeholders. However, for more than 2 decades NASA has struggled to implement an effective IT governance approach that appropriately aligns authority and responsibility commensurate with the Agency's overall mission. Since at least 1990, the OIG and GAO have highlighted a series of challenges stemming from the limited authority of NASA's Chief Information Officer (CIO), decentralization of Agency IT operations, ineffective IT governance, and shortcomings in IT security.

In a June 2013 audit, we examined whether NASA's Office of the Chief Information Officer (OCIO) has the organizational, budgetary, and regulatory framework needed to effectively meet the Agency's varied missions.[30] We found the decentralized nature of NASA's operations and its longstanding culture of autonomy hinder its ability to implement effective IT governance. The CIO has limited visibility and control over a majority of the Agency's IT investments, operates in an organizational structure that marginalizes the authority of the position, and cannot enforce security measures across NASA's computer networks. Moreover, the current IT governance structure is overly complex and does not function effectively. As a result, Agency managers tend to rely on informal relationships rather than formalized business processes when making IT-related decisions. While other Federal agencies are moving toward a centralized IT structure under which a senior manager has ultimate decision authority over IT budgets and resources, NASA continues to operate under a decentralized model that relegates decision making about critical IT issues to numerous individuals across the Agency, leaving such decisions outside the purview of the NASA CIO. As a result, NASA's current IT governance model weakens accountability and does not ensure that IT assets across the Agency are cost effective and secure.

With mission critical assets at stake and in an era of shrinking budgets, NASA must take a holistic approach to managing its portfolio of IT systems. To overcome the barriers that have resulted in the inefficient and ineffective management of the Agency's IT assets, we made a series of recommendations to overhaul NASA's IT governance structure by centralizing IT functions and establishing the Agency CIO as the top management official responsible for the Agency's entire IT portfolio. This would include empowering the CIO to approve all IT procurements over a monetary threshold that captures the majority of IT expenditures and making the CIO a direct report to the NASA Administrator. We also recommended the Administrator reevaluate the relevancy, composition, and purpose of NASA's primary IT governance boards in light of the changes made to the governance structure and require the use of reconstituted governance boards for all major IT decisions and investments. Finally, we suggested the NASA Administrator reevaluate the resources of the OCIO to ensure that the Office has the appropriate number of personnel with the appropriate skills.

Effective implementation of the recommendations will require a cultural shift and significant changes to the Agency's IT management decision-making regime, including the realignment of authority and responsibilities. NASA management has acknowledged the need for change and in our view is taking a considered approach in implementing corrective action. To date, NASA has made the Agency CIO a direct report to the NASA Administrator and completed an organizational assessment to determine if the OCIO has the appropriate number of personnel with the proper capabilities. The Agency is currently implementing phase two of a three-part overhaul of the IT governance model that entails reviewing and revising existing board charters, increasing CIO authority and visibility over Center IT assets including review and approval of IT purchase requests, and assessing the titles and roles of Center and Mission CIOs to more clearly delineate these position's roles and responsibilities. NASA anticipates completing corrective action to address all recommendations by the spring of 2015.

[30] NASA OIG, "NASA's Information Technology Governance" (IG-13-015, June 5, 2013).

Ensuring the Security of NASA's Information Technology Systems

The large number of NASA networks and websites coupled with the Agency's statutory mission to share scientific information present unique IT security challenges. For FYs 2013 and 2014, NASA reported 3,649 computer security incidents resulting in the installation of malicious software on or unauthorized access to Agency computers. These incidents included individuals testing their skills to break into NASA systems, well-organized criminal enterprises hacking for profit, and intrusions that may have been sponsored by foreign intelligence services seeking to further their countries' objectives. Moreover, NASA's vast connectivity with outside organizations – most notably nongovernmental entities such as educational institutions and research facilities – offers cybercriminals a larger target than most other Government agencies.

We recently reported that NASA manages approximately 1,200 publicly accessible web applications, or about half of all publicly accessible, nonmilitary Federal Government websites, that share scientific information with the public, collaborate with research partners, and provide Agency civil servant and contractor employees with remote access to NASA networks.[31] Hundreds of these web applications are part of IT systems NASA characterizes as high- or moderate-impact, meaning that a security breach could result in the loss of sensitive data or seriously impair Agency operations.

In FY 2013, NASA reported exploitation of vulnerable web applications accounted for one-third (61 of 183) of the Agency's total IT security breaches, with several resulting in the loss of sensitive information and disruption to Agency operations. For example, in July 2013 hackers compromised a NASA Shared Services Center website containing personally identifiable information of Agency civil servants and contractors. Further, several NASA websites hosted by the Ames Research Center had to be taken offline in September 2013 after an international hacker posted political statements opposing U.S. policy. Moreover, the frequency and sophistication of attacks directed at NASA's publicly accessible web applications has increased dramatically over the past several years. Between FYs 2012 and 2013, NASA experienced an 850 percent increase (from 42 to 359) in structured query language injection attacks that attempted to compromise Agency web applications to steal data or gain a foothold into its networks for future exploitations.[32]

To protect the Agency against inevitable attacks on its IT systems, NASA must ensure that those systems and associated components are regularly safeguarded, assessed, and monitored. To assist in this effort, in FY 2014 the OCIO dedicated an additional $10 million to fund a series of initiatives to address IT security concerns, including

- modernizing and expanding continuous monitoring and network penetration testing;
- deploying intrusion detection systems across mission, corporate, and research networks;
- increasing web application security scanning; and
- implementing intrusion prevention systems.

[31] NASA OIG, "Security of NASA's Publicly Accessible Web Applications" (IG-14-023, July 10, 2014). NASA's publicly accessible web applications consist mainly of websites, but also include web-based login portals and administrative systems that provide authorized personnel remote access to Agency IT resources.

[32] Structured query language (SQL) is an industry standard computer language used to query, operate, and administer many databases. In an SQL injection attack, the attacker appends (injects) instructions onto the end of a valid SQL statement in an attempt to gain unauthorized access to the system and its data.

The OCIO is in the final stage of deploying NASA's first intrusion prevention systems and recently has implemented risk management procedures to ensure critical and high vulnerabilities are appropriately mitigated.

Over the past 5 years, the OIG has issued 20 audit reports containing 65 recommendations designed to improve NASA's IT security. In the most recent of these reports, we examined NASA's efforts to identify and assess vulnerabilities on its publicly accessible web applications and mitigate the most severe vulnerabilities before hackers exploit them.[33] Reducing the Agency's extensive web "footprint" is one of the more effective ways NASA can counter the threat of cyber attacks. To this end, the OCIO and Center IT security officials are working to reduce NASA's web presence by eliminating unused and duplicative web applications and moving Agency websites to a public cloud-computing environment.[34]

That report also noted that NASA's ongoing efforts to reduce its web presence and to identify and scan for vulnerabilities on its publicly accessible web applications have improved Agency IT security. However, NASA needs to close remaining security gaps, strengthen program oversight, and further reduce the number of publicly accessible web applications. NASA developed an inventory of all publically available web applications maintained by NASA Headquarters and Centers and, consistent with best practices, identified vulnerabilities through automated scanning coupled with manual testing. In addition, during the 15-month period ending March 2014, NASA reduced by 15 percent the number of its publicly accessible web applications.

Despite this progress, we found deficiencies in the design and implementation of NASA's program that leaves the Agency's publicly accessible web applications at risk of compromise. These deficiencies occurred because NASA did not prioritize identification of security vulnerabilities by seriousness of potential impact, identify the underlying cause of vulnerabilities, identify weaknesses associated with unsound IT security practices, or implement an effective process to ensure timely mitigation of identified vulnerabilities. Finally, while NASA has made strides in reducing the scope of its web presence, the Agency's remaining 1,200 publicly accessible web applications continue to present a large target for hackers.

In another review completed this year, we evaluated NASA's management of smartphones, tablets, basic cell phones, and AirCards.[35] These mobile devices pose security threats because of their size, portability, constant wireless connection, physical sensors, and location services. Further, the diversity of available devices, operating systems, carrier-provided services, and applications present additional security challenges. We found that although NASA began enforcing security requirements on all smartphones and tablets that connect to NASA's email systems in September 2013, the Agency still needed to implement a technical tool to mitigate risks when those devices connect to NASA systems other than email. In response to our recommendations, the Agency is reviewing various technical tools and plans to complete corrective action in FY 2015.

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[33] "Security of NASA's Publicly Accessible Web Applications," IG-14-023.

[34] A public cloud-computing environment consists of a third-party IT service provider (e.g., Amazon) that delivers services such as website hosting or data storage to consumers over the Internet.

[35] NASA OIG, "NASA's Management of its Smartphones, Tablets, and Other Mobile Devices" (IG-14-015, February 27, 2014). An AirCard is a device that provides the user with access to wireless broadband cellular services.

In addition to our audit work, the OIG focuses substantial resources investigating IT security issues. OIG investigators have conducted more than 110 investigations of breaches of NASA IT networks over the past 5 years and helped to secure convictions of hackers operating from such wide-ranging locations as Australia, China, Great Britain, Italy, Nigeria, Portugal, Romania, Turkey, and Venezuela. In one notable example, the OIG helped secure indictments of six Estonian nationals involved in a cybercrime scheme that infected millions of computer systems worldwide, including NASA systems, with malicious software. Thus far, the investigation has resulted in over $22 million in restitution and forfeiture orders and two guilty pleas, while legal proceedings for the other defendants continue. In another case, the OIG worked with other Federal agencies to obtain indictments of a British national in three Federal jurisdictions for infiltrating Government computer systems and aggravated identity theft.

Managing NASA's Infrastructure and Facilities

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. 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 not to pose a safety hazard. However, NASA has not been able to fully fund required maintenance for its facilities and in 2014 estimated its deferred maintenance costs at $2.4 billion.

The OIG has conducted 12 audits over the past 5 years examining various aspects of NASA's efforts to manage its aging infrastructure.[36] In last year's management challenges report, we discussed our February 2013 audit assessing NASA's efforts to reduce unneeded infrastructure and facilities and identified 33 facilities – including wind tunnels, test stands, thermal vacuum chambers, airfields, and launch infrastructure – at NASA Centers across the country the Agency was not utilizing or for which NASA officials could not identify a future mission use.[37] These facilities cost the Agency more than $43 million to maintain in FY 2011 alone. We recommended NASA complete its ongoing comprehensive technical capabilities assessment and ensure that process is established into policy. We also recommended NASA develop a mechanism for communicating its decisions regarding facilities to outside stakeholders and ensure that process is updated, documented, and established into policy, as well as implement changes to the NASA Technical Capabilities Database to improve data accuracy.

NASA has yet to address our recommendations. According to Agency officials, responsive action is contingent upon completion of the work of NASA's Technical Capabilities Assessment Team (TCAT), which NASA established in 2012 to assess the Agency's technical capabilities, both workforce and physical assets,

[36] NASA OIG, "NASA's Independent Verification and Validation Program" (IG-14-024, July 16, 2014); "Audit of NASA's Environmental Restoration Efforts" (IG-14-021, July 2, 2014); "NASA's Management of Energy Savings Contracts" (IG-13-014, April 8, 2013); "Review of NASA's Explosives Safety Program" (IG-13-013, March 27, 2013); "NASA's Environmental Remediation Efforts at the Santa Susana Field Laboratory" (IG-13-007, February 14, 2013); "NASA's Efforts to Reduce Unneeded Infrastructure and Facilities" (IG-13-008, February 12, 2013); "NASA's Plans to Modify the Ares I Mobile Launcher in Support of the Space Launch System" (IG-12-022, September 25, 2012); "NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Leasing Practices" (IG-12-020, August 9, 2012); "NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Master Planning" (IG-12-008, December 19, 2011); "NASA Infrastructure and Facilities: Assessment of Data Used to Manage Real Property Assets" (IG-11-024, August 4, 2011); "NASA's Hangar One Re-Siding Project" (IG-11-020, June 22, 2011); and "Audit of NASA's Facilities Maintenance" (IG-11-015, March 2, 2011).

[37] "NASA's Efforts to Reduce Unneeded Infrastructure and Facilities," IG-13-008.

to enable NASA to make informed decisions regarding investment and divestment strategies. To date, TCAT has completed or is working on assessments of microgravity flight services, balloons, life sciences, Earth sciences research, and aircraft operations. The Agency expects the TCAT process will take several years to complete, and it is too early in the process for the OIG to assess its efficacy.

In another example of the difficulty NASA faces "right-sizing" its footprint, in a July 2014 audit we examined NASA's Independent Verification and Validation (IV&V) Program.[38] As part of NASA's quality control process, the IV&V Program assesses whether software associated with Agency science and spaceflight activities will meet program, cost, schedule, and safety requirements. More than 20 years ago, NASA was directed in appropriations legislation to provide West Virginia University with $10 million to establish an IV&V facility. (See Figure 5.) Subsequently, in January 1992 NASA awarded the West Virginia University Research Corporation (Corporation) a $10 million grant that it used to build a computer operations and research facility on the University's campus. According to the grant, upon completion of construction the Corporation would take title to the facility and become responsible for associated operations and maintenance (O&M) expenses. Nevertheless, NASA has continued to pay the facility's O&M costs, which over the last 20 years have amounted to more than $82 million. Moreover, although NASA does not own the facility, the IV&V Program paid the Corporation $993,000 in 2010 to replace its roof.

Figure 5. NASA IV&V Program Facility

Source: IV&V Program website.

We found that by continuing to occupy and maintain the West Virginia facility, NASA is paying more than necessary in O&M expenses, which leaves the Agency with less funding to perform actual IV&V services on NASA software projects. We estimated the Agency could save as much as $9.7 million between FYs 2015 and 2018 if the IV&V Program took steps to reduce costs associated with the facility. In order to make additional funds available for review of mission-critical software, we recommended NASA analyze alternatives for reducing occupancy costs associated with the facility, including abandoning the facility and moving staff to an existing NASA Center or relocating the staff to a nearby office building that would cost significantly less. NASA is currently analyzing alternatives for reducing occupancy costs and plans to complete its assessment by December 2014.

Leasing unneeded facilities 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. Instead, 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.

[38] "NASA's Independent Verification and Validation Program," IG-14-024.

In an October 2014 report, we examined NASA's efforts to transform the Kennedy Space Center (Kennedy) from an exclusively Government launch complex to a multiuser spaceport by making available to private industry and other Government agencies facilities left underutilized by the retirement of the Space Shuttle Program.[39] We found Kennedy has made progress in this effort and has leased or is in the process of negotiating leases for approximately half of its underutilized assets. However, because NASA lacks clear guidance regarding soliciting and awarding lease agreements, Kennedy's process for notifying potential tenants of leasing opportunities evolved over the years and the Center has not consistently provided interested parties with information regarding how Kennedy officials would choose among competing applicants. Moreover, as state and privately run spaceports develop, constraints inherent to operating on a Federal facility may affect NASA's ability to continue to attract commercial partners to Kennedy.
Given the disparity between the Agency's infrastructure and its mission-related needs, as well as the likelihood of continued constrained budgets, it is imperative NASA move forward aggressively with its infrastructure reduction efforts. To achieve this goal, the Agency will need to move away from its longstanding "keep it in case you need it" mindset and overcome historical incentives for the Centers to build up and maintain unneeded capabilities. In addition, NASA officials need to manage the concerns of political leaders about the impacts eliminating or consolidating facilities will have on Centers' missions, their workforces, and the local communities. Moreover, abrupt changes in the strategic direction of the Nation's space policy by the President, Congress, and NASA will continue to add an element of uncertainty regarding the missions the Agency will pursue and therefore the facilities it will need to achieve those missions.

As we noted in our February 2013 report on underused facilities, NASA's best efforts to address these challenges may ultimately be insufficient to overcome the cultural and political obstacles that have impeded past efforts to reduce Agency infrastructure.[40] Accordingly, an outside process similar to the Department of Defense's Base Realignment and Closure Commission may be necessary to make the difficult but necessary decisions.

Ensuring the Integrity of the Contracting and Grants Processes and Proper Use of Space Act Agreements

Approximately 80 percent of NASA's $16.8 billion FY 2013 budget was spent on contracts to procure goods and services and provide funding to grant and award recipients.[41] In addition to these more conventional types of instruments, each year NASA enters into hundreds of Space Act Agreements to advance science and technology, stimulate new industries such as commercial spaceflight, and encourage companies to work with NASA that traditionally have not pursued more conventional agreements because of the complexity of regulatory requirements and associated costs. Space Act Agreements may be reimbursable where the partner reimburses NASA's costs in full or in part, nonreimbursable, or funded where NASA transfers appropriated funds to the partner. In each case, the agreements establish a set of legally enforceable promises requiring a commitment of NASA resources, such as personnel, funding, equipment, expertise, information, or facilities.

[39] NASA OIG, "NASA's Launch Support and Infrastructure Modernization: Commercial Space Launch Activities at Kennedy Space Center" (IG-15-003, October 23, 2014).

[40] "NASA's Efforts to Reduce Unneeded Infrastructure and Facilities," IG-13-008.

[41] Approximately 75.5 percent was spent on contracts with the remaining 4.5 percent funding grants and cooperative agreements.

Given the large amount of taxpayer money NASA spends on contracts, managers face an ongoing challenge to ensure the Agency pays contractors in accordance with contract terms and receives fair value for its money. For its part, the OIG seeks to assist NASA by examining Agency-wide procurement processes; auditing individual contracts, grants, and cooperative agreements; and investigating potential misuse of Agency contract and grant funds. During the past year, the OIG continued to uncover fraud and other problems related to NASA contracts. For example:

- In February 2014, a Federal judge in the Eastern District of Virginia sentenced a former executive of a personnel services company to 5 years in prison and 2 years supervised release and to forfeit $2.9 million in ill-gotten gains. The executive had pled guilty to major fraud for misrepresenting his firm as a disadvantaged small business in order to secure more than $2.4 million in NASA security contracts.
- In July 2014, a NASA contractor and its president were indicted on eight counts of wire fraud and three counts of false claims related to contracts with NASA and the National Science Foundation (NSF). The joint NASA OIG and NSF OIG investigation found $800,000 in NASA and NSF contract funds had been used for personal rather than Government purposes.

One area that presents an ongoing challenge is NASA's Small Business Innovation Research (SBIR) Program. As of August 2014, NASA had awarded approximately $69 million in FY 2014 funds to small businesses under this Program 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. Although NASA has taken steps to minimize opportunities for misconduct in the SBIR Program, the OIG continues to investigate allegations of fraud by award recipients. For example, in May 2014 two individuals were indicted for defrauding NASA, NSF, and the Defense Advanced Research Projects Agency by proposing thousands of hours of labor for highly skilled employees who did not actually work for their companies. Another investigation uncovered a NASA contractor that received more than $1.5 million in SBIR contracts based on duplicate proposals submitted to NASA and the U.S. Air Force.

The OIG's audit work during the past year also illustrated that NASA has significant work to do to improve its multibillion dollar contracting and procurement operations. For example, we found NASA needs to significantly improve its "strategic sourcing" efforts.[42] Strategic sourcing involves centralizing contracting decisions or using Government-wide contracts to lower prices and reduce administrative duplication. Although NASA procurement officials established a Strategic Sourcing Program in 2006, we found the Program has missed opportunities to maximize savings because it failed to develop a robust, Agency-wide effort. Specifically, NASA has not conducted a comprehensive, Agency-wide spend analysis to identify commodities that could benefit from a more strategic procurement approach. Further, although NASA performed limited spend analyses on individual commodities, it has not established requirements regarding how such analyses should be developed, analyzed, and used. While NASA officials said they have realized savings under specific strategic sourcing initiatives, NASA does not track its Agency-wide strategic sourcing efforts and therefore was unable to determine the extent of any efficiencies or cost savings achieved. We made six recommendations to strengthen the Agency's Strategic Sourcing Program.

[42] NASA OIG, "NASA's Strategic Sourcing Program" (IG-14-010, January 15, 2014).

In another audit, we examined the NASA's process for closing out expired award instruments, including deobligating unused funds.[43] Federal and Agency guidelines provide timeframes in which this process should occur, and meeting these timeframes can help limit NASA's exposure to financial risk by promptly identifying any improper payments the Agency may have made and ensuring contractors and grantees have satisfied the terms of the awards. Moreover, timely deobligation of unused funds frees up money for other Agency or Government uses.

We found that although NASA has slowed the growth of its backlog of instruments awaiting closeout, it needs to make further improvements to its closeout process. First, NASA's process is not uniform across the Agency, with Centers varying in the timing and types of award instruments they send to NASA's close-out contractor. As a result, some Centers are not optimizing the services provided by the contractor, thereby contributing to the backlog. Second, contract personnel at the Centers use different guidance when closing out award instruments, impairing their ability to share information and work across the Centers. Third, although we found that NASA generally deobligates unused funds in a timely manner, we identified $2.7 million in funds the Agency did not timely deobligate. Based on this finding, we estimated that Agency-wide NASA has more than 4,000 instruments with $61 million in funds that were not timely deobligated. Fourth, the Agency closed some award instruments without sufficient evidence that the associated funding had been spent appropriately. Consequently, NASA has increased risk that the costs associated with more than $43 million in awards may not be allowable and reasonable. Finally, we identified several best practices that, if applied across the Agency, could help strengthen NASA's closeout process.

We also continued to work with NASA to improve the Agency's practices relating to award-fee contracts. In a November 2013 audit, we found that although NASA had implemented processes intended to improve contractor performance and acquisition outcomes, questionable practices – including overly complex award formulas and a contract clause designed to hold contractors accountable for the quality of the final product that disregards interim performance evaluations – have diminished the effectiveness of award-fee contracts at the Agency.[44] In addition, we found the quality of data entered into the award fee evaluation system lacking, which reduced NASA's ability to measure award fee effectiveness. Although the Agency initially disagreed with 7 of our 12 recommendations, we have now closed or resolved all but 2 recommendations. Most significantly, NASA continues to disagree with our position that the Agency's practice of making funds not awarded during interim award periods available in the final award pool circumvents a provision in the FAR that prohibits Federal agencies from "rolling over" unearned fees to subsequent performance periods. In our view, NASA's practice promotes a philosophy that as long as a mission ultimately provides good science data the Agency will overlook cost and schedule overages that occur during project performance.

NASA also faces the ongoing challenge of ensuring the grant funds the Agency distributes each year are administered appropriately and that recipients are accomplishing stated goals. NASA awards approximately $850 million in grants and cooperative agreements annually to facilitate research and development and to fund scholarships, fellowships, and stipends to students and teachers, as well as research by educational institutions or other nonprofit organizations. The OIG conducted several audits during the past year to identify weaknesses in NASA's management of grants and cooperative

[43] NASA OIG, "NASA's Award Contract Closeout Process" (IG-14-014, February 12, 2014).

[44] NASA OIG, "NASA's Use of Award-Fee Contracts" (IG-14-003, November 19, 2013).

agreements. In one audit, we found that the recipient had underestimated expenditures and overpromised on delivery dates, and therefore would need $595,000 more in award funds and an additional 16 months to complete the promised work.[45] Other audit findings included administrative errors in pre-award and award documentation and the failure to obtain necessary IT security plans.

Over the past 5 years, the OIG has conducted 38 grant fraud investigations resulting in five prosecutions, $13.5 million in restitution and recoveries, and $15 million in civil settlements. For example, an ongoing investigation found that a senior faculty member of a Texas university misrepresented her participation in multiple NASA grant awards, resulting in the payment of $239,000 in unallowable costs. The university fired the faculty member, and NASA is in negotiations with the university seeking return of the questioned funds. In a separate investigation, a political consultant pleaded guilty in August 2014 to helping conceal the improper use of NASA Federal grant funds to repay an illegal campaign debt incurred by an elected official during a 2007 run for office.

Given the large sums of money at stake, we intend to continue to monitor NASA's performance in administering its contracts and grants as we work with the Agency to develop solutions to address the deficiencies identified in our reports. In this regard, we are currently performing audits examining whether NASA is properly and economically using blanket purchase agreements (a procurement vehicle to enable agencies to maximize savings opportunities through competition and price discounts) and whether it has established adequate procedures to ensure costs charged by Agency contractors are properly supported, allowable, reasonable, and allocable. We also continue to audit individual grants and cooperative agreements.

This past year, we also examined NASA's use of Space Act Agreements.[46] Since NASA's inception, the Agency has entered into thousands of these agreements for such varied purposes as obtaining fundamental research to nurturing the development of commercial launch vehicles. While NASA has limited records showing how it used its Space Act authority in the early years, our analysis of more recent data shows that the number of Space Act Agreements increased by more than 29 percent between FYs 2008 and 2012.

We found NASA cannot identify the costs incurred or effectively measure the benefits derived from nonreimbursable Space Act Agreements because it lacks a close-out process or similar mechanism to document such results. Although the agreements involve no exchange of funds, NASA nevertheless bears the expense associated with any personnel, facilities, expertise, or equipment it contributes. Consequently, objectively assessing the value such Agreements bring to the Agency and to the broader aeronautical, scientific, and space exploration communities is difficult without such documentation. We also found NASA could better ensure equal access to its facilities and capabilities and increase interest in Space Act Agreement opportunities by expanding its efforts to solicit a broader number of potentially interested parties. In addition, we found that NASA has unclear guidance regarding when it is appropriate to use the agreements as opposed to leases and how the Agreements must align with the Agency's missions. Most Centers have interpreted NASA's policy to mean the covered activity must directly relate to a NASA mission, while others have taken the position that as long as the proceeds from an Agreement help maintain a needed facility or capability the actual activity performed need not

[45] NASA OIG, "Audit of NASA's Cooperative Agreement with BioServe Space Technologies – University of Colorado at Boulder" (IG-14-028, August 4, 2014).

[46] "NASA's Use of Space Act Agreements," IG-14-020.

directly relate to a NASA mission. Under the latter interpretation, Kennedy received $392,000 from NASCAR and other organizations for use of its Shuttle Landing Facility for aerodynamics testing and the Michoud Assembly Facility an estimated $2.9 million from movie production studios, engineering firms, and manufacturing companies that utilized excess office and warehouse space at the facility.

While there are no indications NASA has failed to collect fees associated with reimbursable Agreements, we found that the Agency cannot readily separate amounts billed and collected for these Agreements from proceeds of other types of reimbursable agreements because its accounting system does not have a common identifier to separate Space Act Agreements from other types of reimbursable activity. Finally, we questioned NASA's decision to refrain from including more specific information about Agency objectives and key safety elements in funded Space Act Agreements and believe it should consider being more prescriptive in the future when using funded agreements to develop spaceflight technology.

APPENDIX A: MANAGEMENT COMMENTS

National Aeronautics and Space Administration
Office of the Administrator
Washington, DC 20546-0001

October 20, 2014

TO: Inspector General

FROM: Administrator

SUBJECT: Agency Response to "NASA's 2014 Top Management and Performance Challenges"

The National Aeronautics and Space Administration (NASA) fully appreciates the opportunity to review and comment on your assessment of "NASA's 2014 Top Management and Performance Challenges."

As you know, I am a strong supporter of the Office of Inspector General (OIG) and its mission to prevent and detect fraud, waste, and abuse, as well as to increase the efficiency and effectiveness of NASA's programs, projects, and operations. The audits and investigations that your office conduct provide valuable oversight and insight which contribute to the Agency's efforts to provide the taxpayer with maximum value for each dollar invested in NASA's wide-ranging, ambitious, and challenging portfolio.

The one overarching and seven specific management and performance challenges identified in your 2014 assessment provide NASA with additional tools and solutions sets for improvement, which the Agency continues to build upon. We continue to aggressively pursue mitigation of the challenges that your office has identified through the audits and investigations conducted by your office during this and previous years.

Charles F. Bolden, Jr.

Enclosure

MANAGEMENT'S RESPONSE
TO THE OFFICE OF INSPECTOR GENERAL'S MEMORANDUM ON
"NASA's 2014 TOP MANAGEMENT AND PERFORMANCE CHALLENGES"
November 2014

Overarching Management and Performance Challenge

We agree with the OIG's assessment that, going forward, NASA's principal challenge will be to effectively manage the Agency's varied programs in an uncertain budget environment, coupled with individual Agency-, project-, and facility-related challenges.

As a means to proactively address these challenges, NASA is embarking on new ways to do business; investing in new technology; and increasing the sustainability, accountability, and transparency in our operations, specifically:

Finding new ways to do business: We are leveraging more public-private partnerships and harnessing the ingenuity of the American people to accomplish our work. We have spent nearly 50 years mastering the science and art of getting to low-Earth orbit. We have proven the technologies and put the infrastructure in place. Now, we are ready to employ the capabilities of emerging U.S. commercial partners who can provide cargo and soon crew services. Transferring low-Earth orbit access to commercial providers allows us to focus our valuable resources on pursuing the next frontier: mastering human access to deep space. In addition, we are expanding our partnerships outside the traditional aerospace industry to share knowledge and expertise in areas such as manufacturing, information technology, and resource management. Also, recognizing the value of the American public as a strategic partner in addressing some of the country's most pressing challenges, NASA relies on the expertise, ingenuity, and creativity of the American public by enabling, accelerating, and scaling the use of open innovation methods, including prizes, challenges, crowdsourcing, and citizen science across NASA.

Investing in cutting-edge technologies: As we prepare for the proposed missions to an asteroid and then to Mars and for the doubling of the global commercial aviation fleet in 20 years, we are entering an exciting time in which we will push the very boundaries of research and technology development. We are implementing a space technology development and test program with partners from industry, academia, and other nations. This program will facilitate our objectives of building, flying, and testing new technologies that have the potential to increase capabilities, decrease costs, and expand opportunities for future space activities. As the enabler for safe and efficient aviation transformation, our research and technologies have formed the DNA of all modern aircraft. Through cutting-edge aeronautics research NASA continues to develop and test solutions that strengthen the air travel and transportation industry while minimizing environmental impact. We will continue to bring innovations to usher national and global air transportation systems into the 21st Century.

Increasing sustainability, accountability, and transparency: Our three strategic goals guide our major initiatives, they also focus on returning tangible benefits of cutting-edge technology development, as well as ensuring sustainability, accountability, and transparency in our operations. NASA's sustainability policy is to execute its mission without compromising our planet's resources so that future generations can meet their needs. Sustainability also involves taking action now to provide a future where the environment and living conditions are protected and enhanced. In implementing sustainability practices, NASA manages risks to mission, to the environment, and to our communities. To this end, NASA seeks to use public funds efficiently and effectively, promote the health of the planet, and operate in a way that benefits our neighbors. We are sharing our data, our successes, and our setbacks with the public at an unprecedented level. Through our transparency, we want the Nation to understand both why and how our challenging work will create a brighter future.

Specific Management and Performance Challenges

1. Managing NASA's Human Space Exploration Programs: the International Space Station, Commercial Crew Transportation, and the Space Launch System

International Space Station (ISS)

In January 2014, the Administration and NASA announced the extension of the operations and utilization of the International Space Station (ISS) until at least 2024. This extension enables NASA to make progress towards the goals of the ISS: extending human spaceflight beyond low-Earth orbit (LEO); enabling the development of the commercial market in LEO; conducting research to benefit humanity in areas such as medicine, physical and life sciences, and earth and space sciences; and providing the basis for exploration international partnerships. The ISS International Partners are expected to address extension in the next couple of years. This will allow sufficient time for each partner to determine their unique level of participation in the ISS program and exploration.

NASA has partnered with the Center for the Advancement of Science in Space (CASIS) to advance the development of the commercial market in LEO through development activities across private industry including pharmaceuticals, material sciences, biomedicine, and earth science. CASIS continues to expand its development activities to fully utilize the research and application capabilities provided by the ISS.

NASA and its International Partners have conducted extensive operational and maintenance analyses to determine the appropriate level of spares, maintenance cycles, and logistics necessary to maintain the ISS on-orbit platform to at least 2024. The partnership has also conducted structural and performance analyses to ensure that the ISS is structurally viable to at least 2028. System upgrades needed to operate the ISS to at least 2024, including docking systems and new lithium ion batteries for the electrical power system, are already under development. Larger external equipment and spares, such as the lithium ion batteries, are planned to launch on the Japanese HII Transfer Vehicle (HTV) prior to its retirement. Occasional failures of external hardware are to be expected, and NASA prepares for these with on-orbit spares and spacewalk preplanning. In response to faster-than-expected

degradation of the solar arrays, NASA is assessing a variety of options to improve power generation/balance in the out years.

The ISS program is currently in the process of procuring commercial cargo transportation services. Once actual costs for transportation beyond the current Commercial Resupply Services (CRS) contract are known through the procurement process, the ISS will update its budget requests accordingly. Commercial crew development activities are currently underway. Once contracted commercial crew costs are known, these will also be incorporated into the ISS budget request.

Commercial Crew

NASA agrees with the four specific challenges identified by the OIG regarding the Commercial Crew Program (CCP), as well as the OIG's recognition of the significant progress that NASA has made regarding each of these challenges during the past year.

Unstable Funding: This challenge is largely outside of NASA's control. However, the Agency has made funding for the CCP a priority among its human spaceflight programs along with Orion, Space Launch System (SLS), and the ISS. NASA has consistently maintained the need for full funding for the CCP and will continue to do so. These efforts have been somewhat successful, as funds appropriated for the CCP budget have increased by an average of 30 percent over the last three years.

Integration of Cost Estimates with the Program Schedule: On September 16, 2014, NASA announced Commercial Crew Transportation Capability (CCtCap) awards to Boeing and SpaceX. The associated Request for Proposal (RFP) required the companies to provide comprehensive, fully integrated plans towards the development of their respective Crew Transportation Systems (CTSs). NASA reviewed these plans, which included detailed cost estimates and schedules along with supporting rationale, during its evaluation and accepted the proposals for Boeing and SpaceX. These companies are now under firm, fixed price contracts for completing the development of their CTSs.

Providing Timely Requirement and Certification Guidance: In the spring of 2014, NASA concluded the Certification Products Contracts (CPC) with SpaceX, Boeing, and Sierra Nevada. The primary objective of CPC was the deliverables, technical interchange, and NASA disposition of early life-cycle CTS certification products. The purpose of the contract deliverables was to assess the contractor readiness to transition to CCtCap. The final contract deliverables included: 97 alternate standards, 109 variances, 316 hazard reports, and Verification and Validation Plans and Certification Plans for each contractor. In addition, almost 500 background data documents were delivered by the contractors and reviewed by NASA. Through NASA's assessment of these deliverables, the Agency was able to give the companies clear and actionable feedback relative to NASA requirements. CPC was an outstanding accomplishment and each company was able to incorporate NASA's feedback into their designs going into CCtCap.

Finally, the OIG suggests that NASA has used funded Space Agreements to acquire human spaceflight services that meet NASA requirements. To clarify, NASA uses Space

Act Agreements when the purpose of that activity cannot be met using a procurement contract, grant, or cooperative agreement. NASA uses funded Space Act Agreements to stimulate the private sector to develop and demonstrate human spaceflight capabilities that could ultimately lead to the availability of commercial human spaceflight services for both commercial and Government customers. With the recent award of the CCtCap contracts, NASA is now using procurement contracts to certify commercially-developed human spaceflight services to NASA requirements and acquire missions to the ISS.

Spaceflight Coordination Issues with Other Federal Agencies: NASA has made significant progress in this area since the last reporting period. NASA and the Federal Aviation Administration (FAA) signed a Joint Program Management Plan describing the detailed roles and responsibilities each agency has for the execution of the CCP. In addition, a program-level NASA/FAA working group and Headquarters-level NASA/FAA legal team were established and have been making excellent progress on issues related to NASA astronauts flying on FAA-licensed vehicles. A substantial number of issues associated with NASA requirements and FAA regulations have been closed and action plans exist on closing the remaining issues. For example, the FAA published an interpretation, which addresses the ability of astronauts to perform operational functions during a commercial launch or reentry. The FAA published additional interpretations covering waivers and international partners. In addition, a Launch & Entry Steering Group has been established which is a forum for NASA, the United States Air Force, and the FAA to establish consistent policy regarding crew, range, and public safety. The charter for this group has been signed and an initial meeting has been accomplished.

Space Launch System (SLS)
The Exploration Systems Development (ESD) Enterprise is aggressively preparing the SLS, Orion Multi-Purpose Crew Vehicle (Orion), and the Exploration Ground Systems (EGS) needed to provide the foundational elements required for Deep Space Exploration. NASA recognizes the challenges of pursuing concurrent development of these three programs and has made substantial progress toward demonstrating these capabilities within the context of a capabilities-driven architecture.

ESD has established a proactive affordability initiative that each program has implemented to find ways to avoid the need for greater expenditures in the development phase of the program. This has resulted in tens of millions of dollars in cost avoidance both now and in the future. The fact that we are adapting existing hardware, facilities, and designs in the ESD Enterprise actually reduces the overall need for and cost of design reviews and testing. A recent audit of the SLS program by the Government Accountability Office[1] (GAO) noted that the program's technical issues were not overly complex, and that management systems were in place to address them.

[1] "Space Launch System: Resources Need to be Matched to Requirements to Decrease Risk and Support Long Term Affordability" GAO-14-631: Published: Jul 23, 2014. Publicly Released: Jul 23, 2014.

The evolvable nature of SLS (and by extension the other exploration programs) is consistent with procurement best-practices for buying down program risk; likewise, evolvability is a key component of the capability-driven architecture. These exploration programs are designed to enable multi-decade human exploration beyond low-Earth orbit in support of national objectives and policy. The requirements for a safe and reliable human exploration transportation system (particularly in terms of lift capacity and volume) are significantly greater than for non-exploration missions. Taken together, the capability-based framework and the evolvable architecture provides the foundation for a sustainable approach to exploration. From this strategy, NASA has identified conceptual missions that provide defined minimum capabilities for SLS (such as required mass delivered to lunar or Martian orbit), while the basic timing of those missions (operating in cis-lunar space through the 2020s, with missions to the Mars vicinity in the 2030s) drives when upgraded capabilities are required. Funding instability and uncertainty remains our number one challenge to success, resulting in limited options to accelerate or modify our development approach.

2. Managing NASA's Science Portfolio

The Science Mission Directorate (SMD) recognizes the inherent difficulties in developing and operating its extensive portfolio of projects and programs in today's fiscally constrained environment. Still, SMD develops and implements the cutting-edge missions necessary to advance science and produce the incredible discoveries for which NASA has long been recognized.

Our scientific missions are inherently complex and present unique challenges, as most represent significant first-of-a kind achievements. But with these challenges, it is increasingly important to execute SMD's missions on time and within budget. In the 2010 Science Plan for NASA's Science Mission Directorate, SMD outlined the Agency's efforts to revise and implement new policies to constrain mission costs and meet schedule goals. These measures include:

- Establishing confidence level-based mission life-cycle budgets
- Obtaining independently generated internal and external cost estimates
- Reviewing projects at multiple, formal Key Decision Points that function as gates to the next stage of development

Additionally, NASA has started requiring the Decadal Survey committees to perform independent cost estimates for their proposed mission concepts. By adhering to these steps over the past six years, NASA has launched many missions within their cost and schedule baselines, demonstrating measurable progress in improving the Agency's mission cost estimation and management tools.

This record of cost and schedule performance for SMD is unprecedented. The Van Allen Probes (formerly known as the Radiation Belt Storm Probes [RBSP]), Juno, Gravity Recovery and Interior Laboratory (GRAIL), Mars Atmosphere and Volatile Evolution (MAVEN) mission, Landsat Data Continuity Mission (LDCM)/Landsat 8, and the Global

Precipitation Measurement (GPM) mission were all executed within the original budget commitments made to stakeholders. The GAO in its 2014 report[2], "NASA: Assessments of Selected Large-Scale Projects" noted, "*The [NASA] total portfolio of major projects saw cost and schedule growth that remains low compared to GAO's first review of the portfolio.*"

In the case of the James Webb Space Telescope (JWST) which was rebaselined in 2011, the GAO stated in its 2014 report[3], "The James Webb Space Telescope (JWST) project is generally executing to its September 2011 revised cost and schedule baseline…." SMD will continue to rigorously maintain these practices to improve schedule and cost performance.

Over the past year the NASA OIG issued several reports and reviews focused on SMD activities, including SOFIA, the NEO program, ICESat-2, and the Mission Extension Process. In the context of these reports SMD has agreed to take corrective actions and appreciates the opportunity to make incremental improvements to its processes and programs.

3. Ensuring the Continued Efficacy of the Space Communications Networks

In 2006, NASA initiated the Space Communications and Navigation (SCaN) Program to create an integrated Agency-wide space communications and navigation architecture to assure continue efficacy of the Agency's space communication networks. The evolution of the integrated system will take place in phases through the SCaN Network Integrated Project which currently is in pre-phase A. The Near Earth Network, Space Network and Deep Space Network initially will remain independent. In the interim, SCaN is adding new capabilities that extend the functionality of the networks and will be incorporated into the integrated architecture.

The SCaN Program has been providing communications, navigation, and delivery of data to space flight missions for over 30 years of uninterrupted service. As the OIG noted the current satellite communications systems are aging and increasingly difficult to repair, thus SCaN has addressed these challenges through three separate activities that are all underway:

- Adding a new generation of communication satellites (the Tracking and Data Relay Satellites [TDRS] project) to the Space Network fleet;
- Upgrading Space Network ground infrastructure through Space Network Ground Segment Sustainment (SGSS) Project, and;
- Upgrading the deep space communication capability through Deep Space Aperture Enhancement Project (DAEP).

SCaN also manages NASA's Spectrum Management Program (SMP) and is deeply involved with other space-faring nations in this area. SMP ensures that all NASA activities comply

[2] "NASA: Assessments of Selected Large-Scale Projects" GAO-14-338SP: Published: Apr 15, 2014. Publicly Released: Apr 15, 2014.

[3] "James Webb Space Telescope: Project Meeting Commitments but Current Technical, Cost, and Schedule Challenges Could Affect Continued Progress" GAO-14-72: Published: Jan 8, 2014. Publicly Released: Jan 8, 2014.

with national and international laws applicable to the use of the electromagnetic spectrum. The program continues to address competing interests for use of the electromagnetic spectrum, including emerging commercial broadband services, to assure necessary spectrum resources are available for NASA missions.

SCaN manages the communication and navigation standards program to assure cross-utilization of both ground infrastructure and spacecraft between the U.S. and our partner nations.

Lastly, SCaN is focused on developing technology to raise the communication capability to the next plateau, that being optical communication. With the exceptional success of the recently completed Lunar Laser Communication Demonstration project, SCaN is well positioned to continue development toward an optical communication operational capability within a decade.

4. Overhauling NASA's Information Technology Governance

Continuing to improve Information Technology (IT) governance structure in response to the eight recommendations in the OIG's June 2013 report is an Office of the Chief Information Officer (OCIO) fiscal year 2015 priority. On December 6, 2013, the NASA Chief Information Officer (CIO) presented a Phase 2 IT Governance model decision package to the Mission Support Council (MSC). The MSC approved implementation of Phase 2 of IT Governance, providing the NASA CIO increased visibility into Center Institutional IT investment planning and execution beginning in FY2016. The implementation plan was presented to the MSC in March of 2014 and the NASA CIO participated in Center IT budget formulation activities for FY 2016. The IT governing board structure and charters, as well as Mission Directorate IT representative roles and responsibilities, will be updated as changes to the IT Governance structure are approved, based on findings from the initial FY2016 formulation activities. In January 2014, the NASA CIO hired an IT Governance Lead to facilitate management and implementation of related NASA IT Governance decisions and actions to help ensure a committed focus on strengthening NASA's IT governance model.

5. Ensuring the Security of NASA's Information Technology Systems

Advancing NASA's IT security posture in response to ever-growing threats and attack vectors remains a priority for the Agency, as demonstrated by increased funding for IT security efforts in FYs 2014-2016. NASA is taking a holistic approach, through continuous monitoring and mitigation, to network, system and information protection by overcoming barriers to ensure efficient and effective management of the Agency's IT assets. Many of these barriers include malicious software, unauthorized access to Agency's computers, and connectivity to partner organizations. To continue building a more solid IT security framework, NASA completed, or is in the process of implementing, several improvements, such as upgrading our intrusion detection systems. Also in FY 2014, we introduced the first intrusion prevention systems at the NASA Trusted Internet Connection (TIC) location (currently in its final stages of deployment). Additionally, the CIO is working across the Agency to reduce NASA's web footprint presence by eliminating unused and duplicative

web applications that increase our attack surface. Finally, we are enhancing our collaboration across Centers \ Mission areas and with external organizations. As budget allows, the Agency will continue to take corrective action to address the highest priority IT security needs and recommendations.

6. Managing NASA's Infrastructure and Facilities

NASA recognizes that managing its technically unique infrastructure is a top management challenge. NASA continues to implement its strategy to reduce and modernize its infrastructure within available and anticipated budget levels.

Eliminating Unneeded Facilities: NASA's demolition program has been active since 2004 and has provided consistent, dedicated funding to demolishing unneeded facilities. From 2012 through 2014 NASA demolished 209 facilities, eliminating almost 1.3 million square feet of unneeded facilities. In addition, NASA transferred or otherwise disposed of 442,000 square feet of unneeded facilities. NASA continues to work on the disposal of the Santa Susana Field Laboratory (SSFL), initiating building demolition this year. NASA has eliminated unneeded leased facilities, ending leases in Huntsville in 2013, and a leased facility in Los Angeles in 2014. NASA is completing a consolidation project at the Jet Propulsion Laboratory (JPL) so that NASA can terminate additional leased space in Los Angeles in 2015. NASA has incorporated Federal "Freeze the Footprint" requirements into its strategy to reduce unneeded infrastructure. In 2013, NASA reduced its office and warehouse space by 1.6 percent from the Agency's 2012 baseline. In 2014, NASA is on track to reduce its baseline well below the Agency's original plan.

Consolidation and Modernization: NASA is continuing its strategy of refurbishing, consolidating, and replacing key facilities within expected budget limits. NASA completed construction of several key replacement facilities such as the Central Communications Facility at Stennis Space Center (SSC), the Mission Integration Center and Logistics Facility at Glenn Research Center (GRC), the central office building at Marshall Space Flight Center (MSFC), and the Facility Support Center at Armstrong Flight Research Facility (AFRC). These facilities facilitate consolidation of functions and net reduction in facility square footage. Assessments of the facilities after construction confirm that the facilities operate with overall lower operating costs than the facilities they replaced. NASA completed construction of a central parking structure at JPL, allowing NASA to end its parking lease with the City of Pasadena and return the parking site to green space. Annual facility assessments estimate that NASA's deferred maintenance, which is an estimate of the essential but unfunded maintenance work necessary to bring all facilities up to normal operating standard, decreased 4.1 percent between 2011 and 2014. The assessment identified demolition and replacing major facilities as dominant factors in condition improvement and deferred maintenance reduction in parts of NASA's infrastructure.

Property Partnerships: NASA is partnering with the private sector and with other agencies to make underutilized NASA facilities available to others when the facilities can support U.S. aerospace initiatives. These partnering agreements defray some of the cost

of operating NASA's infrastructure. When Enhanced Use Leases (EUL) or National Historic Preservation Act Leases are used, proceeds from the leases are used to maintain, repair, and modernize NASA's infrastructure. NASA is in the process of revising its policy and guidance on public/private partnerships to capture best practices in developing these agreements.

Maintenance: Adequately maintaining facilities in the current constrained budget environment is a challenge. Rising utility, labor, and material costs put increasing pressures on level or decreasing facilities budgets. NASA has increased its focus on maintenance of facilities by reallocating resources to this critical activity. Additionally, ongoing efforts to reduce energy costs, demolish unneeded infrastructure, and renew and consolidate into fewer, more efficient facilities are helping to focus facility maintenance funds on maintenance of critical facilities. In an effort to improve savings, NASA's Centers are making small investments in remote monitoring of equipment to reduce the number of field inspections required. Proceeds from EULs support maintenance, repairs, and energy projects across the Agency. NASA is currently developing a lease agreement using the National Historic Preservation Act which will permit commercial use and operation of a historic property. Funds from this lease will be used for the restoration of the facility and support stewardship of other historic properties across the Agency.

Reducing Costs at the Independent Validation and Verification (IV&V) Facility: In response to the OIG's July 2014 audit, NASA is evaluating alternatives for reducing operating costs at the IV&V.

Technical Capabilities Assessments: NASA has established a disciplined approach to strategically perform an assessment of its technical capabilities, both workforce and assets. The objective of the Technical Capability Assessment Team (TCAT) effort is to establish a more efficient operating model for the Agency that maintains critical capabilities across NASA's Centers and meets current and future mission needs. This approach is enabling NASA leadership to make informed decisions on investing/divesting strategically within the budget, while strengthening innovation in critical areas needed to advance the Nation into the next half-century of achievement in aeronautics and space. NASA's TCAT assessment and decision process will take place predominantly in calendar year 2014, but full implementation of each decision could take multiple years, depending on the complexity of a particular decision. By the end of 2014, NASA will fully institutionalize the TCAT process, thus putting in place a long-term approach to Agency capability leadership.

NASA's Capability Leadership Model, once in place by the end of CY2014, will focus on four key areas, which will be reviewed annually for continued progress:

- Building a strong foundation to support all Agency near- and far-term missions
- Advancing capabilities to meet long-term needs
- Optimizing deployment of capabilities across all Centers
- Divesting in facilities and workforce skills that are no longer needed

Technical Capability Assessment Decisions To Date: NASA's MSC has made decisions on six technical capability decision packages, totaling over $800 million dollars in annual costs and over 2,300 persons in the workforce (Civil Service and contractor), including: Balloons, Microgravity Services, Aircraft Operations, Earth Science Research and Analysis, Life Sciences Research, and Human Factors. This has resulted in proposed reinvestment of an estimated annual savings of approximately $50 million towards Aeronautics, Science, and Human Exploration priorities depending on the implementation of the decision recommendations. Implementation actions will be tracked by the MSC. All decisions and options considered are posted internally on the TCAT Web site for employees and distributed to outside stakeholders.

Technical Capability Assessments Scheduled to Complete in CY 2014: The annual cost of technical capabilities currently being assessed and scheduled for completion by the end of CY2014 will be well over $2 billion annually with well over 6,000 in workforce, with significant opportunity for divestment and reinvestment in advancing technical capabilities.

Assessments and decisions that are underway and scheduled for completion by the end of CY2014:

- Mission Operations
- Nuclear Power/Propulsion
- Entry, Aerocapture, Aerobraking, Descent, and Landing
- Space Environments & Natural Environments Test
- Instrument & Sensors
- Propulsion
- Ascent Transportation – Vehicle
- Extra-Terrestrial (ET) Surface Systems (e.g., In Situ Resource Utilization [ISRU])
- Arrival Transportation – Acquisition, Rendezvous, & Docking
- Aerosciences
- Materials

7. Ensuring the Integrity of the Contracting and Grants Process and Proper Use of Space Act Agreements

NASA's Office of Procurement (OP) appreciates the investigative and audit work cited by the OIG and acknowledges the importance of this effort, particularly where fraud is uncovered and process improvements can be made.

NASA procurement is continuing to strengthen and improve contracting and grants processes throughout the Agency. For the areas specifically identified by the OIG we have revised the strategic sourcing plan and strategic sourcing governance structure. We have made significant strides in strengthening the contract and grants closeout processes and will be publishing guidance on this subject to establish standards for closeout. We have

strengthened training in the award fee process and believe NASA's approach to award fee is sound and compliant with the Federal Acquisition Regulation and statute. Finally, we are undertaking a significant effort to strengthen the management of grants through the implementation of the Office of Management and Budget's (OMB) Uniform Administrative Requirements for Federal Awards, which the OMB intends to publish by the end of the calendar year.

We appreciate the findings and recommendations articulated in the OIG's June 2014 report, "NASA's Use of Space Act Agreements" (IG-14-020), and continue to aggressively work towards the implementation of those recommendations through the corrective actions that we have embarked upon. We believe that these corrective actions, once completed, will improve NASA's overall management of Space Act Agreements (SAAs), as well as the underlying processes and procedures.

NASA has also taken other significant actions to improve increasing transparency, accountability, and oversight in regard to SAAs and other similar partnership agreements. For example, the Agency established a NASA Partnership Council (PC) in December 2013. The PC is chaired by the Deputy Administrator (currently chaired by the NASA Chief of Staff while the Deputy Administrator role is vacant) and is responsible for improving the Agency's partnership approval process, helping to ensure that Agency partnerships are aligned with internal and external guidance and policy, and adjudicating partnership issues that cannot be resolved at lower levels. Also, in February 2014, the Agency established a Partnership Office of Primary Responsibility (OPR) within the Mission Support Directorate. The Partnership OPR supports the PC and performs a central role for the Agency in regard to partnership guidance, operations, and advocacy/awareness functions, in coordination with other Agency stakeholder organizations.

APPENDIX B: NASA RECIPIENTS

Office of the Administrator

Administrator
Associate Administrator
Deputy Associate Administrator
Chief of Staff
Associate Deputy Administrator
Associate Deputy Administrator, Strategy and Policy Implementation
White House Liaison

Administrator Staff Offices

Chief Financial Officer
Chief Information Officer
Chief Engineer
Chief Health and Medical Officer
Chief Safety and Mission Assurance
Chief Scientist
Chief Technologist
General Counsel
Associate Administrator for Communications
Associate Administrator for Diversity and Equal Opportunity
Associate Administrator for Education
Associate Administrator for International and Interagency Relations
Associate Administrator for Legislative and Intergovernmental Affairs
Associate Administrator for Small Business Programs

Mission Directorates

Associate Administrator for Aeronautics Research Mission Directorate
Associate Administrator for Human Exploration and Operations Mission Directorate
Associate Administrator for Science Mission Directorate
Associate Administrator for Space Technology Mission Directorate
Associate Administrator for Mission Support Directorate
- Assistant Administrator for Human Capital Management
- Assistant Administrator for Procurement
- Assistant Administrator for Protective Services
- Assistant Administrator for Strategic Infrastructure
- Executive Director, Headquarters Operations
- Executive Director, NSSC
- Director, NASA Management Office
- Acting Director, Internal Controls and Management Systems

NASA Centers

Director, Ames Research Center
Director, Armstrong Flight Research Center
Director, Glenn Research Center
Director, Goddard Space Flight Center
Director, Jet Propulsion Laboratory
Director, Johnson Space Center
Director, Kennedy Space Center
Director, Langley Research Center
Director, Marshall Space Flight Center
Director, Stennis Space Center