NASA OFFICE OF INSPECTOR GENERAL

SUITE 8U37, 300 E ST SW
WASHINGTON, D.C. 20546-0001

November 5, 2015

TO: Charles F. Bolden, Jr.
Administrator

SUBJECT: *2015 Report on NASA's Top Management and Performance Challenges*

Dear Administrator Bolden,

As required by the Reports Consolidation Act of 2000, this memorandum provides our views of the top management and performance challenges facing NASA for inclusion in its fiscal year (FY) 2015 Agency Financial Report.

In deciding whether to identify an issue as a top challenge, we considered its significance in relation to the Agency's mission; its susceptibility to fraud, waste, and abuse; whether the underlying causes are systemic in nature; and the Agency's progress in addressing the challenge. We previously provided a draft copy of our views to NASA officials and considered all comments received when finalizing this report. Management comments can be found in Appendix A of the enclosure.

Looking to 2016, we identified the following as the top management and performance challenges facing NASA:

- Space Flight Operations in Low Earth Orbit: Managing the International Space Station and the Commercial Cargo and Crew Programs
- Positioning NASA for Deep Space Exploration: Developing the Space Launch System, Orion Capsule, and associated Ground Systems, and Mitigating Health and Performance Risks for Extended Human Missions
- Managing NASA's Science Portfolio
- Ensuring the Continued Efficacy of the Space Communications Networks
- Overhauling NASA's Information Technology Governance
- Securing NASA's Information Technology Systems and Data
- Managing NASA's Aging Infrastructure and Facilities
- Ensuring the Integrity of the Agency's Contracting and Grants Processes

During the coming year the NASA Office of Inspector General will conduct audit and investigative work that focuses on NASA's continuing efforts to meet these challenges. Please contact Jim Morrison, Assistant Inspector General for Audits, if you have any questions.

Sincerely,

Paul K. Martin
Inspector General

cc: Dava Newman
Deputy Administrator

Robert Lightfoot
Associate Administrator

Lesa Roe
Deputy Associate Administrator

Michael French
Chief of Staff

Enclosure – 1

NASA's Top Management and Performance Challenges, November 2015

NASA's ability to sustain its ambitious exploration, science, and aeronautics programs continues to 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, Space Launch System rocket and Orion capsule, James Webb Space Telescope, and the personnel and infrastructure associated with these and other projects.

In October 2015, NASA and the rest of the Federal Government began another fiscal year without a full-year appropriation. This uncertainty about funding levels, while inconvenient for some NASA programs, may be significantly disruptive to others – most prominently the Agency's efforts to use American corporations to transport astronauts to the International Space Station (ISS or Station) instead of paying the Russian space agency upwards of $75 million per person.[1] Accordingly, we believe the principal challenge facing NASA leaders in fiscal year (FY) 2016 will be to effectively manage the Agency's varied programs in an uncertain budget environment.

In addition to this overarching challenge, NASA managers face a myriad of project- and facility-specific challenges. This annual report provides the Office of Inspector General's (OIG) independent assessment of the top management and performance challenges facing the Agency, which we organize under the following topics:

- Space Flight Operations in Low Earth Orbit: Managing the International Space Station and the Commercial Cargo and Crew Programs
- Positioning NASA for Deep Space Exploration: Developing the Space Launch System, Orion Capsule, and associated Ground Systems, and Mitigating Health and Performance Risks for Extended Human Missions
- Managing NASA's Science Portfolio
- Ensuring the Continued Efficacy of the Space Communications Networks
- Overhauling NASA's Information Technology Governance
- Securing NASA's Information Technology Systems and Data
- Managing NASA's Aging Infrastructure and Facilities
- Ensuring the Integrity of the Agency's Contracting and Grants Processes

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.

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[1] The Office of Inspector General is conducting a follow-up audit examining the status of NASA's Commercial Crew Program and as part of that review will examine the effects of funding reductions on NASA's plans to begin commercial crew launches by late 2017.

Finally, the eight challenges described in this report track in most major respects to the seven challenges identified in our November 2014 report. For presentation purposes, we divided last year's challenge of "Managing NASA's Human Space Exploration Programs" into two separate challenges – crewed space flight in low Earth orbit and human exploration in deep space – to focus on the programs associated with each of these separate but related challenges.

Space Flight Operations in Low Earth Orbit – Managing the International Space Station and the Commercial Cargo and Crew Programs

NASA has been operating the ISS in low Earth orbit, an orbit with an altitude of less than 1,200 miles above the Earth, for more than 15 years and plans to extend Station operations until at least 2024.[2] Over the past decade, the Agency has entered into contracts worth billions of dollars with private companies to develop commercial transportation systems to supply the ISS with cargo and end U.S. dependency on Russia for crew transportation.

The International Space Station

The result of an international effort to build and operate a permanently crewed space station in low Earth orbit, the ISS is a unique technological achievement and a key part of NASA's plans to send humans to Mars. Specifically, the Agency utilizes the ISS as a research platform to study and develop countermeasures to mitigate a variety of risks associated with human travel and long-term habitation in space. In addition to NASA research, the Station serves as a laboratory for other Government agencies and private entities to conduct scientific research in fields such as health and medicine, robotics, manufacturing, and propulsion.

International Space Station

Source: NASA.

In August 2015, the Senate endorsed NASA's proposal to extend Station operations until at least 2024.[3] As NASA moves forward with this plan, it faces the challenge of ensuring a spacecraft originally designed and tested for a 15-year life span will continue to operate safely and economically for an additional 11 years. Moreover, as it prepares to send astronauts deeper into space for extended periods of time, NASA must continue to be strategic in how it utilizes the Station's limited research capabilities.

[2] NASA has asked The Boeing Company, the primary ISS support contractor, to examine the feasibility of extending Station operations until 2028.

[3] U.S. Commercial Space Launch Competitiveness Act, S1297 114th Congress, first session, August 4, 2015. As of October 2015, the House of Representatives had not passed similar legislation extending Station operations.

ISS Costs

The United States has invested almost $81 billion in the ISS over the last 22 years.[4] In FY 2015, NASA's annual cost to operate the Station – including for on-orbit vehicle operations, research, crew transportation, and cargo resupply missions – was almost $3 billion. The Agency projects this figure will increase to $4 billion by 2020. In May 2014, the U.S. House of Representatives Committee on Appropriations noted that "in order for the Station to remain a sustainable long-term program, NASA must continue to seek and implement cost savings measures with the goal of reducing the ISS operations budget or, at a minimum, slowing the growth in such budget."[5] However, several factors may make it difficult for NASA to accomplish this goal.

We believe the Agency's estimate that it will cost between $3 and $4 billion annually to operate the Station is based on overly optimistic assumptions, and that for a number of reasons costs are likely to be higher. By late 2017, NASA hopes to be sending astronauts to the Station in commercially provided transportation systems and therefore included the costs of these services in its estimate. NASA based that estimate on the cost of a Russian Soyuz seat in FY 2016 – $70.7 million per seat for a total cost of $283 million per mission for four astronauts.[6] However, the Program's independent Government cost estimates project significantly higher costs when NASA purchases flights from commercial companies rather than from Russia. Moreover, over the life of the Station the Agency's international partners – the European Space Agency, Canada, Japan, and Russia – have contributed to operations and shared associated expenses by providing astronauts, ground facilities, launch vehicles, and other items and services. While the Canadians and Russians have indicated they intend to continue their participation through 2024, as of September 2015 the Europeans and Japanese had not yet committed to Station operations beyond 2020. Should they decide not to participate, NASA and the remaining partners will likely face higher costs.

NASA also utilizes more than 30 contracts valued at approximately $39 billion to operate and maintain the ISS. This past year we examined whether NASA's contract administration and oversight processes are sufficient to avoid incurring unnecessary costs on these contracts.[7] We found that over the past several years, NASA has taken steps to control costs, including openly competing and eliminating requirements from some of these contracts, and that between FYs 2011 – 2015 the ISS Program reduced costs by $1.8 billion. However, given the unique operating environment of the ISS and the inherent challenge of operating with a flat operations and maintenance budget of $1.3 billion beginning in FY 2018, it is unclear to what extent the Agency's cost-reduction strategies will result in future cost savings.

ISS Research

A significant amount of research aboard the ISS is related to understanding and mitigating the health and performance risks associated with human space travel. NASA's Human Research Program is managing 25 such risks, and the Station is a suitable platform for conducting mitigation-related research for 23 of these risks. However, even with an extension of Station operations until 2024 NASA only

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[4] This figure includes $49.7 billion for construction and program costs through 2014 and $30.7 billion for 37 supporting Space Shuttle flights, the last in July 2011.

[5] H. Rep. No. 113-448, Commerce, Justice, Science, and Related Agencies Appropriations Bill, 113th Cong. (2014).

[6] NASA purchased additional Soyuz seats for astronaut transportation to the ISS through 2018, with returns in 2019. The total cost was $490 million at approximately $82 million for each of the six seats.

[7] NASA OIG, "Audit of NASA's Management of International Space Station Operations and Maintenance Contracts" (IG-15-021, July 15, 2015).

expects to have time to fully mitigate 11 of these risks. Although the Agency can use other research techniques such as ground-based analogs to develop risk-mitigation procedures, these methods do not provide the same advantages as an actual space environment. Accordingly, in a September 2014 report examining extension of the ISS we recommended NASA prioritize Station research to address the most important risks before Station operations end. NASA agreed and has taken responsive action.[8]

In August 2011, NASA signed a cooperative agreement with the Center for the Advancement of Science in Space (CASIS) to manage non-NASA research aboard the ISS. Pursuant to the agreement, NASA provides CASIS $15 million annually and the organization is expected to raise additional funds from private entities and encourage companies to self-fund research. Further progress on expanding ISS research depends on CASIS's ability to attract private funding and encourage companies and other organizations to conduct research. In an April 2015 assessment of the group's activities, the Government Accountability Office (GAO) reported that CASIS needs to establish better metrics for measuring program performance, including measurable targets.[9]

When we interviewed CASIS officials as part of our ISS extension audit, they told us that provisions in the agreement with NASA requiring researchers to assign patent licenses and data rights to the Government were deterring commercial stakeholders from conducting research on the ISS. To address this issue, NASA submitted proposed legislation to Congress in June 2013 that would allow researchers to retain "all rights in inventions made… during the conduct of [Station] activities." As of October 2015, the legislation has not moved forward.

While utilization of the ISS for research has increased over the past 6 years, several factors continue to pose limits to fully utilizing the Station. For example, until a seventh crew member is brought onboard NASA will not be in a position to maximize the amount of crew time dedicated to research on the Station.[10] Moreover, the crew will devote substantial time in 2016 to reconfiguring the ISS to accommodate the commercial vehicles NASA hopes will be ready to transport astronauts beginning in late 2017.

Another key factor to maximizing research on the Station is developing a U.S. capability to transport cargo and crew. For many years, NASA used the Space Shuttle to ferry astronauts and materials to the Station – first for construction and then for resupply. With the Shuttle's retirement in 2011, NASA has looked to a new model for transporting cargo and crew to low Earth orbit by working with U.S. corporations to develop privately-owned and operated transportation systems. Unlike with the Shuttle, NASA does not own these systems but rather purchases flights from the companies to carry NASA supplies and astronauts. We discuss the challenges associated with commercial transportation to the ISS below.

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

9 GAO, "International Space Station: Measurable Performance Targets and Documentation Needed to Better Assess Management of National Laboratory" (GAO-15-397, April 27, 2015).

10 Although the ISS is capable of supporting a seven-person crew, currently only six individuals can be on Station at one time to accommodate evacuation in case of an emergency. The Russian Soyuz capsule, currently the only vehicle transporting astronauts to the Station, has a three-person capacity and only two Soyuz capsules can be attached to the Station simultaneously.

Commercial Cargo Transportation

Between 2006 and 2008, NASA entered into a series of funded Space Act Agreements with Orbital Sciences Corporation (Orbital), Space Exploration Technologies Corporation (SpaceX), and other private companies to stimulate development of transportation systems capable of transporting cargo to the ISS. NASA selected two companies to ensure redundancy if one was unable to perform.[11]

In 2008, while development efforts were still underway, NASA awarded fixed-price contracts valued at $1.9 billion and $1.6 billion to Orbital and SpaceX, respectively, for a series of resupply missions to the ISS (Commercial Resupply Services or CRS-1 contracts). The contracted services include delivery of supplies and equipment (upmass) to the Station and, depending on the mission, return of equipment and experiments and disposal of waste (downmass) to Earth.[12] Since signing the initial agreements, NASA has extended SpaceX's contract into 2017 and issued task orders for three additional missions and Orbital's contract into 2018 and added three missions.[13] As of June 2015, Orbital had completed two cargo resupply missions and received $1.6 billion from NASA, while SpaceX had completed six resupply missions and received $1.4 billion.

Unfortunately, both companies have also experienced launch failures. In October 2014, Orbital's third delivery mission failed during lift-off, causing the vehicle to crash near the launch pad and destroying the company's Antares rocket and Cygnus spacecraft as well as all cargo aboard. The Virginia Commercial Space Flight Authority's launch pad and supporting facilities at NASA's Wallops Flight Facility on Virginia's Eastern Shore also sustained $15 million in damage. In the aftermath of the failure, Orbital suspended its cargo resupply missions until completion of an investigation and acceptance by NASA of the company's Return to Flight Plan.

Similarly, in June 2015, SpaceX's seventh resupply mission exploded shortly after takeoff from Cape Canaveral Air Force Station in Florida, resulting in a total loss of all cargo aboard. Like Orbital, SpaceX suspended resupply missions until completion of an investigation and acceptance by NASA of a Return to Flight Plan.

In a September 2015 report, we found Orbital's Return to Flight Plan contains technical and operational risks and may be difficult to execute as designed and on the timetable proposed.[14] First, Orbital will restart deliveries to the ISS initially by launching its capsule with an Atlas V rocket. Although the Atlas V has a strong flight record and is a suitable rocket for Orbital cargo deliveries, the company will be integrating its Cygnus capsule with the Atlas rocket for the first time. Second, Orbital must accelerate development of its modified Antares launch system, refitting it with new engines in order to meet its plans for two launches in 2016. This tight schedule does not include a test flight for the modified system and provides limited opportunities for qualification and certification testing. Third, although NASA has increased monitoring of Orbital's milestone plan and engine testing for the modified Antares, the

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[11] In addition, NASA barters with the Japan Aerospace Exploration Agency (JAXA) for cargo transportation on JAXA's H-II Transfer Vehicle and can place a small amount of upmass on the Russian space agency's Progress cargo vehicle. In the past, NASA sent cargo to the ISS on the European Space Agency's Automated Transfer Vehicle, which made its final delivery to the ISS in July 2014.

[12] The SpaceX capsule returns to Earth intact and therefore can carry experiments and other cargo back to Earth. In contrast, Orbital's capsule burns up upon reentry to Earth's atmosphere and therefore removes only waste from the Station.

[13] As a result of these additions, contract values increased to more than $2 billion for each company.

[14] NASA OIG, "NASA's Response to Orbital's October 2014 Launch Failure: Impacts on Commercial Resupply of the International Space Station" (IG-15-023, September 17, 2015).

Agency has not conducted detailed technical assessments of the modified system and the associated qualification testing results. Finally, we believe Orbital's plan to drop one of its five previously scheduled resupply flights and carry the promised cargo in four missions may disadvantage NASA by decreasing the Agency's flexibility in choosing the type and size of cargo the company transports to the ISS, particularly given that NASA officials said they will limit the cargo on the first return flight to non-essential items.

SpaceX's failed mission was carrying 2,393 kilograms (kg) of cargo, including 676 kg of crew supplies, 529 kg of science investigations, 526 kg of docking equipment, 461 kg of vehicle hardware, 166 kg of extravehicular activity equipment, and 35 kg of computer resources. Among the lost equipment was one of the adapters needed to dock the commercial spacecraft NASA hopes will begin transporting astronauts to the Station in late 2017 and replacement parts for the Station's water purification system. The company has formed an Accident Investigation Board pursuant to its commercial space launch license and NASA is conducting an independent investigation through its Launch Services Program. Initial reports from SpaceX suggest failure of a support strut in the second stage liquid oxygen tank as the cause. We are conducting a review of NASA's response to the SpaceX loss similar to our review of Orbital's October 2014 launch failure.

In addition to the Orbital and SpaceX failures, a Russian Progress cargo mission failed to reach the ISS in April 2015. According to NASA officials, despite three unsuccessful cargo resupply missions over 8 months, the ISS crew is in no immediate danger of running out of food or water. Current projections indicate that even without further resupply, food supplies on Station will be sufficient until January 2016 and water supplies until June 2016.

With the exception of a Japanese resupply mission in August 2015 that delivered 4.5 tons of cargo to the ISS, NASA must rely on the Russian Progress until Orbital and SpaceX restart their cargo resupply flights. However, Russian rockets have carried an average of only 65 kg per flight on their past six missions. Moreover, in our judgment the Orbital and SpaceX launch failures have affected research abroad the ISS in three ways: (1) a reduction in available crew time due to a temporary delay in returning the Station's crew complement to six, (2) the cost to regenerate the lost research, and (3) a delay in the return of experiments due to the suspension of flights by SpaceX, the only company using a capsule capable of returning experiments and other cargo to Earth from the Station.

NASA is currently evaluating proposals from commercial companies for CRS-2, the multi-billion dollar follow-on resupply contract the Agency is expected to award in November 2015. According to NASA officials, the contractors selected will perform cargo resupply missions beginning as early as 2018 and continuing through 2024.

Commercial Crew Transportation

Since retirement of the Space Shuttle, the United States has lacked a domestic capability to transport astronauts to the ISS. Instead, between 2012 and 2018 NASA will pay Russia $2.2 billion to ferry 30 NASA astronauts and international partners to and from the Station at prices ranging from $47 million to almost $82 million per round trip. To address this lack of U.S. capacity, NASA has provided approximately $2.8 billion in funding since 2010 to U.S. commercial space flight 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.

As with the Commercial Cargo Program, NASA worked with private companies – Sierra Nevada Corporation, SpaceX, and The Boeing Company (Boeing) – using a combination of funded Space Act Agreements and contracts to develop commercial crew transportation capabilities. A fourth company, Blue Origin, is conducting developmental work under an unfunded Space Act Agreement with the Agency.

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 space flight systems. 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 case of an emergency.

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 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.

In FY 2015, the Program received $805 million out of $848 million. Looking ahead to FY 2016, the NASA Administrator sent a letter to Congress in August 2015 attributing Program delays and the decision to pay Russia for six additional seats on upcoming Soyuz flights to funding shortfalls. He warned that failure to fund the Program at the requested levels could result in further delays.

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) space flight coordination issues with other Federal agencies.[15] Since that time, the Agency has made progress in these areas by publishing a Funded Space Act Agreement Best Practices Guide that includes guidance for cost estimating under those types of agreements, closely tracking deviations and waivers of requirements, and establishing a tri-agency Launch and Entry Steering group to better coordinate with other Federal agencies involved in commercial launches. NASA expects to complete the last of the corrective actions to respond to the recommendations in our report by late 2015. In May 2015, we began a follow-on audit examining whether the Commercial Crew Program is meeting its planned cost and schedule goals and how it is managing risks and certification requirements.

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

Positioning NASA for Deep Space Exploration: Developing the Space Launch System, Orion Capsule, and Associated Ground Systems, and Mitigating Health and Performance Risks for Extended Human Missions

NASA's long-term objective for its human exploration program is a crewed mission to Mars. To meet this challenging goal, the Agency must develop both more sophisticated rockets, capsules, and other hardware, and strategies to mitigate the risks posed by radiation and other space-born hazards that could prevent astronauts from performing their missions or affect their long-term health. In the short- to mid-term, successful development of the Space Launch System (SLS), the Orion Multi-Purpose Crew Vehicle (Orion), and related launch infrastructure while simultaneously addressing health and human performance risks to extended space flight are critical to helping achieve NASA's human exploration goals beyond low Earth orbit.

Developing the Space Launch System, Orion, and Related Ground Systems

Although the NASA Authorization Act of 2010 set a goal for NASA to achieve operational capability for the SLS and Orion by December 31, 2016, NASA will not meet this timetable.[16] Noting technical and funding uncertainties, NASA has adjusted its planning schedule to reflect an SLS launch readiness date of no later than November 2018, with the first crewed flight of Orion expected no later than 2023.

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 basing its design on requirements for the crew exploration vehicle that was part of NASA's predecessor Constellation Program.

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

Artist's Rendering of the Space Launch System

Source: NASA.

On December 5, 2014, Orion flew its first test flight, launching without a crew from Cape Canaveral Air Force Station on a Delta rocket. The mission successfully completed a 4-hour, two-orbit trip around Earth. In September 2015, NASA approved the Orion Program's progression from formulation to implementation for a crewed mission after completing a review known as Key Decision Point C (KDP-C). As part of that process, NASA committed to a launch readiness date for Orion of no later than April 2023, about 20 months later than had been planned. Based on the new target date, NASA expects to spend more than $11 billion to launch the first crew on Orion. The Agency noted that although the 2023 date represents NASA's readiness commitment, the Orion team will continue working toward the original launch date of 2021. In a 2013 report, we examined the Orion Program and are currently conducting a follow-up review evaluating NASA's management of the Program relative to achieving technical objectives, meeting milestones, and controlling costs.[17]

In addition to the SLS and Orion, NASA's Ground Systems Development and Operations Program (GSDO) is modifying launch infrastructure at Kennedy Space Center formerly used for the Space Shuttle, including 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. This past year, we issued a report on the status of GSDO's efforts.[18] We found that GSDO has made steady progress on the major equipment and facilities modernization initiatives needed to launch SLS and Orion, but significant technical and programmatic challenges remain to meet a November 2018 launch date. For the most part, these challenges originate from interdependencies between the GSDO, SLS, and Orion Programs. In short, GSDO cannot finalize and complete its requirements without substantial input from the other two Programs, but NASA is still finalizing the requirements for those Programs. Specifically, GSDO must overcome (1) a short timeframe for performing verification and validation testing between the Mobile Launcher, Vehicle Assembly Building, and Launch Pad 39B; (2) receipt of data and hardware regarding Orion later than planned; (3) the potential that integrated operations for the first test flight (Exploration Mission 1) may take longer than expected; and (4) most significantly, delays associated with development of command and control software. Given the criticality of the software, we are conducting a separate review examining NASA's management of GSDO's software development effort.

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[17] NASA OIG, "Status of NASA's Development of the Multi-Purpose Crew Vehicle (IG-13-022, August 15, 2013).

[18] NASA OIG, "NASA's Launch Support and Infrastructure Modernization: Assessment of the Ground Systems Needed to Launch SLS and Orion" (IG-15-012, March 18, 2015).

At the time of our GSDO audit, the program was scheduled to complete a significant development milestone known as Critical Design Review in March 2015, several months before SLS (May 2015) and Orion (August 2015). The purpose of the Critical Design Review is to demonstrate a project's design is sufficiently mature to proceed to full scale fabrication, assembly, integration, and testing and technical aspects are on track to meet performance requirements within identified cost and schedule constraints. In our judgment, given the many interdependencies between the Programs, a schedule that has GSDO completing Critical Design Review prior to the other two Programs increases the risk GSDO may experience schedule delays or be required to perform costly redesign work.

Finally, coordinating and integrating development of the three individual Programs to meet a common milestone date presents a challenge, particularly since NASA historically has used a single program structure to manage similar efforts such as Apollo and the Space Shuttle. In lieu of central management, NASA established a cross-program integration structure that designates leaders from each Program to coordinate and align the Programs' development schedules. It is too early to say whether these substantial coordination challenges will result in cost or schedule issues for the Exploration Mission 1 launch. Moreover, new issues are likely to be uncovered during integration – the point at which most projects encounter technical problems that impact cost and schedule. Given these challenges, coordination efforts among the GSDO, SLS, and Orion Programs are essential to successfully meeting NASA's human exploration goals on the schedule and at the funding levels promised.

In order to decrease the risk that the GSDO Program will experience cost increases or schedule delays, we recommended the Associate Administrator for Human Exploration and Operations reevaluate allowing GSDO to complete Critical Design Review before the SLS and Orion Programs. NASA management concurred with our recommendation and indicated it had changed the dates of the Programs' Critical Design Reviews so that the SLS and Orion reviews will precede the GSDO review. NASA should closely monitor the Programs to ensure any such risks identified during these reviews are mitigated so as to avoid significant cost increases or schedule delays.

Funding uncertainties continue to challenge the SLS and its associated Programs. For example, the Orion Program anticipates receiving a flat budget of approximately $1.1 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.[19] 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.

Mitigating Human Health and Performance Risks

Space flight is an inherently risky endeavor. Apart from the tremendous engineering challenges in launching and returning astronauts safely to Earth, humans living in space experience a range of physiological changes that can affect their ability to perform necessary mission functions and, in the longer term, lead to cancers, damaged vision, reduced bone strength, and other harm to their health and wellbeing. NASA has identified 30 human health and performance risks and two concerns associated with space travel, including behavioral health and performance, inadequate food and

[19] 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).

nutrition, space radiation, and vision impairments and intracranial pressure.[20] And, although NASA has developed mitigation strategies to reduce the impact of most of the risks associated with travel in low Earth orbit, its plans to send humans deeper into space for extended periods of time will expose astronauts to new and increased hazards. With respect to human travel, the deep space environment differs from low Earth orbit in several important respects: (1) it likely poses risks that have not yet been identified (unknown risks), (2) ways to mitigate many of the known risks have yet to be developed, and (3) humans will not be able to communicate with Earth in real-time or return to Earth quickly in case of emergency.

Astronaut Scott Kelly during his 1-year mission on the International Space Station

Source: NASA.

To further understand the risks to human health and performance associated with space travel, NASA and its partners are performing a variety of studies on Earth and on the ISS. For example, in March 2015 NASA launched astronaut Scott Kelly on the first 1-year U.S. mission to the ISS. NASA will compare health data taken from Scott Kelly with that of his twin brother and former astronaut, Mark Kelly, in the hope of advancing knowledge about the effects on the human body of longer duration habitation in space.

In October 2005, NASA established the Human Research Program at the Johnson Space Center to focus Agency research investment on investigating and mitigating the highest risks to astronaut health and performance. The Program conducts basic, applied, and operational research with the goal of increasing understanding of and developing countermeasures for 23 of the human health and performance risks and the two concerns NASA has identified. In 2014, the Program completed a detailed schedule, known as the Path to Risk Reduction, setting forth the rate by which it expects to complete development of countermeasures for the 23 risks assigned to it. In February 2015, the Program reported that the majority of risks for ISS missions up to a year in duration could be mitigated to an acceptable level. However, more than half of the risks for a 3-year planetary mission, such as a trip to Mars, remain unmitigated.

In an October 2015 audit, we examined NASA's efforts to manage the health and human performance risks posed by space exploration.[21] Although NASA continues to improve its process for identifying and managing health and human performance risks associated with space flight, we believe that given the current state of knowledge, NASA's risk mitigation schedule is optimistic and the Agency will not develop countermeasures for many deep space risks until the 2030s at the earliest. One of the major factors limiting more timely development of countermeasures is uncertainty about the mass, volume, and weight requirements of deep space vehicles and habitats. Moreover, even as NASA gains additional knowledge about those vehicles and habitats, and the effects of radiation and other space conditions on the human body, the Agency may be unable to develop countermeasures that will lower the risk to deep

[20] Concerns are issues the Agency has not yet accepted as risks.

[21] NASA OIG, "NASA's Efforts to Manage Health and Human Performance Risks for Space Exploration" (IG-16-003, October 29, 2015).

space travelers to a level commensurate with Agency standards for low Earth orbit missions. Accordingly, the astronauts chosen to make at least the initial forays into deep space may have to accept a higher level of risk than those on missions to the ISS. We also found that NASA cannot accurately report the true costs of developing countermeasures for the identified risks.

Furthermore, NASA's management of crew health risks could benefit from increased efforts to integrate expertise from all relevant disciplines. While many life science specialists attempt to utilize the range of available expertise both inside and outside the Agency, NASA lacks a clear path for maximizing expertise and data at both the organizational and Agency level. For example, NASA has no formalized requirements for integrating human health and research among life sciences subject matter experts nor does it maintain a centralized point of coordination to identify key integration points for human health. Moreover, integrating the experiences of NASA's engineering and safety efforts would benefit the outside life sciences community. The lack of a coordinated, integrated, and strategic approach may result in more time consuming and costly efforts to develop countermeasures to the numerous human health and performance risks associated with deep space missions.

According to NASA's Space Flight Human System Standards, the human system should be viewed as an integral part of overall vehicle design. In other words, the standards of the human system should be centrally incorporated into vehicle design, mission architecture, countermeasures, and research. Several senior Agency officials we met with noted that although NASA has traditionally and successfully operated with a vehicle-centered design focus, a shift to a more human-centered design is necessary for Mars and other exploration class missions. While Agency officials agreed that a shift in the Agency's focus is required, they offered little insight into how NASA would effectively utilize human-centered design for long-term decision making in mission planning and vehicle design. However, many Agency officials pointed to astronaut input in the configuration of the Orion capsule in areas such as seating placement and lighting options.

Long duration missions will likely expose crews to health and human performance risks for which NASA has limited effective countermeasures. Accordingly, for these missions NASA will have to determine the level of risk that is acceptable and clearly communicate the Agency's decisions to astronauts, Congress, and the public. Moreover, NASA needs to continue to explore whether its current health care model for astronauts is sufficient to meet both the long-term health needs of the astronaut community and the research needs of the Agency.

Managing NASA's Science Portfolio

With a relatively constant annual budget of approximately $5 billion since FY 2009, NASA's Science Mission Directorate (SMD) oversees more than 100 projects and programs in various phases of development and operation. However, throughout its history NASA has struggled with accurately estimating the amount of time and money required to complete these projects. The resulting cost and schedule overruns have, in turn, led to challenges in the project development process, diverted funding from other projects, and reduced the number and scope of projects the Agency can undertake. For example, in September 2011 NASA rebaselined the largest program in SMD's portfolio – 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. Consequently, in FY 2012 NASA moved $156 million from other SMD projects and the Cross Agency Support account to help cover the cost increases. In addition, several other missions including the Wide-Field Infrared Survey Telescope were postponed to make additional funding available for JWST.

Over the years, studies have identified several root causes for NASA's challenges in producing accurate cost and schedule estimates. In 2012, we conducted an extensive review examining NASA's project management practices in an effort to identify the primary challenges the Agency faces achieving its cost, schedule, and performance goals.[22] This review identified four factors that appear to present the greatest challenges to successful project outcomes at NASA: a culture of optimism; underestimating technical complexity; funding instability; and limited opportunities for project managers' development. NASA itself and other outside groups have pointed to these and additional factors such as inadequate risk assessments, inadequate reserves, and changes in project scope (design/content).

While some root causes are outside the Agency's control, NASA has developed tools to help improve the fidelity of its cost and schedule estimates. To this end, since 2006 NASA has incorporated progressively more sophisticated estimating techniques into Agency policy, culminating in 2009 with formal adoption of a Joint Cost and Schedule Confidence Level (JCL) requirement.

A JCL analysis generates a representation of the likelihood a project will achieve its objectives within budget and on time. The process uses software tools and models that combine cost, schedule, risk, and uncertainty to evaluate how expected threats and unexpected events affect a project's cost and schedule. To generate this data, project managers develop comprehensive project plans, inputs, and priorities that integrate costs, schedules, risks, and uncertainties. NASA officials contend that gathering this data encourages better communication among project personnel; improves cost, schedule, risk, and uncertainty analyses; and fosters an understanding of how project elements impact one another. Accordingly, a JCL analysis not only establishes the basis for proposing project and program budgets, but may improve project planning and provide stakeholders the rigor and documentation to better justify funding requests. Since 2009, NASA has completed a JCL analysis for 22 projects with a combined price tag of more than $49 billion.

We examined NASA's JCL process in a September 2015 audit report.[23] Based on our review of these 22 projects, it appears the JCL policy is having a positive impact on NASA's historical challenges with cost and schedule fidelity. That said, the process is relatively new, still evolving, and not a one-stop solution to solving all root causes of cost overruns and schedule delays. Specifically, the process has inherent limitations in that, like any estimating practice, it does not fully address the issue of predicting "unknown/unknowns" or address some of the root causes of NASA's project management challenges such as funding instability and underestimation of technical complexity.[24]

We also identified varied expectations and understandings among Agency stakeholders about the JCL process, ranging from those who see JCL as a multifunctional tool that can significantly improve cost and schedule management to others who view it as just another task projects must complete before moving into the development phase. There were also issues with the quality of some JCL cost, schedule, and risk data inputs for several of the projects we reviewed. In-depth assessments of 9 of the 22 projects revealed 5 projects that had significant weaknesses in project scheduling, risk assessment, and cost estimating. Remedying these weaknesses would improve the overall accuracy of JCL analyses.

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

[23] NASA OIG, "Audit of NASA's Joint Cost and Schedule Confidence Level Process" (IG-15-024, September 29, 2015).

[24] "Unknown/unknowns" are future situations that are impossible to predict.

Moreover, the effectiveness and consistency of the process NASA uses to review projects' JCL analyses could be improved. For example, the extent and type of review varied widely from project to project. We attributed this inconsistency to a lack of formal guidance, inadequate training for review board members, and inconsistent expectations among the review board chairs regarding how projects should consider and incorporate the results of board reviews. We also found training for project personnel could be improved.

As of August 2015, 10 of the 22 projects for which NASA performed a JCL analysis – all SMD projects – have launched.[25] As shown in Table 1, four of the projects came in under budget, one met its budget, and five exceeded their budgets.[26] However, only two of the overruns exceeded 10 percent.

Table 1: Projects with JCLs Completed That Have Launched

Project	Baseline Development Cost (millions of dollars)	Actual Development Cost (millions of dollars)	Percent Change
MSL[a]	$1,720	$1,769	3%
SOFIA[b]	1,118	1,120	0
MMS	857	877	2
LDCM	588	503	(14)
MAVEN	567	472	(17)
GPM[c]	519	484	(7)
SMAP	486	479	(1)
OCO-2[d]	249	329	32
LADEE	168	188	12
NuStar	110	116	6

Source: NASA OIG analysis.

[a] MSL development cost reflects project rebaseline after October 2009 launch date was missed. In 2006, NASA baselined development costs at $969 million.

[b] SOFIA development cost reflects the project's second rebaseline value. Historical development cost estimates are difficult for comparative purposes due to changing programmatic milestones. However, in 1997 NASA estimated costs for the project to reach its Operational Readiness Review of $265 million.

[c] GPM development cost reflects the project's rebaseline value. NASA descoped the project and set the initial baseline at $555 million with a launch date of July 2013. The Project was further descoped and rebaselined to launch in February 2014.

[d] OCO-2 baseline development cost reflects initial Agency Baseline Commitment, which for comparison purposes is analogous to the other projects listed in the table.

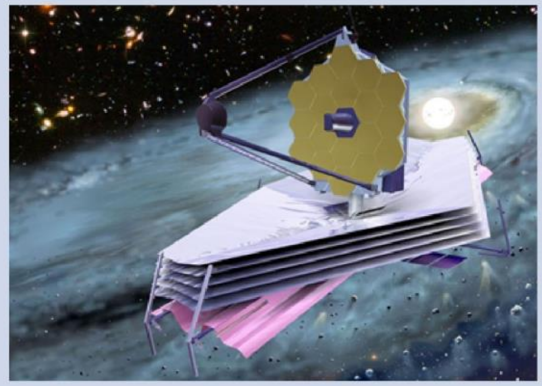
The JWST – the scientific successor to the Hubble Space Telescope – is SMD's largest and most expensive program and is expected to be the premier space-based observatory of the next decade when it is launched aboard an Ariane 5 launch vehicle provided by the European Space Agency in October 2018. The observatory is designed to help understand the origin of the first stars and galaxies in the universe, the evolution of stars, the formation of stellar systems, and the nature of celestial objects in our own solar system. JWST consists of a 25-square-meter mirror composed of 18 smaller mirrors, an

[25] The 10 projects are: Global Precipitation Measurement (GPM); Lunar Atmosphere and Dust Environment Explorer (LADEE); Landsat Data Continuity Mission (LDCM); Mars Atmosphere and Volatile EvolutioN (MAVEN); Magnetospheric Multiscale Mission (MMS); Mars Science Laboratory (MSL); Nuclear Spectroscopic Telescope Array (NuStar); Orbiting Carbon Observatory-2 (OCO-2); Soil Moisture Active Passive (SMAP); Stratospheric Observatory for Infrared Astronomy (SOFIA).

[26] The JCL analyses for MSL, SOFIA, and GPM were performed in connection with rebaselines rather than initial estimates.

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.[27]

Artist's Concept of James Webb Space Telescope



Source: NASA.

JWST has faced significant challenges meeting cost, schedule, and performance goals throughout its development life cycle. 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.

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.[28] 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.

Out of 48 milestones the JWST Program planned to complete in FY 2015, 44 were completed and 4 deferred to next year. This is an improvement over the previous year, which saw 11 of 36 tasks deferred to FY 2015. Significant accomplishments include integration of several instruments on the Integrated Science Instrument Module, which completed vibration, acoustics, and electromagnetic compatibility and electromagnetic interference testing; integration of major telescope structural components; and delivery of one of the five sunshield membrane layers from the manufacturer. Though not unanticipated, unexpected issues have arisen during integration and testing that require time and money to address. In particular, the cryo-cooler, a compressor designed to keep JWST's Mid-Infrared Instrument at its operating temperature of minus 267 Celsius, remains on the critical path.[29] However, the Program is maintaining funded schedule reserve above the established plan. In the next year, the

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

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

[29] The term "critical path" describes sequential tasks in a program's development schedule. Any significant slippage of tasks in the critical path would delay development efforts, launch date and most likely increase the project's cost.

Program plans to concentrate on completing the three main components of the observatory (instruments, telescope, spacecraft) and continue integration and testing of major components, which may reveal new challenges managers will have to address for the mission to successfully launch on time and within its current budget.

We will continue to monitor NASA's use of the JCL process as it manages ongoing science projects. In addition, we recently opened an audit examining NASA's management of its Earth Science mission portfolio to assess whether it is achieving established goals and priorities and meeting stakeholder needs.

Ensuring the Continued Efficacy of the Space Communications Network

NASA's satellites and other spacecraft are significantly more sophisticated than their predecessors, capable of acquiring huge amounts of data and employing rudimentary artificial intelligence to make autonomous decisions. However, even after decades of space flight one key requirement has not changed – spacecraft must be able to communicate with Earth to receive commands from human controllers and to return scientific data for study. To meet this need and provide communications, navigation, and transmission of scientific data to space flight missions NASA operates the Space Communications and Navigation (SCaN) Program.

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. 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 2016 budget of $632 million, the Near Earth, Space, and Deep Space Networks initially will remain independent. In the interim, SCaN is investigating different approaches to equipment commonality and adding new capabilities that extend the functionality of each Network. 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 each of the major aspects of the SCaN Program and in March 2015 issued the second audit in this series, which focused on NASA's Deep Space Network.[30] Established in 1963 to provide communications for NASA robotic missions operating outside of Earth orbit, the Network provides deep space missions with the tracking, telemetry, and command services required to control and maintain spacecraft and transmit science data. Although the Network primarily services NASA missions, it also

[30] NASA OIG, "NASA's Management of the Deep Space Network" (IG-15-013, March 26, 2015).

supports missions by the Agency's international partners and because of its importance, NASA has designated the Network as NASA Critical Infrastructure.[31] During FY 2015, the Deep Space Network supported more than 30 missions, including the flyby of Pluto by NASA's New Horizons mission.

To allow for continuous communication with spacecraft traveling through deep space, the Deep Space Network operates communications complexes in three locations: Goldstone, California; Madrid, Spain; and Canberra, Australia (see Figure 1), with one 70-meter antenna and multiple 34-meter antennas at each location for around-the-clock coverage. NASA pays operating costs for all three sites and has contracts with Spanish and Australian government entities to manage day-to-day operations for the foreign sites and with the Jet Propulsion Laboratory (JPL), a federally funded research and development center operated pursuant to contract by the California Institute of Technology, for the Goldstone site.

Figure 1: Locations of Primary Deep Space Network Communications Complexes

Source: NASA OIG representation of Deep Space Network information.

Much of the Deep Space Network's hardware is more than 30 years old, costly to maintain, and requires modernization and expansion to ensure continued service for existing and planned missions. Accordingly, in 2009 management proposed an upgrade project to build new antennas and transmitters between 2009 and 2025. Moreover, the Network has significant information technology (IT) and physical infrastructure components it must protect against compromise from cyber attack, espionage, and terrorism. To this end, the JPL, Madrid, and Canberra agreements require each contractor to follow specified Federal and NASA security policies.

[31] NASA Critical Infrastructure are operations, functions, physical assets, or information technology resources essential to the success of the Agency's mission. NASA considers the Deep Space Network Critical Infrastructure because of its high public visibility, importance to the accomplishment of NASA missions, high dollar value, and the difficulty of replacing the Network in a reasonable amount of time.

We found that although the Deep Space Network is meeting its current operational commitments, budget reductions have challenged the Network's ability to maintain these performance levels and threaten its future reliability. Specifically, in FY 2009 the Network implemented a plan to achieve $226.9 million in savings over 10 years and use most of those savings to build new antennas and transmitters. However, in FY 2013 the SCaN Program reduced the Network's budget by $101.3 million, causing management to delay upgrades, close antennas, and cancel or re-plan tasks. In addition, SCaN officials are considering additional reductions for the Network in FY 2016 that could further delay maintenance and upgrade tasks. Finally, despite these reductions the Network has not revised life-cycle cost estimates for the upgrade project or performed a detailed funding profile beyond FY 2018, making it difficult to effectively plan and justify funding for the project and the Network's future commitments. If budget reductions continue, the Network faces an increased risk that it will be unable to meet future operational commitments or complete the upgrade project on schedule.

We also found that NASA, JPL, and the Deep Space Network have significantly deviated from Federal and Agency policies, standards, and governance methodologies for the security of the Network's IT and physical infrastructure. For example, the Network's system security categorization process did not consider all Network mission functions, vulnerability identification, and mitigation practices and the IT security configuration baseline application did not comply with Federal and Agency policy. Further, required physical security controls were missing or inconsistently implemented at the three Complexes, procedures to assign security level designations did not comply with NASA policy, required facility security assessments had not been completed, and security waivers or other risk acceptance documentation were not consistently in place. As a result, the Network's IT and physical infrastructure may be unnecessarily vulnerable to compromise.

Finally, NASA has not required the Madrid contractor to provide detailed cost support for contract expenses on a timely basis or ensured the Defense Contract Audit Agency performs incurred cost audits of the Madrid and Canberra contracts on a routine basis. Consequently, NASA cannot ensure approximately $37 million in annual payments made to these contractors is allocable, allowable, and reasonable.

We made 12 recommendations, including that NASA develop a realistic, accurate, and transparent budget that supports the Network's ability to provide communication services; ensure the Network follows established IT security policies, standards, and governance methodologies; develop a strategy for implementing evolving IT and physical security policies at JPL through means that minimize time-consuming negotiation of formal contract modifications; ensure physical security requirements are implemented consistently across the Network Complexes; and improve oversight of the foreign contracts. Management concurred with our recommendations and described planned corrective actions. The Agency has completed corrective actions for three of the recommendations and continues to work to implement the recommendations related to improving IT and physical security.

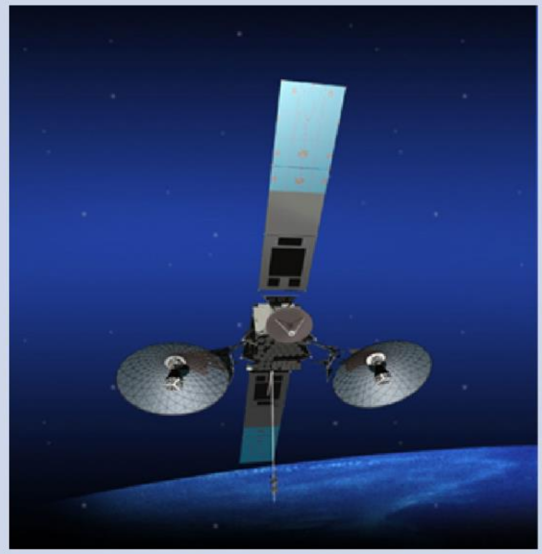
Issued in April 2014, our first SCaN audit focused on the Space Network.[32] In that report, we found key components of the Network were not meeting planned cost, schedule, and performance goals, and that taken together the delays and cost growth increased the risk the Network would be unable to continue to provide adequate communication services to NASA missions and its customers.

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

NASA is upgrading the Space Network through the Space Network Ground Segment Sustainment (SGSS) Project, with the goal of implementing a modern ground system that will enable delivery of high quality services while significantly reducing operations and maintenance costs. 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.

At the time of our audit, NASA's baseline commitment for the SGSS Project was $862 million and the scheduled completion date was June 2017. We found the Project could cost $329 million more than this commitment and the schedule for completion slip more than 18 months. Consistent with our finding, in June 2015 NASA's Agency Program Management Council approved a new agency baseline commitment of $1.2 billion and a Project completion date of September 2019.

Artist's Concept of Tracking and Data Relay Satellite



Source: NASA.

We also reported that because of budget reductions and the loss of other expected revenue, in FY 2016 the Space Network would 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 projected a $63 million budget shortfall in FY 2016 and even larger estimated shortfalls in subsequent years. However, as the Agency worked through the FY 2016 budget process, the Network received a budget that will allow it to meet its obligations. Finally, as we had reported in a prior audit, we found that NASA had 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.[33] The Agency has since updated the rate and put a policy in place to ensure periodic reviews of the rate.

We opened the third audit in our SCaN series in April 2015. In this audit, we are examining how NASA's Near Earth Network, which provides science missions in low Earth orbit with tracking, telemetry, and command services needed to control spacecraft and transmit data, is managing risks and adjusting capabilities to meet current and future requirements within its cost, schedule, and performance goals. The Network operates antennas and transmitters at four locations: Wallops Flight Facility, Virginia; White Sands Complex, New Mexico; Alaska Satellite Facility, Fairbanks, Alaska; and the U.S. McMurdo Antarctic Station. By 2017, the Near Earth Network will increase its capacity to support human space flight activities associated with the SLS and Orion Programs by operating new antennas in Florida. To meet increasing demand for communications services, the Network procures communications and navigation services from commercial communications providers. Specifically, the Network obtains

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

about half of its services using commercial providers for ground stations in Australia, Chile, Germany, Norway, South Africa, and Sweden, and it is not clear whether NASA's reliance on commercial providers is less expensive than using Government-owned services. At the same time, the Network's assets are aging, located in extreme environments, and require maintenance and modernization to ensure continued services for existing and planned missions. And, similar to our audit of the Deep Space Network, we believe that the Near Earth Network may face IT security risks.

We plan to complete our series of audits on the SCaN Program with a review of Spectrum Management and a capping report on the overall Program.

Overhauling NASA's Information Technology Governance

NASA spends more than $1.5 billion annually on a portfolio of 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.[34] 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 had limited visibility and control over a majority of the Agency's IT investments, operated in an organizational structure that marginalizes the authority of the position, and could not enforce security measures across NASA's computer networks. Moreover, the IT governance structure in place at the time was overly complex and did not function effectively. As a result, Agency managers tended to rely on informal relationships rather than formalized business processes when making IT-related decisions. While other Federal agencies were moving toward a centralized IT structure under which a senior manager has ultimate decision authority over IT budgets and resources, NASA continued to operate under a decentralized model that relegated 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.

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

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. In addition, IT Governance was the subject of the first Business Services Assessment under NASA's Technical Capabilities Assessment Team (TCAT) process.[35] The Assessment took nearly 7 months to complete and addressed many of the issues discussed in our report. For example, the Assessment reviewed the IT governance board framework including the relevancy, composition, and purpose of existing IT boards. The associated recommendations included creating a senior-level IT Council and eliminating the existing IT Management and Business Systems Management Boards. Agency officials have directed the CIO to develop an implementation plan to address the results of the Assessment. NASA anticipates completing corrective action to address all the recommendations in our report by January 2016. Within the next 18 months, we plan to open a follow-up audit to examine whether the changes the Agency implements have improved its IT governance process.

Securing NASA's Information Technology Systems and Data

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 3,413 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. From October 2013 through June 2015, NASA reported the following trends:

[35] TCAT was tasked with establishing a more efficient Agency operating model that maintains critical capabilities and meets current and future mission needs.

- Incidents related to unauthorized access have increased primarily due to lost and stolen equipment.
- Incidents related to installation of malicious software have declined; however, they continue to represent the largest type of incidents at the Agency. Phishing campaigns continue to be the most significant method of attack for incidents related to installation of malicious software.[36]
- Agency websites are constantly scanned to identify vulnerabilities and exploit weaknesses.

NASA manages approximately 1,200 publicly accessible web applications, or about half of all publicly accessible, nonmilitary Federal Government websites, to share scientific information with the public, collaborate with research partners, and provide Agency civil servant and contractor employees with remote access to NASA networks.[37] 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 June 2015, the Office of Personnel Management disclosed that it had been the target of a data breach targeting millions of sensitive civil servant and contractor personnel records. Federal officials described this as among the largest breaches of Government data in history. In light of this event and to further improve Federal cybersecurity, the Office of Management and Budget launched a 30-day Cybersecurity Sprint, requiring Federal agencies to patch critical vulnerabilities, tighten access for privileged users, and increase the use of multi-factor authentication. We plan to review the results of NASA's efforts in our next annual Federal Information Security Management Act (FISMA) evaluation. We also are planning to open audits examining security over NASA's information systems and critical infrastructure.

NASA must also ensure that its IT systems and associated components are regularly safeguarded, assessed, and monitored to protect against inevitable attacks on those systems. To assist in this effort, NASA completed a series of initiatives over the past 2 years 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.

While the completion of these initiatives improves NASA's security posture, as we have reported in our last four annual FISMA evaluations, NASA officials have not developed an Agency-wide risk management process specific to information security. Risk management is a comprehensive process that requires an organization to describe the environment in which risk-based decisions are made to access, respond to, and monitor risk over time. Ongoing monitoring is a critical part of an agency's risk management program.

[36] Phishing refers to the use of deceptive computer-based means to trick individuals into disclosing sensitive personal information. In a phishing attack, an attacker creates a website or e-mail that looks as if it is from a well-known organization like a credit card company or financial institution.

[37] 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.

Over the past 5 years, the OIG has issued 19 audit reports containing 75 recommendations designed to improve NASA's information security program. In a 2014 report, 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.[38] Reducing the Agency's extensive web "footprint" is one of the more effective ways NASA can reduce 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.[39] NASA developed an inventory of all publically available web applications maintained by NASA Headquarters and Centers and identified vulnerabilities through automated scanning coupled with manual testing. In addition, during the 15-month period ending March 2014, NASA reduced the number of its publicly accessible web applications by 15 percent.

While 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, the Agency's remaining 1,200 publicly accessible web applications continue to present a large target for hackers. NASA needs to close remaining security gaps, strengthen program oversight, and further reduce the number of publicly accessible web applications. To address security concerns over publicly accessible applications under development or in testing mode, NASA plans to deploy an enterprise web application firewall in May 2016.

In a review completed in 2014, we evaluated NASA's management of smartphones, tablets, cell phones, and AirCards.[40] 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 e-mail 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 e-mail. The Agency is still reviewing various technical tools and plans to complete corrective action in FY 2016.

In an August 2012 audit, we examined the effectiveness of NASA's Security Operations Center (SOC) in managing the Agency's computer security incident detection and handling program to prevent unauthorized cyber intrusions into Agency networks.[41] NASA consolidated its previously Center-based computer security incident detection and response programs into the SOC in November 2008 in an effort to improve its capability to detect and respond to evolving threats posed by increasingly sophisticated cyber-attacks. Located at Ames Research Center, the SOC provides centralized, continuous monitoring of computer network traffic entering and leaving NASA Centers and includes an information system for Agency-wide coordination, tracking, and reporting of IT security incidents. In general, we found that the SOC has improved NASA's computer security incident handling capability by providing continuous incident detection coverage for all NASA Centers. However, NASA still needs to improve overall SOC availability and plans to complete related corrective actions by September 2016.

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[38] NASA OIG, "Security of NASA's Publicly Accessible Web Applications" (IG-14-023, July 10, 2014).

[39] 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.

[40] 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.

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

In our March 2015 report on NASA's Deep Space Network, we found that NASA's SOC was not adequately integrated into JPL's computer network operations.[42] Although JPL is required to report computer security incidents on its network to the NASA SOC, we found NASA lacks the ability to verify the accuracy or completeness of JPL's reporting. Further, we found JPL has network connections that NASA is not monitoring because JPL and NASA have not come to an agreement on plans for comprehensive monitoring. As a result, NASA lacks the ability to monitor a large portion of JPL network traffic – which may be destined for or originate from Network associated components – for suspicious activity, provide timely assistance in the event of an incident, and ensure its information systems and data are fully protected. The Agency agreed to take action on our recommendation to ensure the NASA SOC has appropriate oversight at JPL to support NASA's Agency-wide incident management program by February 2016.

In addition to our audit work, the OIG expends substantial resources investigating IT security issues. OIG investigators have conducted more than 100 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, England, Italy, Nigeria, Portugal, Romania, and Turkey. In one notable example, an OIG investigation recently resulted in an Estonian national accused of directing an Internet fraud scheme pleading guilty to hacking-related charges associated with operating a sophisticated Internet fraud scheme that infected more than four million computers located in over 100 countries. The malware secretly altered the settings on infected computers, enabling the individual and others to digitally hijack Internet searches and re-route computers to specific websites and advertisements. In another case, OIG agents successfully investigated an insider threat involving a former contract employee who illegally accessed and attempted to destroy NASA systems.

Managing NASA's Aging Infrastructure and Facilities

NASA controls approximately 5,000 buildings and structures with an estimated replacement value of more than $35 billion, making the Agency among the larger Federal Government property holders. More than 80 percent of the Agency's facilities are 40 or more years old and thus beyond their design life. NASA strives to maintain these facilities in an efficient operational status, and when not operational, 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 2015 estimated its deferred maintenance costs at $2.3 billion.

The OIG has dedicated substantial resources over the last 5 years to examining NASA's infrastructure challenges.[43] This past year we added to this body of work with reports on Plum Brook Station and

[42] NASA OIG, "NASA's Management of the Deep Space Network" (IG-15-013, March 26, 2015).

[43] 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).

NASA's Pressure Vessel and Pressurized Systems Program.[44] As in our prior work, in both reports we found infrastructure that requires substantial resources to maintain and, in several instances, is significantly underutilized.

Plum Brook Station, located about 50 miles west of NASA's Glenn Research Center in Sandusky, Ohio, is home to several unique space-related test facilities, including the Space Power Facility (SPF), an environmental simulation chamber used to test hardware in a simulated space or planetary environment. However, a majority of Plum Brook's test facilities are underutilized and the level of use and funding they receive depends on whether individual NASA programs or external customers choose to perform testing there rather than at other NASA or private facilities. Over the past 10 years, Plum Brook has eliminated approximately 1.3 million square feet of buildings and structures from its property inventory. However, it continues to maintain several major testing facilities – most prominently the SPF and the Spacecraft Propulsion Research Facility (B-2), the world's largest thermal vacuum chamber that is also capable of testing rocket engines. Of these facilities, only the SPF has a full slate of testing planned over the next several years. In contrast, Plum Brook's Hypersonic Tunnel Facility and Cryogenic Components Laboratory have not been utilized for at least 4 years while a third facility – the Combined Effects Chamber designed for large-scale liquid hydrogen experiments – is unusable in its current condition. As of February 2015, NASA had not identified any customers for these three facilities. Moreover, although NASA's Solar Electric Propulsion Project plans to perform testing in the B-2 vacuum chamber in 2015, future utilization of the facility's rocket testing capabilities is uncertain. While NASA officials told us the B-2 could be used to test the SLS's upper stage rockets, such testing would require $15 million in basic refurbishment to the facility – costs the SLS Program or any other potential customer would be expected to cover in addition to potentially significant program-specific test costs.

To conduct its space and science operations, NASA uses a variety of pressure vessels and pressurized systems (PVS) such as storage tanks, cylinders, and piping that deliver compressed gas or liquid under significant pressure. Because of the nature of these gasses and liquids and how they are used, PVS may fail and cause harm to people, facilities, and the surrounding environment if not properly operated and maintained. NASA has experienced PVS failures in the past that resulted in loss of mission, injury, and property damage.

As of February 2015, NASA managed 10,109 active PVS and spent approximately $22 million annually to inspect and maintain these systems. Most PVS failures occur when a vessel or piping wall fails or ruptures because the internal pressure of the material inside exceeds the strength of the wall. Similar to the skin of a balloon that progressively grows thinner as inflated and weaker after multiple inflation-deflation cycles, over-pressurization or repeated pressurization and depressurization can gradually weaken the skin or walls of PVS, eventually leading to failure. Internal or external corrosion and physical damage (scratches, dings, and dents) can also increase the risk of PVS failure.

We found NASA Centers could benefit from stronger oversight and clarification of policies and procedures to ensure reliable operation of their PVS, which in turn could reduce risk to personnel and facilities. Specifically, NASA policy and standards for the management, operation, inspection, and maintenance of PVS are intentionally written at a fairly high level and do not contain specific guidance

[44] NASA OIG, "Audit of NASA's Requirements for Plum Brook Station" (IG-15-014, April 23, 2015); "Review of NASA's Pressure Vessels and Pressurized Systems Program" (IG-15-019, June 30, 2015).

regarding the application of national consensus codes and standards or the level of experience, education, and training sufficient to qualify an individual to serve as a Center Pressure Systems Manager. In addition, NASA's Office of Safety and Mission Assurance did not provide adequate oversight of Center PVS Programs.

We also found multiple issues of concern at each of the Centers we visited, including corrosion on a large number of PVS, inadequate inventory and property controls, and unclear assignment of Pressure Systems Manager roles and responsibilities. For example, at Langley Research Center we identified significant corrosion on high pressure piping and components, ground water penetration, and obstructed piping and systems in an underground utility corridor that contains high pressure steam piping, electrical conduit, and fiber optic communication lines (as shown in figure 2). If a rupture were to occur in this corridor, the resulting damage could cause power and communications outages that would impact Center operations. In our judgment, NASA's PVS Program could be improved by establishing clear lines of communication for resolving issues, implementing corrosion prevention and mitigation programs, and evaluating and providing the PVS Programs sufficient resources to meet Center mission goals and objectives.

Figure 2: High Pressure Lines in a Langley Research Center Utility Corridor

Source: NASA OIG.

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 assessment and 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 its infrastructure challenges may ultimately be insufficient to overcome the cultural and political obstacles that have impeded past efforts to reduce Agency infrastructure.[45] 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.

In 2014, NASA embarked on an effort to strategically address the technical capabilities required to support Agency goals. Referred to as the Technical Capabilities Assessment Team (TCAT) and championed by the NASA Associate Administrator, this effort aims to provide NASA leadership with the information needed to make informed decisions about investing and divesting to ensure the Agency has the right mix of people and assets to carry its mission forward. Personnel from all 10 NASA Centers and 4 Mission Directorates, as well as the senior managers responsible for executing the decisions, participated in the process.

As of September 2015, TCAT has assessed 18 technical capabilities, including Mission Operations and Propulsion, and issued 11 formal decisions. As a result of these decisions, the Agency has excessed some aircraft, eliminated internal microgravity flight operations, and updated several external and internal memorandums of agreement. Agency decision-makers are considering what additional actions to take based on TCAT's work.

We plan to open a review early in 2016 examining the impact of TCAT and the status of the Agency's other strategic infrastructure initiatives.

Ensuring the Integrity of the Contracting and Grants Processes

Approximately 74 percent of NASA's $17.6 billion FY 2014 budget was spent on contracts to procure goods and services, and the Agency awarded another $868 million in grants and cooperative agreements. Accordingly, NASA managers face the ongoing challenge of ensuring the Agency pays contractors in accordance with contract terms and receives fair value for its money, and that grants and cooperative agreements are administered appropriately and recipients are accomplishing stated goals. 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:

- The OIG and the Internal Revenue Service investigated the validity of consulting fees charged to a NASA contract. The investigation identified a tax evasion scheme whereby the Chief Executive Officer (CEO) of a NASA contractor used the consulting fees as a vehicle to avoid paying taxes on large portions of his personal income. Ultimately the CEO pled guilty to making false statements on a Federal income tax return, was sentenced to 3 years in Federal prison, and agreed to make $294,300 in restitution and pay $99,000 directly to NASA.

[45] NASA OIG, "NASA's Efforts to Reduce Unneeded Infrastructure and Facilities" (IG-13-008, February 12, 2013).

- The CEO of another NASA contractor agreed to pay $4.5 million to settle civil claims relating to his involvement in a fraudulent scheme whereby he created a front company to obtain contracts through the Small Business Administration's Section 8(a) Program. The Section 8(a) Program allows qualified small businesses to receive sole-source and competitive-bid contracts set aside for minority-owned and disadvantaged small businesses. The CEO was also criminally prosecuted for the scheme and received a 72-month prison sentence and ordered to forfeit $6.1 million.

Given NASA's continued reliance on contractors to provide essential services, the Agency will remain susceptible to contract fraud schemes at any stage of the procurement and acquisition process. Typical schemes involve collusion among bidders, employers, and contractors; corrupt payments in the form of bribes and kickbacks; bid manipulation; failure to meet contractual specifications; substitution of products or materials of lesser quality than specified in the contract; use of counterfeit, defective, or used parts in an attempt to increase profits or comply with contract time schedules; submission of false, inflated, or duplicated invoices; making false claims regarding a contractor's abilities or level of experience; establishing fictitious vendors; and conflicts of interest. Government-wide spending reductions may result in additional exposure to fraud, as fewer opportunities will undoubtedly result in enhanced competition among contractors and reduced top-line and bottom-line growth. Given its potential susceptibility, NASA must ensure proper controls are utilized to mitigate the risk of falling victim to contract fraud and must strive to proactively identify potential fraud that deprives the Agency of critically-needed funds that would otherwise be utilized to finance its initiatives.

The OIG's audit work during the past year illustrated that NASA has work to do to improve its multibillion dollar contracting and procurement operations. For example, NASA can improve its utilization of Blanket Purchase Agreements (BPA) which are a simplified method of acquiring goods and services and establish terms and conditions (including prices) between a Federal agency and vendors for commonly used goods and services. NASA uses two types of BPAs: General Services Administration (GSA) schedule agreements that incorporate the terms and conditions of an underlying GSA contract, and NASA-specific agreements to purchase items, such as copier paper, and services, such as engineering research support.[46] In FYs 2011 and 2012, NASA obligated more than $248 million through 5,529 BPA orders. In a December 2014 audit, we found that by not consistently seeking price reductions on orders, establishing single- rather than multiple-award agreements without appropriate justification, and failing to perform required annual reviews to ensure established BPAs still represent the best value to the Government, NASA contracting officials failed to maximize competition and missed potential cost savings.[47] We also found deficiencies in NASA's use of GSA schedule agreements and NASA-specific agreements issued by Goddard Space Flight Center's Advanced Manufacturing Branch. In our judgment, the Branch missed opportunities to obtain lower costs by not seeking greater competition.

We also continue to work with NASA to improve the Agency's practices relating to cost-type contracts. More than half of the $15.6 billion NASA spent in FY 2013 acquiring goods and services was associated with cost-type contracts pursuant to which NASA reimburses contractors for allowable costs they incur producing or delivering the contracted goods or service. Cost-type contracts pose a financial risk to NASA because they do not promise delivery of a good or service at a set price.

[46] GSA schedule BPAs follow procedures defined by Federal Acquisition Regulation Subpart 8.4, "Federal Supply Schedules," and NASA-specific BPAs follow Part 13, "Simplified Acquisition Procedures."

[47] NASA OIG, "NASA's Use of Blanket Purchase Agreements," (IG-15-009, December 16, 2014).

To mitigate the risk involved with the use of cost-type contracts, Federal regulation requires contractors to submit annual cost data – commonly referred to as an incurred cost proposal – for review and potential audit. Audits of incurred cost proposals assess whether costs contractors charge the Government are properly applied to the contracts, sufficiently supported, and allowable. NASA generally has 6 years to recover any unallowable costs from the date an adequate incurred cost proposal is submitted. The Defense Contract Audit Agency (DCAA) performs incurred cost audits for NASA under a reimbursable agreement and estimates it has a 6-year backlog of more than 19,000 proposals awaiting review, including 1,153 proposals related to NASA contracts, about 39 percent of which predate 2009. In an effort to reduce this backlog, in 2012 DCAA changed its methodology for determining which proposals to select for incurred cost audits.

In an audit issued in December 2014, we found NASA is at increased risk of paying unallocable, unallowable, and unreasonable incurred costs and of losing the opportunity to recoup improper costs because Agency contracting officers rely too heavily on DCAA's incurred cost audit process.[48] Under its new, risk-based methodology, DCAA has significantly decreased the number of contractor proposals it audits in an effort to reduce its 6-year backlog of incurred cost proposals awaiting review. However, NASA contracting officers generally wait for a DCAA audit and do not perform additional oversight to ensure the appropriateness of contractor costs. Meanwhile, the Agency has not strengthened its internal controls to account for the significant reduction in DCAA oversight of Agency cost-type contracts. In addition, NASA's reliance on DCAA is inhibiting the Agency's efforts to timely close out awards, which further delays the identification of questionable costs and limits availability of excess funds for other uses.

Moreover, similar to findings in several previous audits our work this year found instances in which final award-fee scores and payments were not supported by the written evaluations. For example, in our audit of ISS contracts we identified a contract for which the award-fee evaluations did not support the overall award-fee scores.[49] Specifically, in two consecutive award-fee periods the written performance evaluation stated, "Contractor performance did not meet expectations in the Cost Control Factor"; rated the Factor as a "significant weakness" due, in part, to a significant cost overrun; and noted, "There were no strengths identified in this area." Nevertheless, the contractor received a rating of "satisfactory" for the Cost Control Factor in both performance periods. Overall, we questioned between $500,000 and $700,000 of award-fee payments made on ISS contracts between October 2012 and February 2014.

NASA also faces the ongoing challenge of ensuring the grant and cooperative agreement 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 examine NASA's management of grants and cooperative agreements. In one review, NASA awarded cooperative agreements worth a combined $8.08 million to the Wise County Clerk of Circuit Court (Wise County) in Wise, Virginia, in 2008 and 2014 to support the Agency's DEVELOP National Program. DEVELOP is a capacity building program that seeks to address environmental management and public policy issues through interdisciplinary research projects that apply NASA Earth observations to community concerns around the globe. DEVELOP

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48 NASA OIG, "Costs Incurred on NASA's Cost-Type Contracts," (IG-15-010, December 17, 2014).

49 NASA OIG, "Audit of NASA's Management of International Space Station Operations and Maintenance Contracts," (IG-15-021, July 15, 2015).

participants conduct applied science research projects under the guidance of science advisors from NASA and partner organizations. Projects funded through the Wise County agreements include a study of the weather in southwest Virginia, an aerosol climatology project, and using data obtained by NASA's Gravity Recovery and Climate Experiment Mission to help water managers in North Africa measure ground water storage.

Although Wise County satisfied the overall performance goals and objectives of its cooperative agreements with NASA, we identified substantial deficiencies in the County's management of award funds that caused us to question the total amount of the awards.[50] Specifically, for the 2008 cooperative agreement, Wise County improperly combined cooperative agreement revenues and expenditures with those relating to other County business in its accounting records. As a result, the County's accounting system could not identify transactions by award, impairing the audit trail required to ensure the County spent cooperative agreement funds appropriately. In addition, the County failed to disclose in required financial reports unexpended funds and improperly retained and used those funds to pay for activities carried out pursuant to subsequent agreements. Moreover, we identified $65,446 in unallocable, unallowable, or unsupported expenses, including tuition payments for courses not related to DEVELOP and extermination fees. We also found $165,325 in award funds Wise County spent outside approved budget periods. Further, without prior NASA approval, Wise County reprogrammed $540,000 of the 2014 award budget for program support purposes, reducing the amount of funds available for actual research projects.

In another example, NASA procurement officials awarded a 1-year cooperative agreement valued at $1.4 million to the City of New Orleans in September 2011 to provide fire protection services to the Michoud Assembly Facility (Michoud). NASA subsequently modified the agreement, increasing its value to $2.1 million and extending the period of performance through March 31, 2013. In April 2013, NASA and the City entered into an interagency agreement valued at $8.5 million for fire protection services through March 31, 2018. Our review of the cooperative agreement awarded to the City of New Orleans found that NASA did not have an adequate system of controls in place to ensure proper administration of the cooperative agreement for fire protection services at Michoud.[51] The City received approval from NASA to bill for services using the costs set forth in its proposed award budget, which were calculated using the highest rate of pay for positions at the Michoud Fire Station with an additional 15 percent indirect cost rate. An analysis comparing the actual payroll costs for the personnel who staffed the Fire Station with the quarterly invoiced amount determined that the Agency had overpaid the City by $185,621 for the period January 17, 2012, through April 16, 2012. Subsequent analysis found that NASA had overpaid the City by as much as $1.07 million over the six quarters invoiced under the cooperative agreement.

NASA also did not verify that the City of New Orleans performed required tests and inspections or consistently staffed the Michoud Fire Station with the number of personnel specified in the cooperative agreement. Without establishing and implementing oversight procedures and adequately documenting the City's performance, NASA had little assurance that the objectives of the cooperative agreement were accomplished.

[50] NASA OIG, "Audit of NASA's Cooperative Agreements Awarded to Wise County Circuit Court," (IG-15-022, July 16, 2015).

[51] NASA OIG, "Audit of NASA's Cooperative Agreement Awarded to the City of New Orleans," (IG-15-018, June 29, 2015).

Over the past 5 years, the OIG has conducted 41 grant fraud investigations resulting in 5 indictments, 7 prosecutions, $967,000 in recoveries, and $22.9 million in civil settlements. For example, an ongoing investigation determined a university in West Virginia billed administrative costs as direct costs, charged costs that were not allowable, and misused Federal funds and property acquired with Federal funds. The university has agreed to a $2.3 million civil settlement.

Given the large sums of money at stake, we intend to continue to monitor NASA's administration of its contracts, grants, and cooperative agreement awards as we work with the Agency to develop solutions to address the deficiencies identified in our reports.

Appendix A: Management Comments

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

October 28, 2015

TO: Inspector General

FROM: Administrator

SUBJECT: Agency Response to Office of Inspector General Memorandum "NASA's 2015 Top Management and Performance Challenges"

Thank you for the opportunity to review and comment on "NASA's 2015 Top Management and Performance Challenges." This product, along with those issued in conjunction with the audits and investigations conducted by your office, provides valuable perspective into, and insight and oversight of the programs, projects, and activities that NASA is entrusted to execute. The senior leadership and I appreciate and recognize the efforts of your office as a key partner in driving efficiency and effectiveness across NASA's wide-ranging, ambitious, and challenging portfolio.

While the challenges outlined in this year's memorandum are closely aligned with those highlighted in 2014, I am pleased to note that you no longer report Space Act Agreements as an element of the contracting and grants challenge. I believe this small but important step is an indication of NASA's commitment to addressing the top management and performance challenges facing the Agency.

Please find as an enclosure, NASA's response to the one overarching and eight specific challenges articulated in your 2015 Top Management and Performance Challenges memorandum.

If you have any questions regarding NASA's response to the 2015 Top Management and Performance Challenges, please contact Paul Roberts on (202) 358-2260.

Charles F. Bolden, Jr.

Enclosure

MANAGEMENT'S RESPONSE
TO THE OFFICE OF INSPECTOR GENERAL'S MEMORANDUM ON
"NASA's 2015 TOP MANAGEMENT AND PERFORMANCE CHALLENGES"

Overarching Challenge:

Effective Management of NASA's Varied Programs in an Uncertain Budget Environment

NASA shares the OIG's concerns about the challenges that come with managing our programs in an uncertain budget environment. As the OIG notes, several of NASA's largest development programs have acquisition strategies that are highly sensitive to fluctuations in funding from year to year. Given the lack of additional available funding, and to be effective stewards of taxpayer dollars, it is imperative that programs and projects be delivered within their cost and schedule baselines. We believe the steps NASA has taken in response to the recommendations from the OIG, as outlined in this letter, are important components of that work.

In addition, NASA has implemented significant changes over the past several years to improve the fidelity of our cost estimates when a project is confirmed at Key Decision Point (KDP)-C and to provide surveillance of contractor performance through improved Earned Value Management (EVM) capabilities. In addition to responding to the OIG's recommendations with regards to our Joint Cost and Schedule Confidence Level (JCL) capabilities, we have also made significant progress over the past year implementing recommendations issued by the Government Accountability Office (GAO) in their 2012 report[1] on EVM. I am pleased to report that based on specific actions taken by NASA with respect to these recommendations, the GAO closed all remaining recommendations in September 2015.

Specific Management and Performance Challenges:

Space Flight Operations in Low Earth Orbit: Managing the International Space Station and the Commercial Cargo and Crew Programs

The International Space Station: 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. In August, the U.S. Senate passed the Commercial Space Launch Competitiveness Bill by unanimous consent. Among the issues dealt with in this bill related to commercial space launch, it extends operation of the ISS to 2024. However, the House and Senate versions are different and remain to be reconciled before final passage an enactment. ISS extension to 2024 allows NASA to continue to make progress toward the goals of the ISS, specifically: 1) extending human spaceflight beyond low-Earth orbit (LEO); 2) enabling the development of the commercial market in LEO; 3) conducting research to benefit humanity in areas such as medicine, physical and life sciences, and Earth and space sciences; and 4) providing the basis for exploration international partnerships. Of the ISS International Partners, the U.S., Russian, and

[1] GAO Report: "NASA: Earned Value Management Implementation across Major Spaceflight Projects Is Uneven" (GAO-13-22; November 19, 2012)

Enclosure

Canadian space agencies have committed to supporting the ISS until at least 2024, and the Japanese and European Space Agencies are moving toward the same commitment.

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.

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 and has now filled its 50 percent allocation of National Laboratory resources on the ISS.

As of 2015, CASIS is utilizing its 50 percent of the ISS resources dedicated to the National Lab and has filled the pipeline with a wide variety of commercial and other Government agency projects. Regarding metrics, it has always been NASA's intent to implement target metrics once CASIS has developed enough of a track record to make the targets not only effective but also reasonable. FY 2016 marks the beginning of CASIS's fourth year at full staffing level, so it is a reasonable time to begin agreeing to targets with CASIS.

Commercial Cargo Transportation: Despite the launch failures of both Orbital-ATK and SpaceX in the past year, the ISS remains well supplied with both consumables and research, thanks to a robust provisioning strategy. With the successful launch of the Japanese HTV-5 in August 2015, supplies onboard the ISS are in excellent shape to reach return-to-flight of both CRS companies. Orbital-ATK has procured two Atlas V launch vehicles that will fly two enhanced Cygnus missions prior to resuming flights on the upgraded Antares rocket, scheduled for June 2016. Both Orbital-ATK and NASA have completed investigations into the October 2014 failure, and Orbital-ATK has a plan in place to resume launches from Wallops Flight Facility with its new Antares launch vehicle configuration. While SpaceX's failure report is not yet complete, they have indicated that they are nearing being able to return to flight. Both CRS companies should be delivering cargo in the next few months, as well as disposing of trash and returning vital science results to Earth.

The ISS program is currently in the process of procuring additional 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. Contracted commercial crew costs have already been incorporated into the ISS FY 2016 President's Budget request.

Commercial Crew Transportation: NASA has largely addressed the four challenges identified by the OIG regarding the Commercial Crew Program. "Unstable Funding" is, and will continue to be, an ongoing challenge mostly outside of NASA's control. NASA believes that it has addressed the remaining three commercial crew challenges. Also, the Agency looks forward to continuing to work with the OIG during the new audit initiated earlier this year.

Positioning NASA for Deep Space Exploration: Developing the Space Launch System, Orion Capsule, and Associated Ground Systems, and Mitigating Health and Performance Risks for Extended Human Missions

Developing the Space Launch System, Orion Capsule, and Associated Ground Systems: Exploration Systems Development (ESD) continues to make steady and sustained progress in preparing the Orion crew vehicle, the Space Launch System (SLS), and Exploration Ground Systems (EGS) to support deep space exploration. NASA recognizes the challenges of pursuing concurrent development of these three foundational programs. Therefore, and in addition to the comprehensive and rigorously reviewed development activities at the program level, ESD has made technical and programmatic integration a top focus for the enterprise. At the program level, all three programs have reached the level of technical and programmatic maturity needed to establish their Agency Baseline Commitments. These commitments were made based on the programs' demonstrated progress to date, including the successful test flight of Orion, SLS hardware, and GSDO systems and processes on Exploration Flight Test 1 (EFT-1) in December 2014; successful testing of the booster and engine that will power SLS on its maiden flight on Exploration Mission 1 (EM-1); and modernization of facilities at Launch Complex 39 (LC-39) at the Kennedy Space Center. These and many other hardware and testing milestones validated the designs, plans, and processes that were reviewed during the programs' preliminary design reviews. A single Standing Review Board (SRB) provided an independent Agency assessment during these reviews, and the same SRB also supported the enterprise-level integrated review that looked specifically at all technical and cross-program related issues. At both the program and integrated reviews, though forward work requiring attention was noted in a number of areas, the SRB validated the overall program and enterprise approach to both program-level and cross-program integration and noted that the process continues to mature.

In addition to the review work by the programs, enterprise, and SRB (and noting the leveraging of the capabilities of the NASA Engineering and Safety Center and Independent Verification and Validation [IV&V] Center on an issue-by-issue basis), the GAO and OIG have conducted over thirteen focused audits of ESD programs, after which nearly all recommendations were concurred upon and either have already been or will be implemented at the appropriate time. Integration will continue to be a primary focus across the enterprise, both near term, as the three programs complete their critical design reviews (SLS in July 2015; Orion in September 2015; and EGS in December 2015) and the enterprise-wide integration review in 2016, and long term, through preparation for integrated testing, integration, and operations leading to first flight on EM-1 and beyond. Funding instability and uncertainty (both in terms of total dollars and timing of full-year appropriations) remains a critical challenge to success, resulting in limited options to accelerate or modify our development approach. In summary, challenges remain as Orion and SLS begin large-scale hardware production and testing, and preparation continues for integration at KSC. However, based on substantial and independent review of all aspects of enterprise operations, NASA is confident that the proper designs and processes are in place to overcome these challenges, and that SLS, Orion, and EGS will form the core of the Agency's exploration capability for decades to come.

Mitigating Health and Performance Risks for Extended Human Missions: The successful mitigation of human system risks for space flight is essential for NASA to conduct long duration space missions in and beyond LEO. This mitigation approach requires the integration of human health and performance, engineering, mission management and policy disciplines to enable the safe conduct of human space flight missions and the protection of the long-term health of astronauts. The Human Exploration and Operations Mission Directorate (HEOMD), Office of the Chief Health and Medical Officer (OCHMO), and the Human Health and Performance Directorate (HHPD) at the Johnson Space Center (JSC) have worked diligently for the past decade to achieve an integrated approach to human health in space that incorporates the human system into spacecraft design and operations, following an occupational health model, as recommended by the National Academies of Science, Engineering, and Medicine. The Health and Medical Technical Authority has promulgated health standards and evidenced-based risk management, which address integrated space health risks that drive spacecraft design as well as the Human Research Program's (HRP) research and development (R&D) priorities and investments.

Ensuring the Continued Efficacy of the Space Communications Networks

NASA's Space Communications and Navigation (SCaN) Program enters its tenth year focused on its mission of creating the integrated Agency-wide space communications and navigation architecture necessary to assure continued efficacy of the Agency's space communication networks. As NASA's missions require larger and larger amounts of data delivered reliably and accurately, SCaN continues its evolution of the integrated system. The SCaN Network Integrated Project is currently in pre-phase A, working towards full integration of all three networks. The Near Earth Network (NEN), Space Network (SN) and Deep Space Network (DSN) 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.

During FY 2016, SCaN will continue addressing the critical challenges that must be met in order to meet NASA's requirements for space communications and navigation necessary for the success of all space missions, specifically:

- Completing 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 the Space Network Ground Segment Sustainment (SGSS) Project.
- Upgrading the deep space communication capability through the Deep Space Aperture Enhancement Project (DAEP).

To address these issues in FY 2015, SCaN accomplished the following:

- TDRS-L transitioned into full operations as part of the Tracking and Data Relay Satellite System.
- The NEN AS-3 11-meter antenna entered operations at the University of Alaska Fairbanks Station.
- The first DAEP antenna, DSS-35, also entered operations.

SCaN will continue to address these challenges in FY16, with the addition of the following:

- Upgrading NASA NEN ground antenna capabilities.
- Completion of development of the TDRS-M satellite, and storage pending availability of a launch vehicle.

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 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 commercial broadband services, to assure necessary spectrum resources are available for NASA missions. In early FY 2016, SCaN's SMP will participate in the State Department-led U.S. delegation to the International Telecommunication Union's World Radio Communication Conference to negotiate the critical radiofrequency spectrum for NASA's missions.

SCaN is responsible for coordinating between the U.S. and our international partners on the communication and navigation standards to assure cross-utilization of both ground infrastructure and spacecraft. This includes the critical issue of the development of optical communication standards, which represents a paradigm shift in space communications. Optical communication will make possible the transmission of a vastly increased amount of data, including video images, which will change how scientific data is managed and studied. SCaN continues to collaborate within NASA and with external partners on the development of this exciting new technology. The Laser Communication Relay Demonstration mission is now slated to launch in 2017.

Managing NASA's Science Portfolio

The Science Mission Directorate (SMD) develops and implements an extensive portfolio of scientific projects and programs that are inherently complex and present unique challenges. Still SMD continues to develop and implement the cutting-edge missions necessary to advance science and produce the incredible discoveries for which NASA has long been recognized.

The *2010 Science Plan for NASA's Science Mission Directorate* outlined the Agency's efforts to revise and implement new policies to constrain mission costs and meet schedule goals. One of these measures included "Establishing confidence level-based mission life cycle budgets" – the Joint Cost and Schedule Confidence Level (JCL) requirement. As the recent OIG report[2] on the

[2] NASA OIG Report, "Audit of Joint Cost and Schedule Confidence Level Process" (IG-15-024; September 29, 2015)

JCL process pointed out, the JCL policy is having a positive impact on NASA's historical challenges with cost and schedule fidelity.

NASA agrees with the OIG's observation that "the JCL policy is having a positive impact on NASA's historical challenges with cost and schedule fidelity" and recognizes that JCL is not a one-stop solution for addressing all cost and schedule challenges. NASA is undertaking numerous efforts aimed at continuous improvement of the JCL process, consistent with the recommendations of the recent OIG audit on the JCL process. These efforts include an ongoing scheduling initiative to strengthen NASA's scheduling capabilities, a detailed training course for estimators/programmatic analysts that includes a significant JCL training component, and enhanced training of project managers and SRB chairs/members.

In the specific case of the James Webb Space Telescope (JWST) which was re-baselined in 2011, the GAO stated in its 2015 report[3] "JWST project continues to report that it remains on schedule and budget with its overall schedule reserve currently above its plan." SMD will continue to rigorously maintain practices to improve cost and schedule performance.

SMD looks forward to working with the OIG on the recently opened audit examining NASA's management of its Earth Science mission portfolio.

Overhauling NASA's Information Technology Governance

NASA's Office of the Chief Information Officer (OCIO) has continued to address remediation of Information Technology (IT) Governance, initially identified in the OIG's June 2013 report. Specifically, two of the eight OIG recommendations were implemented by NASA and closed by the OIG during FY 2015.

In recognition of the importance of IT management in meeting NASA's mission, senior leadership initiated the first-ever Business Services Assessment (BSA) of Information Technology across NASA. The BSA provided multiple recommendations to improve IT management and strengthen IT governance. As a result of the BSA recommendations, the Agency Mission Support Council (MSC) decided to: 1) Establish a senior leader/stakeholder IT Council as the top decision-making governing board; 2) Develop IT Strategic Sourcing guidance; 3) Conduct an annual capital investment review for all NASA IT spending; 4) Conduct Center functional reviews to assess compliance and; 5) Strengthening the role of the Chief Information Officer (CIO).

The MSC made these decisions to strengthen visibility and enable a stronger approval process for all NASA IT spending, which also fulfills the requirements of Federal Information Technology Acquisition Reform Act (FITARA).

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[3] GAO Report: "James Webb Space Telescope: Project Facing Increased Schedule Risk with Significant Work Remaining" (GAO-15-483T; March 24, 2015)

The CIO expects to complete implementation of management actions in response to the OIG's 2013 audit report in early 2016.

Securing NASA's Information Technology Systems and Data

Advancing NASA's IT Security posture in response to the ever-growing threats and attack vectors remains a priority for the Agency. Significant threats include stolen identity credentials, phishing, malware, and an aging IT infrastructure. Building upon the tools and capabilities already deployed, NASA is implementing an integrated approach through enhancements to continuous monitoring and mitigation, network intrusion detection and prevention, data loss detection and prevention, Personal Identity Verification (PIV)-based authentication, and developing a risk-based process to inform decisions at all levels.

In FY 2015, NASA significantly improved the Security Operations Center (SOC) capabilities with enhanced intrusion detection systems (IDS), intrusion prevention, and strengthening security of the Agency Trusted Internet Connection (TIC) boundaries. Actions taken using the Department of Homeland Security's (DHS) Cyber Hygiene Report have greatly reduced vulnerabilities on internet facing systems. An agency-wide effort to implement PIV authentication on both privileged and unprivileged accounts, has also contributed greatly to our security posture through strong user authentication.

Priority actions in FY 2016 include: 1) implementing a National Institute of Standards and Technology (NIST) compliant risk management framework, to process and manage the volume of data being collected by tools and sensors; 2) deployment of DHS' Continuous Diagnostics & Mitigation (CDM) enterprise services; 3) increasing in PIV usage; 4) implementing an anti-phishing and secure mobile device management service; 5) planning budgets to replace ageing infrastructure and; 6) reducing NASA's publically exposed IT infrastructure. Finally, we will focus on improving the speed of response to identified IT security vulnerabilities.

We continue to work toward addressing all OIG recommendations and welcome their support in our work to maintain the security of all NASA's information assets.

Managing NASA's Aging Infrastructure and Facilities

NASA recognizes the challenges associated with managing its diverse and unique infrastructure. NASA continues to implement its strategy to reduce and modernize its infrastructure within available and anticipated budget levels.

NASA continues to work to identify underutilized assets, consolidate capabilities into a suite of core facilities and dispose of facilities that are no longer needed. NASA has completed Technical Capability Assessment Team (TCAT) assessments. To assess technical capabilities, NASA has transitioned from TCAT to the enduring technical capability leadership model. NASA has established Technical Capability Leaders who report recommendations about core technical capabilities annually. These recommendations become input to the Agency's annual Agency Strategy Implementation Planning meeting which establishes budget planning guidance for the next budget planning cycle. In one of the early capability reviews under this new process, NASA evaluated space environments test capabilities. As a result of the evaluation, NASA made divestment and consolidation decisions for a number of space environments test facilities. The facilities identified for disposal will be integrated into NASA's five-year demolition plan. In 2015, NASA completed its Real Property Efficiencies Plan. This plan integrated the Agency's building consolidation and disposal plans into a single integrated five-year plan focused on reducing the Agency's building footprint within available resources. NASA will use this plan to manage square foot reduction efforts over the next five years.

When major technical facilities have extended time periods between test programs, NASA moves the facility to an inactive status when practical. This allows NASA to minimize the annual operating costs. When a new test program is identified, the cost to bring the facility back on line, along with any costs to modify the facility to meet the new test requirements become the responsibility of the test program. This allows NASA to minimize operating expenses during extended inactive periods.

NASA maintains a large inventory of pressure systems. NASA manages this inventory through an active pressure systems program which includes remaining life and risk assessments. The management program includes a community of practice of technical experts who share information and best practices. NASA is revising its pressure systems standard to provide more specific guidance in areas where no national standard exists.

Ensuring the Integrity of the Agency's Contracting and Grants Processes

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 identified by the OIG, OP published procurement guidance regarding Blanket Purchase Agreement (BPA) requirements specifically in the areas of requesting vendor price discounts and conducting annual reviews. We published contract administration guidance regarding the monitoring of incurred cost reportable audits that will strengthen our administration of contracts.

We have strengthened training and issued policy guidance relative to 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 continued to strengthen the management of grants through our issuance of a completely revised 2 CFR 1800 "*Uniform Administrative Requirements, Cost Principles, and Audit Requirements For Federal Awards,*" which implemented the requirements of 2 CFR 200 and included revised new technology terms and conditions, and eliminated the allowance of a "fee" for assistance awards.

Appendix B: NASA Recipients

Office of the Administrator

Administrator
Deputy Administrator
Associate Administrator
Deputy Associate Administrator
Chief of Staff
Senior Advisor to the Administrator for 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
- Deputy Associate Administrator
- 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

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