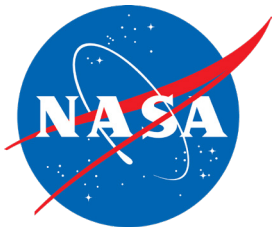
Office of Inspector General

2023 Report on NASA's

TOP MANAGEMENT and PERFORMANCE CHALLENGES

November 2023



Office of Inspector General

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Cover photo: NASA's Space Launch System rocket carrying the Orion spacecraft launches on the Artemis I mission, Wednesday, November 16, 2022, from Launch Complex 39B at NASA's Kennedy Space Center in Florida.
Source: NASA.

TABLE OF CONTENTS

MESSAGE FROM THE

INSPECTOR GENERAL

As required by the Reports Consolidation Act of 2000, this annual report presents the Office of Inspector General's independent assessment of the top management and performance challenges facing NASA.[1] For 2023, we identified the following seven challenges.

- **Challenge 1:** Returning Humans to the Moon
- **Challenge 2:** Improving Management of Major Programs and Projects
- **Challenge 3:** Sustaining a Human Presence in Low Earth Orbit
- **Challenge 4:** Maturing Information Technology Management and Security
- **Challenge 5:** Improving Oversight and Management of Contracts, Grants, and Cooperative Agreements
- **Challenge 6:** Attracting and Retaining a Highly Skilled and Diverse Workforce
- **Challenge 7:** Addressing NASA's Outdated Infrastructure and Facilities

1. The Reports Consolidation Act of 2000 (Pub. L. No. 106-531) requires NASA to include in its performance and accountability report a statement by the Inspector General summarizing the most significant management and performance challenges facing the Agency and the progress made in addressing them.

Office of Inspector General

NASA stands at the forefront of aeronautics, science, and space exploration and is responsible for numerous scientific discoveries and technological innovations. Since its creation in 1958, NASA has made extraordinary achievements in human space flight with missions such as Apollo, the Space Shuttle Program, and the International Space Station. Likewise, science and aeronautics research, such as the images captured by the James Webb Space Telescope, and evolving technologies for sustainable aviation demonstrate NASA's position as a global leader in these fields. The Agency also continues to maintain world renowned testing and launch facilities and, for the past 11 years, has been ranked as the best place to work in the federal government among large agencies.

Despite these important achievements, substantial cost growth and lengthy schedule delays continue to impact not only human space flight programs, like the Space Launch System and Orion Multi-Purpose Crew Vehicle, but also other major science and exploratory programs, projects, and missions. In addition, the International Space Station's planned retirement at the end of the decade poses a challenge for the Agency as it seeks to maintain an active human presence in low Earth orbit.

The Agency also faces long-standing challenges managing its information technology; overseeing contracts, grants, and cooperative agreements; ensuring it attracts and retains a highly technical and diverse workforce; and managing outdated infrastructure and facilities.

In deciding whether to identify an issue as a "top challenge," we consider its significance in relation to NASA's overall mission; whether its underlying causes are systemic in nature; and its susceptibility to fraud, waste, and abuse. These seven highlighted challenges are not the only significant issues that confront NASA, and identification of an issue as a top challenge does not denote lack of attention on the Agency's part. Rather, most of these issues are long-standing, difficult challenges central to NASA's core missions and likely will remain top challenges for years to come. Consequently, they require consistent, focused attention from NASA leadership and ongoing engagement with Congress and other stakeholders.

In this report, we explain why each of the seven issues are characterized as top challenges, identify NASA's progress in addressing the challenge, and highlight additional efforts needed to continue the forward momentum.

The Office of Inspector General is committed to providing independent, objective, and comprehensive oversight of NASA programs, projects, and personnel with the singular goal of improving Agency outcomes. To that end, we plan to conduct audits and investigations in the coming year that focus on NASA's continuing efforts to address these and other top challenges.

Paul K. Martin
Inspector General

RETURNING HUMANS TO THE MOON

WHY THIS IS A CHALLENGE

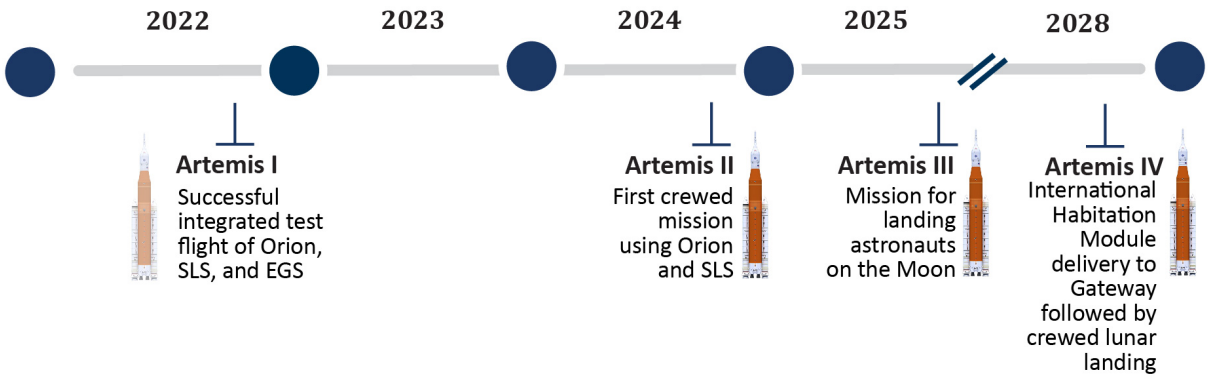
The Artemis campaign seeks to return humans to the Moon as a stepping stone to crewed missions to Mars. To accomplish this ambitious and costly goal, NASA is working with an array of commercial and international partners to develop and test new technologies. This includes the Space Launch System (SLS) heavy-lift rocket and the Orion Multi-Purpose Crew Vehicle (Orion) capsule that will transport astronauts to lunar orbit, the Human Landing System (HLS) that will ferry astronauts to the lunar surface, next-generation spacesuits that will enable astronauts to live and work while on the Moon, and a Moon-orbiting space station called Gateway that will provide staging points for deep space exploration. Figure 1 shows the Artemis I launch in November 2022 and the current timeline for the Artemis II through IV missions.

Development of the systems required to get humans to the Moon and Mars safely within the funding Congress allocates has proven to be especially challenging in past years due to changing requirements, significant technical issues, increased costs, and overly optimistic schedules. For example, given the expense of the SLS/Orion system and related ground launch infrastructure, the launch cost for the first four Artemis missions will be at least $4.2 billion per launch, a figure that does not include $42 billion in formulation and development costs spent over the past dozen years in bringing these systems to the launch pad.[2] Further, in recent legislation, Congress directed NASA to plan for no fewer than one SLS launch per year with a goal of two per year to maintain the workforce.[3] Given these enormous costs and ambitious schedule, the long-term sustainability of the Artemis program poses a significant challenge to the Agency's crewed exploration goals.

SLS rocket and Orion spacecraft atop a mobile launcher at Kennedy Space Center.
Source: NASA

2. Cumulative obligations for Orion, SLS, and Exploration Ground Systems from fiscal year 2012 to 2022.
3. Title VII of the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act of 2022 included the NASA Authorization Act of 2022. The Act directed NASA to plan for not fewer than one SLS launch annually after Artemis II with a goal of two per year as soon as practical. It also directed NASA to create a Moon to Mars Program Office and required that each Artemis mission advance technology directly related to enabling human missions to Mars.

Figure 1: Artemis I through Artemis IV Missions (as of October 2023)



Source: NASA OIG presentation of Agency information

PROGRESS IN ADDRESSING THE CHALLENGE

On December 11, 2022, NASA successfully completed Artemis I—a 25.5-day uncrewed test flight to the lunar orbit and the first launch of the SLS/Orion system. Since then, the Agency has pored over reams of mission data to assess vehicle performance and identify items for further investigation in preparation for the first crewed mission currently scheduled for November 2024 but likely to slip into 2025.

NASA has made progress toward the development of key systems for Artemis III, the mission that will return humans to the surface of the Moon. In April 2023, Space Exploration Technology Corporation (SpaceX)—the HLS Program's contractor for Artemis III—conducted the first orbital test flight of the combined HLS Starship and Super Heavy Booster. Although the vehicle exploded prior to reaching orbit, SpaceX regarded the test as a positive step forward in the Starship's development. In addition, in May 2023 NASA announced the selection of Blue Origin to develop and demonstrate a second lunar landing vehicle under a firm-fixed-price award valued at $3.4 billion.

In March 2023, Axiom Space, Inc. revealed a prototype of its next-generation spacesuit that astronauts will wear as they step on the lunar surface for the first time in over 50 years. To accommodate the diverse physical characteristics of NASA astronauts, next-generation spacesuits are being designed to fit a broad range of crew members and utilize improved mobility to maximize range of motion and technological innovations in life support systems. In September 2022, NASA awarded a task order to Axiom Space—worth $229 million—to develop spacesuits for the Artemis campaign and 3 months later awarded Collins Aerospace a $97 million task order to develop replacement spacesuits for the International Space Station (ISS or Station). To enhance redundancy, in July 2023 NASA issued $5 million task orders to both companies to cross develop spacesuits—with Axiom developing suits for the ISS and Collins for the lunar surface.

In an effort to reduce the cost of lunar missions beyond Artemis IV, NASA intends to award an evaluation and readiness contract by spring 2024 in preparation for the larger SLS Exploration Production and Operations Contract (EPOC). EPOC transitions the method of contracting for SLS from procuring space flight hardware from multiple contractors to a single contractor—Deep Space Transport (DST)—a new joint venture between The Boeing Company (Boeing) and Northrop Grumman. Under EPOC, the new company will own and operate the SLS for five launches (Artemis V through IX) with an option for five more (Artemis X through XIV). Select systems engineering and integration functions—currently performed in-house by NASA—will also transition to DST.

Over the past year, the Agency has taken several steps to improve its management of the Artemis missions. In response to a congressional mandate, NASA created a new Moon to Mars Program Office within the Exploration Systems Development Mission Directorate (ESDMD), bringing the various Artemis-related programs under central leadership. In 2022, NASA also conducted its first Moon to Mars Architecture Concept Review, a process that serves to define elements for an initial lunar surface architecture and align the exploration strategy with 63 Moon to Mars objectives. Moreover, the Orion, SLS, and Exploration Ground Systems Programs are implementing cost reduction targets in an effort to make the Artemis campaign financially sustainable.

Conceptual rendering of Orion spacecraft orbiting Earth.
Source: NASA

WORK REMAINING TO ADDRESS CHALLENGE

The Agency's primary human exploration challenge is preparing for Artemis II—the first crewed test flight of the SLS/Orion system. NASA must address a variety of challenges to safely fly the four astronauts to lunar orbit on their planned 10-day mission. While considered a near-perfect flight by NASA officials, Artemis I revealed technical issues such as the protective material on the Orion heat shield eroded in an unexpected way. This is important because the heat shield protects the capsule and the crew from temperatures about half as hot as the surface of the Sun during reentry. In addition, the Mobile Launcher-1 platform—the ground structure used to assemble, process, transport, and launch the SLS—sustained more damage than expected. Overall, ESDMD considers preparation of Orion's Crew Module—and the delivery of the integrated Crew Module and Service Module to Exploration Ground Systems at Kennedy Space Center (Kennedy)—to be the primary critical path for the Artemis II mission.

Looking ahead to Artemis III, NASA officials are concerned that the technical difficulties associated with SpaceX's Starship HLS will delay the mission currently scheduled for December 2025 to sometime in 2026. The extent of delays will depend on when SpaceX can resume flight testing of the Starship. In addition to overcoming technical challenges, the company must gain approval from the Federal Aviation Administration, who is investigating the company's April 2023 Starship failed launch attempt. SpaceX is also facing a lawsuit from a coalition of environmental groups concerned about the impact of its launches on the ecosystem near its Boca Chica, Texas, launch complex. Further, SpaceX must conduct multiple Starship flight tests and launches before using its lander variant with astronauts for Artemis III. For example, SpaceX must launch a series of Starship vehicles to establish a "fuel depot" in low Earth orbit to refuel each Starship heading to the Moon. Moreover, under its contract with NASA the company is required to send an uncrewed Starship to the lunar surface and back prior to Artemis III to demonstrate its readiness for a crewed mission.

For missions beyond Artemis III, the second mobile launcher (ML-2) is a critical part of the infrastructure needed to launch the upgraded SLS Block 1B and Block 2. In June 2022, we reported that the ML-2 project is significantly behind schedule and over budget, jeopardizing launch schedules for Artemis IV and beyond.[4] While the first steel components were delivered to Kennedy in May 2023, we estimate completion of the launcher will not occur until late 2026 at the earliest, 2.5 years behind the project's originally scheduled date.

Given the $4.2 billion cost-per-launch for at least its first four Artemis missions, it is critical that the Agency identify and implement effective ways to reduce costs to enable fiscal sustainability for its flagship human exploration effort. This will be especially important as Congress urges NASA to increase the Orion/SLS launch cadence at the same time NASA (and much of the federal government) may be operating under a flat annual budget. However, our work has shown that some key cost reduction efforts may fall short of expectations. For example, in May 2023 we reported that for the key SLS engine production contract NASA is projecting manufacturing cost savings of 30 percent per engine starting with production of the seventh of 24 new engines. However, those projected savings do not capture overhead and other costs, which we estimated at $2.3 billion.[5]

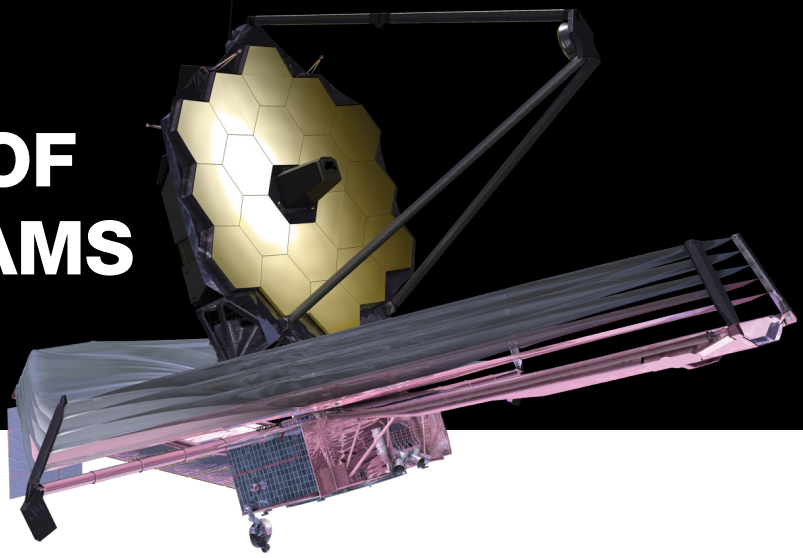
Agency Facts

- The Artemis II crew of 3 American astronauts and 1 Canadian astronaut will be the first humans in over 50 years to be more than 400 miles beyond Earth since the Apollo 17 crew in 1972.
- The flight plan for the Artemis II crew will take them more than 230,000 miles from Earth with reentry into the Earth's atmosphere at nearly 25,000 mph with the underside of the Orion capsule reaching temperatures of 5,000 degrees Fahrenheit—half as hot as the surface of the Sun.
- As of September 2023, 29 countries have signed the Artemis Accords which, among other things, establish principles for cooperation in outer space for peaceful purposes.

4. NASA OIG, *NASA's Management of the Mobile Launcher 2 Contract* (IG-22-012, June 9, 2022).

5. NASA OIG, *NASA's Management of the Space Launch System Booster and Engine Contracts* (IG-23-015, May 25, 2023).

IMPROVING MANAGEMENT OF MAJOR PROGRAMS AND PROJECTS



Conceptual rendering of James Webb Space Telescope.
Source: NASA

WHY THIS IS A CHALLENGE

NASA's accomplishments in technology development, Earth and space exploration, and scientific discovery continue to demonstrate the Agency's amazing achievements. In the past year, the Mars 2020 Ingenuity helicopter—the first aircraft in history to fly under its own power on another planet—marked 2 years of operations by completing its 50th flight after only expecting to fly 5 times. As part of the Artemis I mission, the Orion spacecraft flew farther from Earth—about 270,000 miles—than any other spacecraft designed to carry humans and stayed in space longer than any other human-rated spacecraft without docking to the ISS. The James Webb Space Telescope detected the universe's most distant complex molecules in a galaxy more than 12 billion light-years away from Earth. However, these historic missions have also consistently cost more and taken longer to develop than promised—the effects of which are often felt across the Agency.

A more recent challenge for NASA's management of its major programs and projects is a shift to stimulate new commercial space economies by procuring missions as a "service." While moving to a service-based procurement approach could result in significant cost savings, development of the projects under the commercial approach has consistently cost more and taken longer than planned. For example, both the Commercial Orbital Transportation Services (commercial cargo) and Commercial Crew programs exceeded cost projections and were significantly delayed in achieving operational success.[6] A more recent example is NASA's Commercial Lunar Payload Services (CLPS) initiative. Between November 2018 and November 2019, NASA contracted with 14 U.S. companies at a cost of up to $2.6 billion through 2028 to support the goal of enabling rapid, frequent, and affordable access to the lunar surface and helping to establish a viable market for commercial lunar landing services. Deliveries to the Moon were to begin as soon as September 2020. However, of the 10 fixed-price task orders NASA issued through June 2023, not one company had met the contracted schedule or delivered their payload to the Moon despite the Agency paying many of the contractors more than the initial "fixed-price" agreement. Moreover, NASA has struggled to manage these contractors due to poorly defined requirements and limited insight into contractor activities and their financial position.

Among the project management challenges facing NASA are procurement and contracting options, establishing a credible cost and schedule baseline, and then successfully managing the project's cost and schedule. Moreover, NASA has experienced staffing shortages that have negatively affected the execution of its projects. For example, the Psyche mission—a spacecraft intended to travel to a metal-rich asteroid orbiting the Sun between Mars and Jupiter—was delayed a year due, in part, to staffing shortages in critical positions and did not launch until October 2023 after NASA added about $132 million to its development costs. Psyche's problems had the secondary effect of delaying the Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy (VERITAS) mission for at least 3 years and the Janus spacecraft being put in long-term storage pending identification and funding for an alternative mission and launch opportunity. Likewise, contracting decisions that failed to include performance incentives on the primary fixed-price contracts for the On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) mission contributed to negative consequences for the project.[7]

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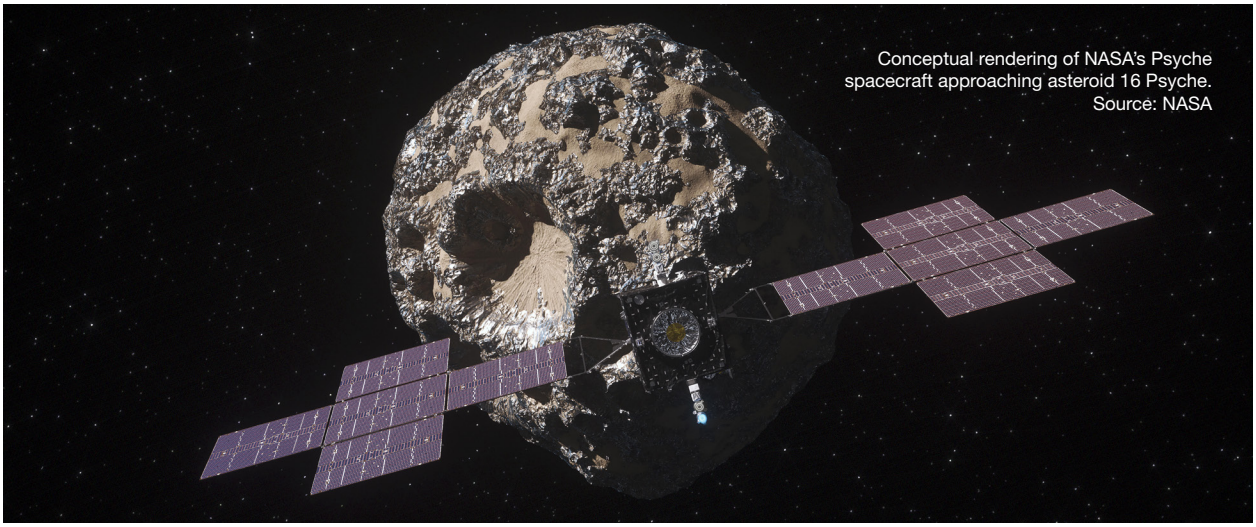
6. NASA OIG, *Commercial Cargo: NASA's Management of Commercial Orbital Transportation Services and ISS Resupply Contracts* (IG-13-016, June 13, 2013) and *NASA's Management of Crew Transportation to the International Space Station* (IG-20-005, November 14, 2019).

7. NASA OIG, *NASA's Efforts to Demonstrate Robotic Servicing of On-Orbit Satellites* (IG-24-002, October 4, 2023).



Conceptual rendering of NASA's Psyche spacecraft approaching asteroid 16 Psyche. Source: NASA

PROGRESS IN ADDRESSING THE CHALLENGE

While the Government Accountability Office (GAO) first designated NASA's acquisition management as high risk in 1990, in the past 3 decades the Agency has made significant progress.[8] Of the five criteria that GAO uses to assess an agency's progress toward addressing high-risk areas—action plan, capacity, demonstrated progress, leadership commitment, and monitoring—NASA has fully met all but the demonstrated progress criteria.[9] GAO stated that the Agency partially met this final criteria but needed to further demonstrate sustained improvement in cost and schedule performance for its portfolio by controlling the extent to which the most expensive and complex projects have cost overruns and schedule delays.

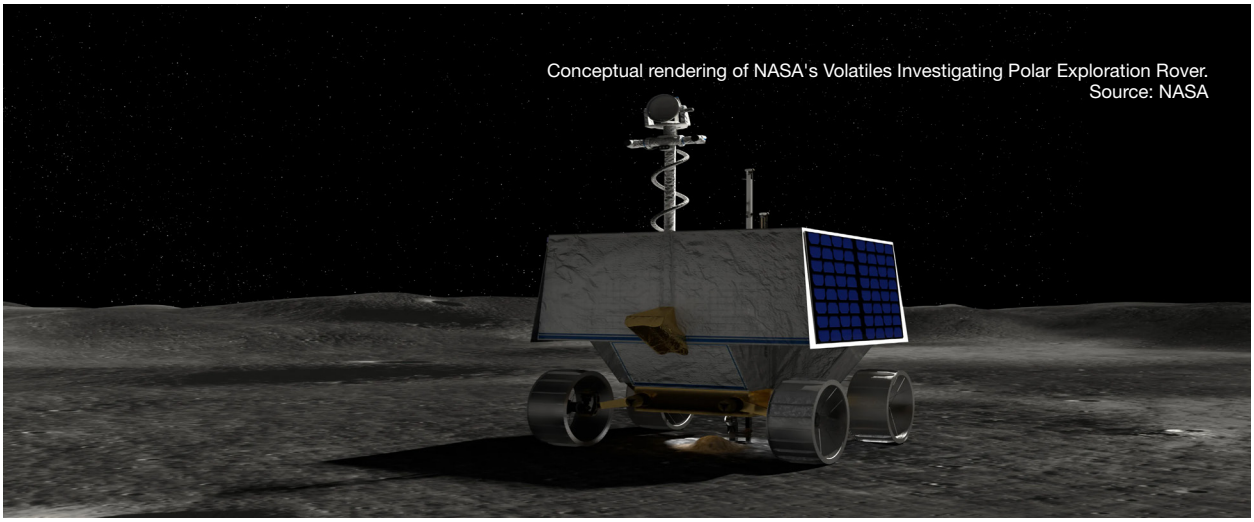
To address the GAO concerns, NASA has continued to update its Corrective Action Plan and in the latest version the Agency lists several new initiatives to drive improvements in its project management.[10] One new initiative is implementation of a Schedule Database that will serve as a storehouse of schedule data and provide managers access to historical schedules and data analytics to plan and develop timelines for future projects. In addition, NASA intends to strengthen its implementation of Standing Review Boards—composed of independent experts who assess projects and provide recommendations to improve technical and programmatic approach, risk, and progress—to improve independent assessments of major programs and projects.

Lastly, NASA uses Independent Review Boards (IRB) to assess some of its most challenging and costly programs and projects.[11] Most recently, in May 2023 the Agency convened its second IRB for the Mars Sample Return Program (the first IRB reported out in October 2020). The IRB is tasked with reviewing the Program to make recommendations to increase the probability of mission success. As part of its charter, the IRB was asked, among other things, to evaluate the cost, schedule, and risks and determine whether the current funding profile is optimal to execute the mission. In our opinion, it was a prudent decision for NASA to charter an IRB to evaluate such a complex mission prior to NASA establishing an Agency Baseline Commitment (ABC).

Agency Facts

- In March 2023, NASA reported that it had 14 major projects in development, and 4 of them (Low-Boom Flight Demonstration, NASA-ISRO Synthetic Aperture Radar, Psyche, and VIPER) over the past year had cost increases of 8 percent or more and schedule delays of 9 months or more.
- As of July 2023, NASA's Science Mission Directorate had 134 missions in formulation through extended operations.
- NASA's October 2022 Economic Impact Study found that NASA's Moon to Mars exploration approach generated more than $20.1 billion in total economic output and supported more than 93,700 jobs nationwide. For investments in climate research and technology, the Agency's activities generated more than $7.4 billion in total economic output and supported more than 37,000 jobs nationwide.

8. GAO, *High-Risk Series: Efforts Made to Achieve Progress Need to Be Maintained and Expanded to Fully Address All Areas* (GAO-23-106203, April 20, 2023).
9. GAO stated that NASA improved its capacity to reduce acquisition risk by, among other things, completing nine initiatives in its 2018 Corrective Action Plan and implementing several recommendations.
10. As of June 2023, the most current version is 2022 High Risk Corrective Action Plan (August 2022, updated January 2023).
11. Independent Review Boards are typically executed via contract and consist of members with considerable experience in program and project management, engineering, and science relevant to the program or project being reviewed.



Conceptual rendering of NASA's Volatiles Investigating Polar Exploration Rover.
Source: NASA

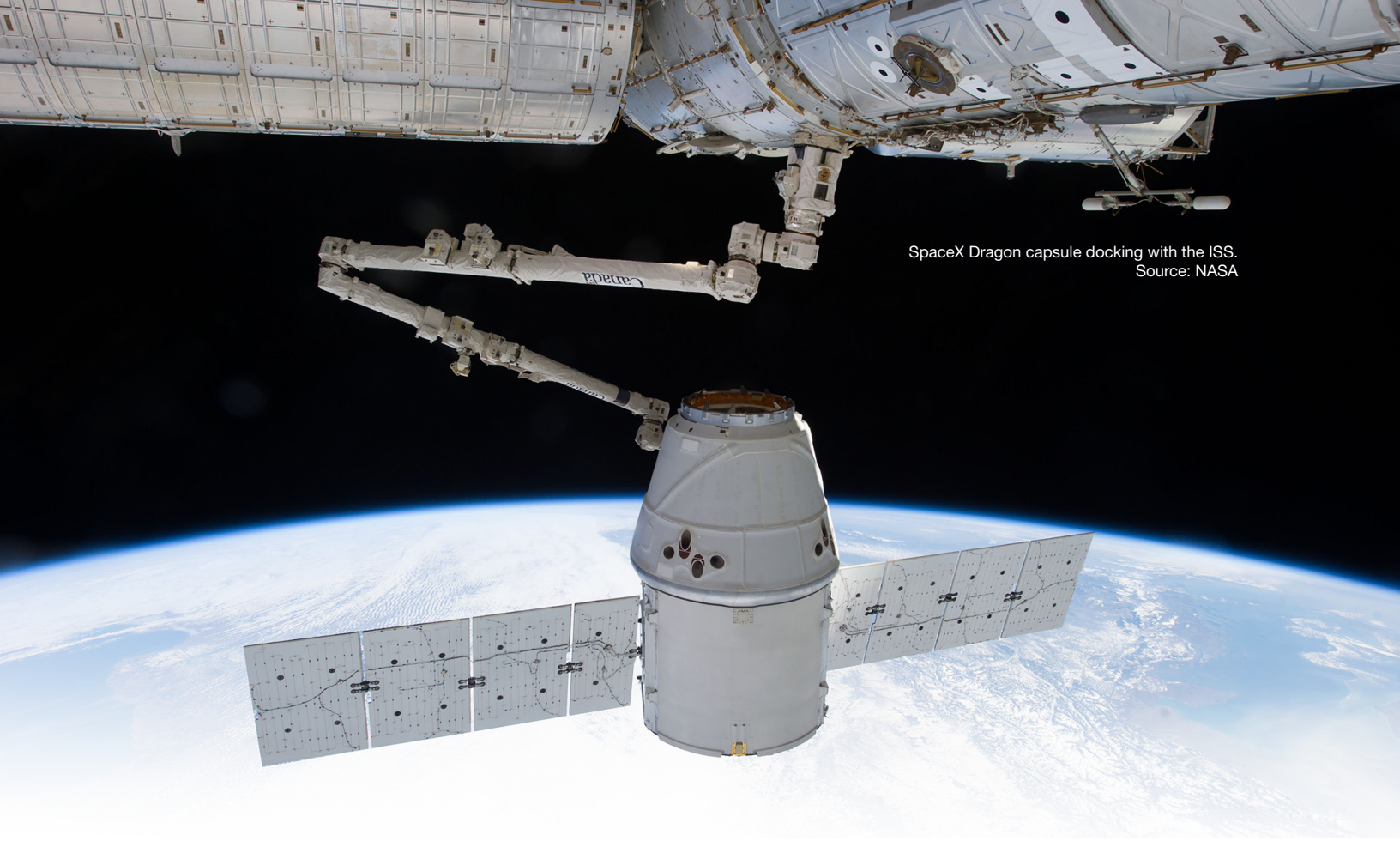
WORK REMAINING TO ADDRESS CHALLENGE

NASA's success in managing its major projects begins with proper stewardship of taxpayer funds and the Agency's adherence to cost and schedule commitments it makes to Congress and other stakeholders. NASA does this through an ABC that establishes and documents an integrated set of project requirements, cost, schedule, and technical content. In turn, the ABC is based on a Joint Cost and Schedule Confidence Level (JCL) to support NASA's commitment to the Office of Management and Budget and Congress.[12] In 2012, we first reported that NASA frequently establishes overly optimistic estimates of the cost and timeline to complete programs and projects.[13] That trend continues today. In addition, we have more recently noted that the Agency is not establishing ABCs that consider the entirety of the program and project risks. For example, in April 2022 and June 2022 we reported that NASA had neither established life-cycle costs nor made cost and schedule commitments for some of the programs supporting the Artemis campaign.[14] By failing to do so, the Agency is circumventing congressional requirements for reporting and tracking the costs of its Artemis missions. Moreover, NASA disagreed with four recommendations in our April 2022 report and has chosen not to implement them. We continue to believe the Agency needs to provide full visibility into its investments as it begins a multidecade Moon to Mars initiative at a cost that could easily reach into the hundreds of billions of dollars. As the programs that support these exploration missions transition from development to production and operation, it is critical that NASA establish credible, complete, and transparent cost and schedule estimates from which they can measure success and be accountable to Congress and other stakeholders.

We also believe NASA is trending in the wrong direction with its application of JCL. Despite NASA leadership promoting the benefit of applying a rigorous and well-developed JCL and the Science Mission Directorate tracking progress across projects, NASA chose not to conduct a JCL that would encompass the entirety of the mission for Artemis programs, such as SLS and Orion and the CLPS initiative's Volatiles Investigating Polar Exploration Rover (VIPER) mission.[15] A JCL analysis for each individual Artemis mission would consider the interdependencies across SLS, Orion, Exploration Ground Systems, Gateway, and HLS and consider the development schedule risks that each pose to the overall cost and schedule of the mission. Similarly, we find it troubling that NASA chose not to include the VIPER delivery system, which was still in development by a company that had never demonstrated this capability, in that project's ABC as a risk to the project's cost and schedule.[16] The Agency essentially ignored this risk and in July 2022 caused a mission delay of a year and an additional $64 million in VIPER development costs, as well as adding $67.8 million to the cost of the CLPS task order.

Overcoming the challenge of developing major projects on cost and schedule requires a concerted effort that begins with consideration of all risks leading to a credible, reasonable, and transparent cost and schedule baseline. COVID-19 impacts continue to reverberate through the economy, manifesting in labor shortages, supply chain issues, and inflation, all of which must be incorporated into the Agency's planning. As NASA moves toward a portfolio that is increasingly based on missions incorporating a "service," it is vital that those external risks be considered and incorporated into JCL analysis and reflected accurately in ABCs.

12. JCL is an analysis of the probability that cost will be equal to or less than the targeted cost and the schedule will be equal to or less than the targeted finish date. To read more about NASA's JCL process, see our *Audit of NASA's Joint Cost and Schedule Confidence Level Process* (IG-15-024, September 29, 2015).
13. NASA OIG, *NASA's Challenges to Meeting Cost, Schedule, and Performance Goals* (IG-12-021, September 27, 2012).
14. NASA OIG, *NASA's Cost Estimating and Reporting Practices for Multi-Mission Programs* (IG-22-011, April 7, 2022) and IG-22-012.
15. VIPER, the most expensive mission in the CLPS portfolio, is a mobile robot intended to land at the South Pole of the Moon in late 2024. See NASA OIG, *NASA's Volatiles Investigating Polar Exploration Rover (VIPER) Mission* (IG-22-010, April 6, 2022) for additional information.
16. IG-22-010.



SpaceX Dragon capsule docking with the ISS.
Source: NASA

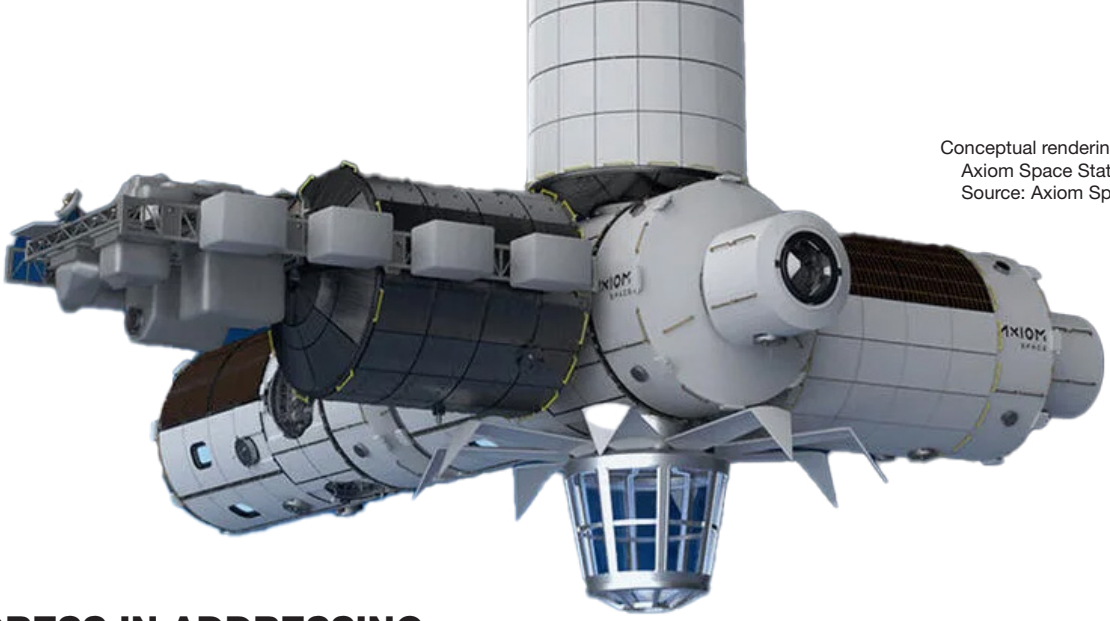
SUSTAINING A HUMAN PRESENCE IN LOW EARTH ORBIT

WHY THIS IS A CHALLENGE

For over 22 years, humans have sustained a continuous presence in low Earth orbit (LEO) living and conducting research onboard the ISS. NASA's activities within LEO—the region in space from about 100 to 600 miles above the Earth's surface—consumes approximately 33 percent of NASA's annual human space flight budget and approximately 16 percent of the Agency's total annual budget. NASA has committed to operating the Station through 2030, with current plans to deorbit the structure in 2031.

The microgravity environment that LEO provides is essential for conducting crew training, fundamental and applied research, advanced systems development, and other activities that will facilitate human travel to deep space environments. After the ISS is retired, NASA plans to sustain a human presence in LEO by becoming one of many customers of commercial LEO destinations. The transition to these commercial space stations will require a significant financial investment by NASA and private companies as well as significant demand for non-NASA services in LEO to ensure long-term economic viability. Avoiding a gap between the advent of commercial platforms and the end-of-life of the ISS by 2030 is the crux of this challenge.

A key factor in maintaining an ongoing and vibrant presence in LEO is reliable and cost-efficient transportation of cargo and crew. Having multiple crew transportation options is necessary for redundancy and safety and helpful to engender more competitive pricing. While NASA has continued working with Boeing and SpaceX for crew transportation services to the ISS, SpaceX is currently the only commercial provider available for ISS crew transportation with Boeing experiencing years of delays and cost overruns of nearly $900 million. The company's latest crewed flight was deferred indefinitely due to issues with the capsule's parachute system and harness and is now scheduled for no earlier than March 2024.



Conceptual rendering of Axiom Space Station. Source: Axiom Space

PROGRESS IN ADDRESSING THE CHALLENGE

NASA has taken considerable steps in multiple areas related to this challenge. In November 2021, we reported on potential risks to the structural integrity of the Station, specifically leaks within the Station's Service Module Transfer Tunnel.[17] Since then, the leaks have been patched, tested, and are under continuous monitoring. While the root cause of the cracks has not been determined, leak rates have remained steady and there has been no indication of other leaks onboard the Station.

Assessing NASA's progress in developing a more robust commercial economy in LEO, the Agency contracted for commercial modules that will be attached to the Station and awarded Space Act Agreements for design of stand-alone commercial space stations. Four industry partners—Axiom Space; Blue Origin; Nanoracks, LLC; and Northrop Grumman—are currently working on preliminary design plans for these commercial platforms. The Agency's goal is to have at least one site available by 2028, allowing for a 2-year overlap with the ISS to effectively transition operations and meet the needs of the United States and its international partners. Transition from a government-owned to a privately-owned station is estimated to save the Agency between $1.3 billion and $1.8 billion per year, based on current expected capabilities and estimated prices for commercial LEO destination services.[18]

Furthermore, as of August 2023 SpaceX has successfully launched 28 cargo and 11 crewed missions to the Station. In addition, as of June 2023 Axiom Space has conducted two private astronaut missions, which could potentially indicate increasing demand for future commercial destinations.[19] Onboard the two Axiom Space missions (Ax-1 and Ax-2), the crew successfully conducted commercial scientific experiments and engaged in media outreach activities. Future Axiom Space private astronaut missions are being scheduled, including the Ax-3 mission that will have similar objectives as Ax-1 and Ax-2—media, science, research, Earth observation, and other commercial activities.

To ensure a continuous, safe, and cooperative presence within LEO, NASA reached a nonmonetary seat barter, or integrated crew agreement, with Roscosmos in July 2022 to allow Russian cosmonauts to fly on U.S. spacecraft in exchange for U.S. astronauts flying on Russia's Soyuz spacecraft. In September 2022, a U.S. astronaut flew onboard Soyuz MS-22 with Expedition 68, while a Russian cosmonaut flew onboard a SpaceX Crew Dragon launch as part of the Crew-5 mission in October 2022. A second Russian cosmonaut was a part of SpaceX's Crew-7 mission in August 2023. Despite ongoing geopolitical disputes, NASA and Roscosmos continue their decades-long partnership, working together to maintain ISS operations.

Agency Facts

- The ISS has made more than 128,000 revolutions around the Earth in its more than 22 years in orbit.
- As of September 2023, more than 273 individuals from 21 countries have visited the International Space Station.
- The ISS has conducted 32 debris collision avoidance maneuvers—a slight repositioning of the Station to avoid orbital debris—since 1999.

17. NASA OIG, *NASA's Management of the International Space Station and Efforts to Commercialize Low Earth Orbit* (IG-22-005, November 30, 2021).
18. This savings is estimated at approximately $1.3 billion in 2031, increasing to $1.8 billion by 2033.
19. Private Astronaut Mission Ax-1 launched in April 2022 where the crew spent 15 days onboard the ISS, and Ax-2 launched in May 2023 where the crew spent 8 days onboard.

Conceptual rendering of orbiting space debris.
Source: European Space Agency

WORK REMAINING TO ADDRESS CHALLENGE

Moving forward with its LEO activities, the Agency will need to continue balancing multiple priorities including maintaining ISS operations, stimulating a commercial LEO economy, ensuring sufficient crew and cargo capabilities, managing orbital debris (i.e., human-made objects or space junk that no longer serve a useful purpose), and planning for the Station's deorbit.

The timely development of commercial platforms remains a top priority for the Agency, given that the schedule for ensuring a period of overlap with the Station is aggressive. Absent availability of a viable commercial platform before the Station's end-of-life, NASA faces the challenge of either a gap in LEO availability or the need to extend the Station beyond 2030.

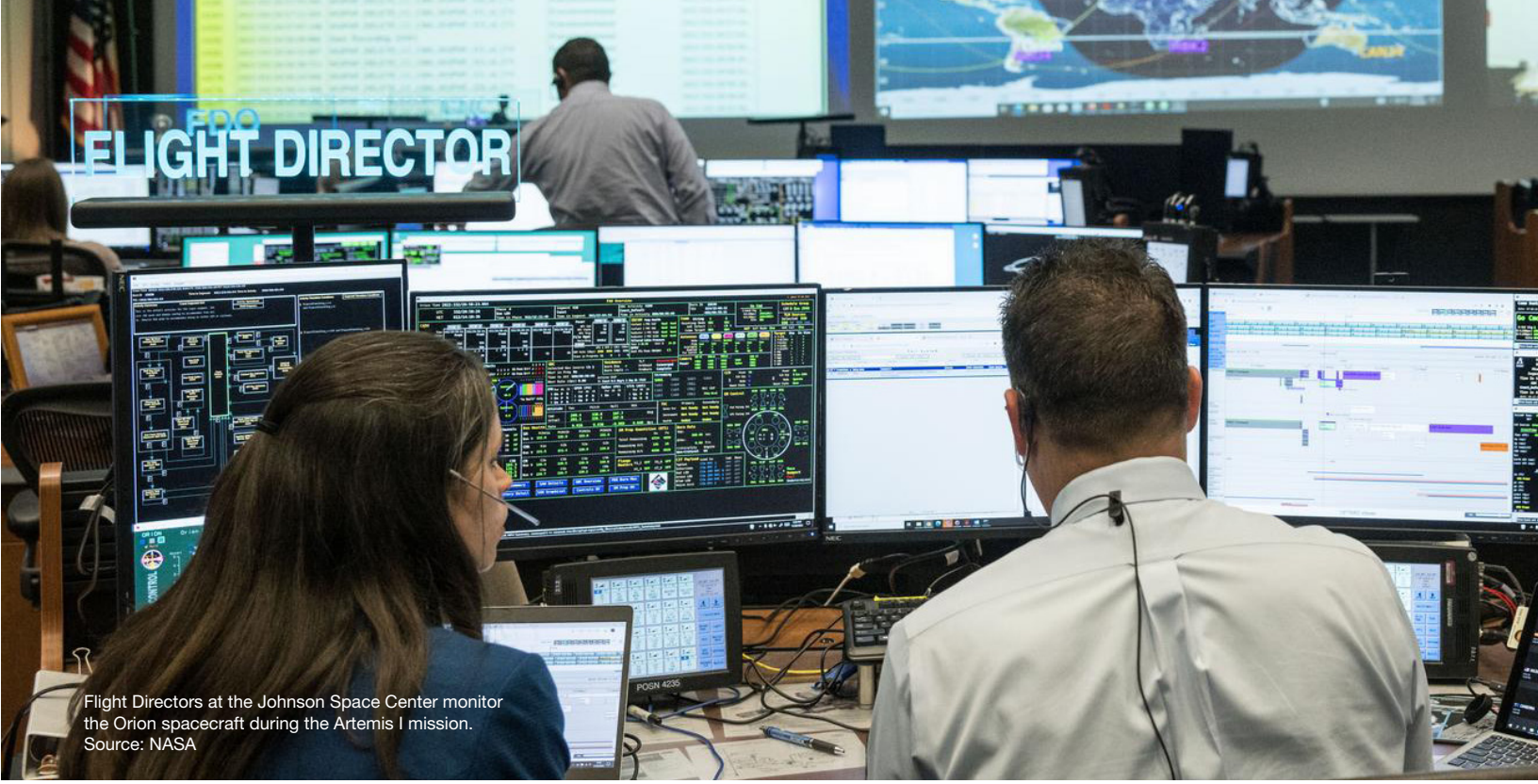
Similarly, the need for reliable cargo resupply services will also remain a priority for the Agency to enable consistent delivery of science investigations, supplies, and equipment. Following Northrop Grumman's commercial resupply mission to the Station in August 2024, the Antares rocket engines will be replaced, and the company plans to utilize SpaceX's Falcon 9 rocket for cargo resupply until the new version of Antares is ready in 2025. Until that time, U.S.-based cargo resupply capabilities will be limited to SpaceX's launch vehicles. Correspondingly, Boeing's ongoing delays to perfect crew transportation to the ISS leave SpaceX as the sole commercial provider with the ability to transport astronauts to and from the Station. To meet operational needs and to provide redundancy for crew transportation, the Agency's challenge is to continue to work with Boeing to certify its Starliner vehicle to safely carry crew.

Furthermore, all ISS partners have agreed to continue operations onboard the Station until 2030 except for Russia, which has publicly committed to ISS operations until at least 2028.[20] While the Station's structure is expected to remain viable through 2030, the increase of space activity has accelerated the creation of orbital debris, increasing the safety threat to the ISS and its crew. As we discussed in a January 2021 report assessing NASA's efforts to mitigate the risks posed by orbital debris, activities focused only on preventing the creation of additional debris are not sufficient to stabilize the orbital debris environment in LEO. In that report, we urged NASA to consider developing cost-effective debris removal technologies and increasing its leadership in responsible mitigation activities.[21]

Lastly, NASA remains dependent on Russia capabilities for deorbiting the Station. While NASA continues to coordinate with Roscosmos on plans for a safe deorbit, the Agency is also seeking to develop a space tug deorbit vehicle—estimated to cost approximately $1 billion dollars—to supplement Station deorbit possibilities.

20. Russia has historically committed to extended Station operations in 4-year increments.

21. NASA OIG, *NASA's Efforts to Mitigate the Risks Posed by Orbital Debris* (IG-21-011, January 27, 2021).



Flight Directors at the Johnson Space Center monitor the Orion spacecraft during the Artemis I mission. Source: NASA

MATURING INFORMATION TECHNOLOGY MANAGEMENT AND SECURITY

WHY THIS IS A CHALLENGE

Critical to the Agency's day-to-day operations, information technology (IT) is the invisible glue that often only gains attention when it fails to protect the security, confidentiality, integrity, and availability of the digital ecosystem. This year, the NASA Office of Inspector General broadened its oversight focus to include a macro view of NASA's efforts to form a more cohesive, "whole of NASA" enterprise approach to IT management. One such effort, now a year old, the Cybersecurity and Privacy Enterprise Solutions and Services (CyPrESS) contract is laying the foundation to standardize and mature the cybersecurity of NASA's networks. Since the CyPrESS contract award in May 2022, the Office of the Chief Information Officer (OCIO) has begun consolidating assessment and authorization activities, reducing duplication, and standardizing cybersecurity services for institutional and mission IT systems.

However, shifting NASA to an enterprise computing model is likely years away largely due to the Agency's history of decentralized IT management where 54 percent of the Agency's IT assets and budgets are controlled by Mission Directorates and Center Mission Support offices rather than with the Agency's Chief Information Officer.[22] As our prior reviews have identified, NASA's decentralized management structure negatively affects the ability to protect information and IT systems vital to its mission. Lingering operational deficiencies, such as limited monitoring and use of elevated privileges coupled with poor inventory practices continue to impact IT maturity. Similarly, NASA's latest Federal Information Security Modernization Act grade continues to underscore our concern—scoring IT maturity and overall health below the "managed and measurable" rating the Office of Management and Budget considers effective.[23]

22. NASA's IT assets generally fall into two broad categories: institutional and mission. Institutional systems include desktop and laptop computers, enterprise business applications, web services, data centers, and networks. Mission systems support the Agency's aeronautics, science, and space exploration programs.

23. The Federal Information Security Modernization Act, as amended in 2014 (Pub. L. No. 113-283), modified the original 2002 law to clarify and update the responsibilities and authorities of Department of Homeland Security and Office of Management and Budget in relation to federal agency information security.

Pleiades, NASA's supercomputer at Ames Research Center.
Source: NASA

PROGRESS IN ADDRESSING THE CHALLENGE

NASA is making meaningful progress in maturing its IT management and security. The tone at the top, set by the Chief Information Officer and Senior Agency Information Security Officer, reflects the seriousness and importance of managing and securing NASA's IT systems. We are encouraged by a series of initiatives the OCIO has undertaken to manage over 275,000 devices and 627 system security plans and authorizations to operate for both institutional and mission systems, including:

- Since 2016, a 97 percent reduction of unpatched critical vulnerabilities has significantly reduced NASA's IT risk exposure.

- Building on a June 2022 *IT Scorecard* initiative, the OCIO further enhanced its dashboard to include implementation status on the National Security Council action for all agencies to focus on three specific cybersecurity elements: (1) multifactor authentication, (2) Data-at-Rest encryption, and (3) Data-in-Transit encryption.[24]

- Completed the *OneNASA* Intranet project building the Agency's first-ever interconnected intranet encompassing 109 websites that includes all NASA Centers, Mission Directorates, and mission support enterprise organizations. The project was completed on schedule and under budget.

- Implemented Virtual Private Network enforcement controls requiring users to have special access permission for end-of-life operating systems (e.g., Windows 7, 8, Vista, MacOS 10.14).

Agency Facts

- Within NASA's fiscal year (FY) 2023 IT budget of $2.2 billion, OCIO manages $667 million. Separate from the OCIO, mission organizations are allocated $1.5 billion.

- OCIO security systems block 5 billion attempts per day of malicious and unauthorized network traffic, including approximately 1.5 million email threats per week.

- In 2022, NASA reduced its web footprint by 473 domains and now totals 2,242 domains.

24. Executive Order 14028, *Improving the Nation's Cybersecurity,* (May 12, 2021).

NASA is developing its humanoid robot Valkyrie to utilize artificial intelligence on future deep space missions. Source: NASA

WORK REMAINING TO ADDRESS CHALLENGE

The promising overall picture, however, masks persistent challenges needed to mature NASA's IT management. Implementing multifactor authentication, Data-at-Rest and Data-in-Transit encryption, and zero-trust enterprise-wide are critical undertakings in the coming years, with the goal of eliminating implicit trust and continuously validating every stage of a digital interaction with the Agency. In March 2022, NASA submitted its zero-trust plan to the Office of Management and Budget and the Department of Homeland Security for review. Zero trust is an ongoing process focusing on "never trust, always verify," consequently the Agency will update this plan in the future.

Additionally, in a series of audits we identified a number of ongoing challenges exacerbated by decentralized management of institutional and mission IT systems.

• Software Licensing. In a January 2023 audit, we found that significant shortcomings stymie NASA's software license and asset management activities exposing the Agency to operational, financial, and cybersecurity risks with management of the software life cycle largely decentralized and ad hoc. Efforts to implement an enterprise-wide Software Asset Management program have been hindered by both budget and staffing issues and the complexity and volume of the Agency's software licensing agreements.[25]

• Artificial Intelligence (AI). In a May 2023 audit, we found that NASA lacks a single standard definition for AI, hindering the Agency's ability to effectively manage its AI inventory. Without an AI-specific classification mechanism or means to appropriately categorize and classify AI within in its system of records, the Agency faces increased challenges to implement federal AI cybersecurity controls.[26]

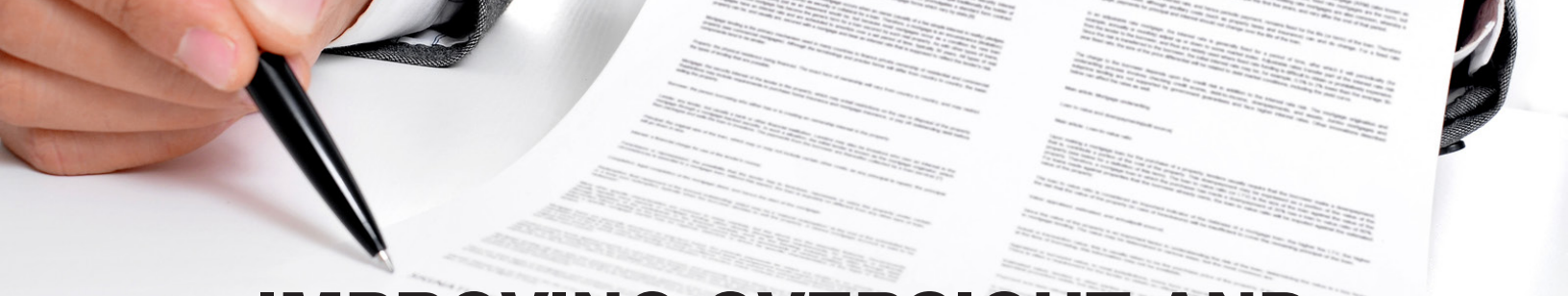
• Enterprise Architecture. As we reported in May 2021, the Agency's cybersecurity preparedness is strained due to ambiguity surrounding the requisite technical integration between Enterprise Architecture and Enterprise Security Architecture—the blueprints for how an organization analyzes and operates its IT and cybersecurity—as well as disjointed internal management structures and funding authorities.[27]

Overall, while NASA continues to mature its IT management, history has shown that driving change can be an uphill effort when management decisions hinge on the Agency's federated model, with multiple lines of independent authority among headquarters and geographically dispersed missions and Centers. This is especially true when issues like IT management and cybersecurity cross organizational boundaries and where competing interests and independent budgets come into play.

25. NASA OIG, *NASA's Software Asset Management* (IG-23-008, January 12, 2023).

26. NASA OIG, *NASA's Management of Its Artificial Intelligence Capabilities* (IG-23-012, May 3, 2023).

27. NASA OIG, *NASA's Cybersecurity Readiness* (IG-21-019, May 18, 2021).



IMPROVING OVERSIGHT AND MANAGEMENT OF CONTRACTS, GRANTS, AND COOPERATIVE AGREEMENTS

WHY THIS IS A CHALLENGE

In FY 2022, NASA spent approximately $19.9 billion through contracts, grants, and cooperative agreements for research and development initiatives and acquiring essential services, supplies, and equipment necessary to support Agency operations and missions. Given the breadth and scale of these obligations, it is crucial for the Agency to obtain fair value for these investments and ensure appropriate oversight and utilization of funds.

Our audit and investigative work have consistently shown that NASA's inadequate management and oversight of contracts, grants, and cooperative agreements results in inappropriate expenditures and wasted taxpayer dollars that negatively impact the Agency's mission. Relatedly, as noted in our Project Management challenge, the Agency has often experienced substantial growth in the cost and schedule in many of its programs. We found that the Agency often struggled to make the most appropriate contracting decisions and oversee contractor performance when managing its programs, resulting in increased costs. For example, in May 2023 we reported the Agency's decision to use cost-plus instead of fixed-price contracts for its solid rocket boosters and both RS-25 rocket engine contracts—needed to power the SLS—contributed to increased costs and schedule delays.[28] In another recent report, we questioned the Agency's decision to use a firm-fixed-price contract for the OSAM-1 mission instead of a fixed-price incentive or fixed-price award fee structure.[29] In our view, this decision limited the Agency's ability to incentivize the contractor's performance. Consequently, NASA is providing significant services and personnel to supplement the contractor's efforts in order to mitigate performance issues and minimize additional impact to cost and schedule.

We also raised repeated concerns about the Agency's payment of overly generous award fees to contractors performing poorly. In our May 2023 report examining the Agency's SLS engine and booster contracts, we questioned over $44.3 million in award fees that NASA paid on the RS-25 contract even though production of the engines was not yet complete and the solid rocket boosters' contract experienced significant cost overruns. Similarly, in June 2022 we reported that despite continued poor performance on NASA's ML-2 project, the Agency awarded the contractor $2.9 million in award fees—a decision we questioned.[30]

Our financial statement audit continues to identify challenges in the Agency's timely closure of grants, specifically in the completion of final payment procedures.[31] Over 1,600 grants reached the end of their performance period in FY 2022 and our audit revealed 297 grant awards where payments were recorded more than 120 days after the end of the period of performance without appropriate extension approvals, and 173 grants that remained open for more than a year beyond the end date of their periods of performance. Untimely closure results in funding not being available for other Agency priorities and can lead to improper payments being made.

Furthermore, our investigative work has uncovered improper use of grant funds, fraud, and other waste and abuse, and over the past 3 years resulted in 8 indictments, 8 convictions, 4 suspensions, and 7 debarments, with over $3.6 million in civil settlement fines returned to NASA. In addition, more than $2.6 million in criminal restitution and nearly $8.9 million in civil settlement fines were returned to the U.S. Treasury as a result of our investigations.

28. IG-23-015.
29. IG-24-002.
30. IG-22-012.
31. Fiscal Year 2022 Management Letter, prepared by Ernst & Young LLP (IG-23-007, December 19, 2022).

PROGRESS IN ADDRESSING THE CHALLENGE

To its credit, NASA is pursuing affordability initiatives through a variety of procurement strategies. For example, beginning with Artemis IV NASA has taken a positive step by procuring sets of SLS boosters on a fixed-price-incentive-fee basis instead of the previous cost-plus contract structure, thereby transferring a greater share of the risk from the Agency to the contractor.[32] By utilizing fixed-price contracts when appropriate, NASA can effectively distribute risk between the government and the contractor, a contract structure that has demonstrated success in constraining cost escalation like in the later phases of the Commercial Crew Transportation Services. NASA is also procuring HLS transportation services that enable public-private partnerships in which contractors take on a significant portion of the development costs. These contracts allow NASA to gain the efficiencies of a commercial partnership and leverage state-of-the-art innovation. Additionally, NASA has taken other steps to improve contract management practices. For example, the Agency has decreased the use of award-fee contracts over recent years from 42 percent in 2020 to 28 percent in 2022. While NASA's procurement actions represent encouraging progress toward improving affordability of its projects and missions, any such savings are contingent upon establishing firm requirements and limiting changes to the scope of work.

NASA has also implemented several measures to improve its grant closeout procedures. These include establishing a centralized reporting and tracking tool that aids in identifying grants approaching expiration or ready for closure. The Agency has also deployed automated email notifications to initiate grant closeout processes, as well as automatic reminders and delinquent notices to grantees once the 120-day reporting period has lapsed. Lastly, NASA has implemented post-award monitoring procedures to gather relevant data on performance throughout the grant award's life span and ensure recipient compliance with applicable rules and regulations.

Agency Facts

- Over the past 3 years, NASA has spent over $58.8 billion on procurements with the Agency executing over 26,000 procurement actions in FY 2022 alone.
- NASA's FY 2022 procurement portfolio was composed of 33 percent firm-fixed-price contracts, 28 percent award-fee contracts, 27 percent cost-plus-fixed-fee contracts, and the remaining 12 percent incentive contracts and other award types.
- In FY 2022, NASA awarded 1,787 grants and 270 cooperative agreements.

WORK REMAINING TO ADDRESS CHALLENGE

While NASA has made progress in improving oversight and management of its contracts, grants, and cooperative agreements, there is a need for further action to enhance transparency, accountability, and oversight. In May 2023, we recommended that NASA improve its management of key SLS contracts by gaining a better understanding of the SLS Program's needs and complexity before transitioning from development to production, as well as accurately defining the scope of work during contract definitization. Moreover, it is crucial that the Agency ensure it selects the appropriate contract type while considering cost and schedule risks. Fixed-price contracts can be beneficial to contain costs but are not a one-size-fits-all solution, particularly if requirements are not firm or the project scope is likely to change. Additionally, when award fee and incentive type contracts are the best options, the Agency needs to ensure they accurately assess, score, and reward contractor performance based, in large part, on how well they have met cost and schedule.

Finally, NASA should continue its efforts to improve grant closeout policies and procedures to ensure the timely closure of current and future grants. This commitment to oversight will enhance financial accountability, ensure proper fund utilization, and facilitate the reallocation of obligated funds within multiyear appropriations.

32. Fixed-price-incentive-fee contract structures include progress payments when milestones are met, while cost-plus-incentive-fee contracts reimburse contractors for actual costs incurred even if those costs are higher than anticipated at the outset of the contract.

ATTRACTING AND RETAINING A HIGHLY SKILLED AND DIVERSE WORKFORCE

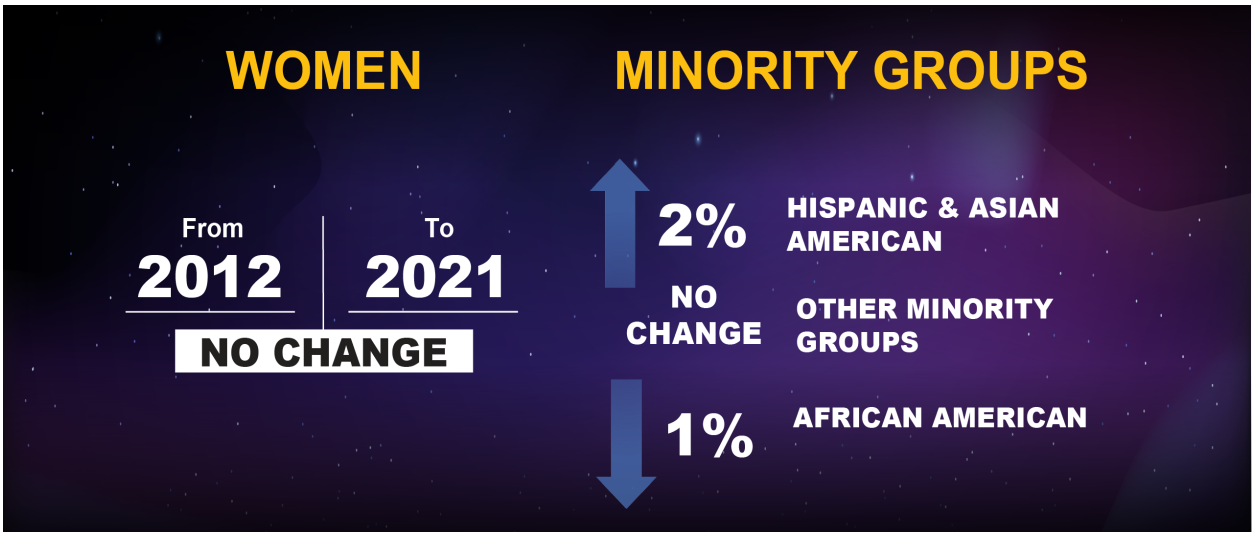
WHY THIS IS A CHALLENGE

NASA's workforce—personnel at the Agency's Headquarters, Centers, and other NASA-operated facilities across the country and around the world—is its greatest asset for advancing missions in space and on Earth. As of April 2023, NASA had over 18,000 civil service employees working at its facilities with the majority in science and engineering fields. The Agency continues to seek ways to attract, promote, and retain a diverse, multigenerational workforce that possesses the technical skills critical to the Agency's varied missions. Our work has shown NASA faces multiple workforce challenges, including increasing the representation of women and minorities in its civilian and leadership ranks; developing a pipeline of women and minorities in Science, Technology, Engineering, and Mathematics (STEM) fields; addressing a shortfall of employees with the right skills in specific technical occupations; and focusing on the fact that a significant percentage of the NASA workforce is retirement eligible.

Despite its efforts to increase diversity in its civilian workforce, the overall percentage of women and minority groups at NASA has remained unchanged for over a decade (see Figure 2). At the same time, the Agency struggles to promote more women and racial and ethnic minorities to senior leadership positions. Specifically, the Agency's demographic representation for senior leadership positions has remained consistently male, (holding steady at just over 70 percent) with positions held mostly by White employees (nearly 80 percent) over the past 10 years. Additionally, NASA, much like the broader federal government, has struggled to recruit, hire, and retain diverse STEM employees. NASA also remains at risk from a shortage of STEM staff as competition increases with the growth of the commercial space industry. Further compounding these issues, nearly 40 percent of NASA's science and engineering workforce is nearing retirement. Finally, the Agency continues to face workforce shortages for some of its key science projects resulting in delays to missions and significant risks due to the loss of unique skillsets in engineering disciplines from retiring employees.

NASA Astronaut Christina Hammock Koch will be the first woman to fly around the Moon during the Artemis II mission. Source: NASA

Figure 2: Change in NASA Workforce Demographics



Source: NASA OIG presentation of Agency information

PROGRESS IN ADDRESSING THE CHALLENGE

For the past 11 years, NASA has been voted the best large agency to work for in the federal government according to the Partnership for Public Service. At the same time, NASA continues to work to prioritize and implement strong diversity, equity, inclusion, and accessibility (DEIA) initiatives. Per NASA's DEIA Policy statement, the success of the Agency's DEIA initiatives impacts NASA's reputation and remains a priority to enable the Agency to recruit and engage the best talent, driving workplace productivity. The Agency also continues to modernize its human capital processes and talent acquisition systems and is working to expand its engagement with younger students to encourage them to enter STEM fields.

In 2021, NASA elevated diversity initiatives to the Administrator and Deputy Administrator level to ensure strategic prioritization and senior level management review of DEIA activities and policies. The Agency also established the DEIA Strategic Plan in 2022 focusing on workforce diversity, equity and inclusion, accessibility, and ways to integrate these concepts into NASA's mission.[33] Also in 2022, NASA's Centers and Mission Directorates completed implementation plans to align their programs, initiatives, and activities to the DEIA Strategic Plan, specifically identifying how milestones are tracked and will support performance goals. As part of implementing the DEIA Strategic Plan, the Agency established a governance structure elevating DEIA responsibility to the Deputy Administrator and making the head of the Office of Diversity and Equal Opportunity a direct report. Finally, in 2023 NASA created a Diversity Ambassador position responsible for partnering with external entities to further NASA's DEIA efforts and help the Agency recruit and hire employees with diverse backgrounds.

NASA continues to recognize both the Agency's and the nation's need for a steady pipeline of skilled STEM workers and through its Office of STEM Engagement (OSTEM) is hoping to engage students to enter the STEM workforce. For FY 2024, NASA requested $158 million for OSTEM, 10 percent more than was enacted in FY 2023 to expand opportunities for students from underrepresented communities. OSTEM representatives also serve as part of the Space STEM Task Force, an interagency group established to develop and facilitate coordination and implementation of federal actions to grow, diversify, and strengthen the space workforce. Moreover, the Interagency Roadmap to Support Space-Related STEM Education and Workforce report published by the Office of Science and Technology Policy in September 2022 outlines the goals and activities of the task force including steps to inform future space STEM education and workforce strategy.[34]

Agency Facts

- In 2021, 67 percent of NASA's workforce were employed in STEM occupations, of which 25 percent were women and 26 percent were from minority racial and ethnic groups.
- Approximately 30 percent of NASA's workforce is under the age of 40 while another 23 percent was eligible to retire as of July 2023.
- Veteran hiring rates at NASA have declined over the past 10 years, decreasing from 28 percent in 2015 to 13 percent in 2021.

33. NASA Strategic Plan for Diversity, Equity, Inclusion, and Accessibility.

34. Office of Science and Technology Policy, Interagency Roadmap to Support Space-Related STEM Education and Workforce, (September 2022).

The crew of NASA's Artemis II mission.
Source: NASA

WORK REMAINING TO ADDRESS CHALLENGE

NASA's ambitious missions require the Agency to focus on its workforce needs and staff appropriately. Significantly, in September 2022 the GAO reported NASA faces uncertainties in its workforce planning for its Artemis campaign.[35] While NASA conducts workforce planning across the next 5 budget years, the Agency is committing billions of dollars to contracts for future Artemis missions that will extend well into the 2030s and therefore must address the challenge of ensuring the skilled, agile, and effective workforce it needs to execute these future missions. The Agency also has a large segment of its workforce approaching retirement, which could affect its readiness for the Artemis missions. To address future workforce uncertainties, GAO recommended the Agency develop guidance that identifies a regular and recurring process for workforce scenario planning.

Additionally, a November 2022 IRB found a significant factor in the year-long delay of the Psyche mission—intended to explore a metallic asteroid orbiting the Sun between Mars and Jupiter—was an imbalance between the workload and the available engineering workforce at the Jet Propulsion Laboratory (JPL).[36] While NASA concurred with the recommendations of the independent review and are working to implement corrective action, the mission delay will cost NASA at least $132 million. We also discussed similar staffing issues in our prior reviews of projects at JPL and are concerned that other Centers may face the same challenge.[37] For example, Goddard Space Flight Center faces a heavy workload with large projects such as the OSAM-1 Mission; Roman Space Telescope; and Capture, Containment, and Return System for the Mars Sample Return mission, all of which are competing for a limited technical workforce as each prepares for launch in the next 3 to 5 years. These workforce challenges will require sustained attention and commitment from the Agency to address.

Lastly, as NASA continues its efforts to integrate DEIA initiatives into Agency functions, comprehensive and complete data will aid managers in their decision-making. In our April 2023 report, we found the Agency lacks a comprehensive and consolidated source for DEIA data and instead relies on localized data collection.[38] To be most effective, the Agency needs to capture current DEIA data; conduct analyses to identify barriers to recruiting, selecting, promoting, and retaining underrepresented groups; and leverage data to monitor outcomes.

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35. GAO, *NASA Lunar Programs: Improved Mission Guidance Needed as Artemis Complexity Grows*, (GAO-22-105323, September 2022).

36. NASA, Psyche Independent Review Board Report, (November 4, 2022).

37. We have highlighted these workforce issues since 2018 in multiple reports including: NASA OIG, *NASA's Surface Water and Ocean Topography Mission* (IG-18-011, January 17, 2018); *Management of NASA's Europa Mission* (IG-19-019, May 29, 2019); and *NASA's Planetary Science Portfolio* (IG-20-023, September 16, 2020).

38. NASA OIG, *NASA's Efforts to Increase Diversity in Its Workforce*, (IG-23-011, April 20, 2023).

NASA's SLS rocket and Orion spacecraft rollout of Kennedy Space Center's Vehicle Assembly Building ahead of the Artemis I mission. Source: NASA

ADDRESSING NASA'S OUTDATED INFRASTRUCTURE AND FACILITIES

WHY THIS IS A CHALLENGE

NASA and its commercial partners rely on the Agency's facilities and infrastructure, including office buildings, laboratories, launch complexes, test facilities, and communication sites, to develop new technologies to advance space exploration missions, scientific research, and aeronautics. Today nearly 83 percent of NASA's facilities are beyond their original design life and the Agency faces a deferred maintenance backlog estimated at $3 billion as of September 2022.[39] At the same time, NASA officials acknowledge the Agency has more infrastructure than it needs for current and planned missions. In addition, some portion of NASA's facilities and infrastructure requirements may shift as the Agency evolves from exclusively on-site work requirements as well as increasing use of commercial companies for selected missions.

As NASA seeks to analyze its existing and planned infrastructure to meet future mission demands, the Agency has encountered significant challenges with planning for and implementing projects. Over the past several years we have assessed a variety of the Agency's infrastructure efforts including environmental remediation projects; management of historic real and personal property; leasing practices; efforts to "rightsize" the Agency's workforce, facilities, and other supporting assets; and prioritization of Construction of Facilities (CoF) projects. Additionally, we have assessed whether NASA met cost, schedule, and performance goals for the construction of new assets such as test stands, Mobile Launchers for the Artemis campaign, and antennas for the Deep Space Network. Common issues identified from these reviews include NASA's slow implementation of corrective actions, inconsistent implementation of Agency policies, inadequate life-cycle cost considerations, decentralized strategies and decision-making processes, questioned costs, and substantial cost increases and schedule delays due to poor contractor performance.

39. Deferred maintenance is the total essential but unfunded maintenance work necessary to bring facilities and related equipment to acceptable maintenance standards. Deferring maintenance until equipment fails has resulted in repair and replacement costs up to three times more than had NASA conducted regular maintenance.

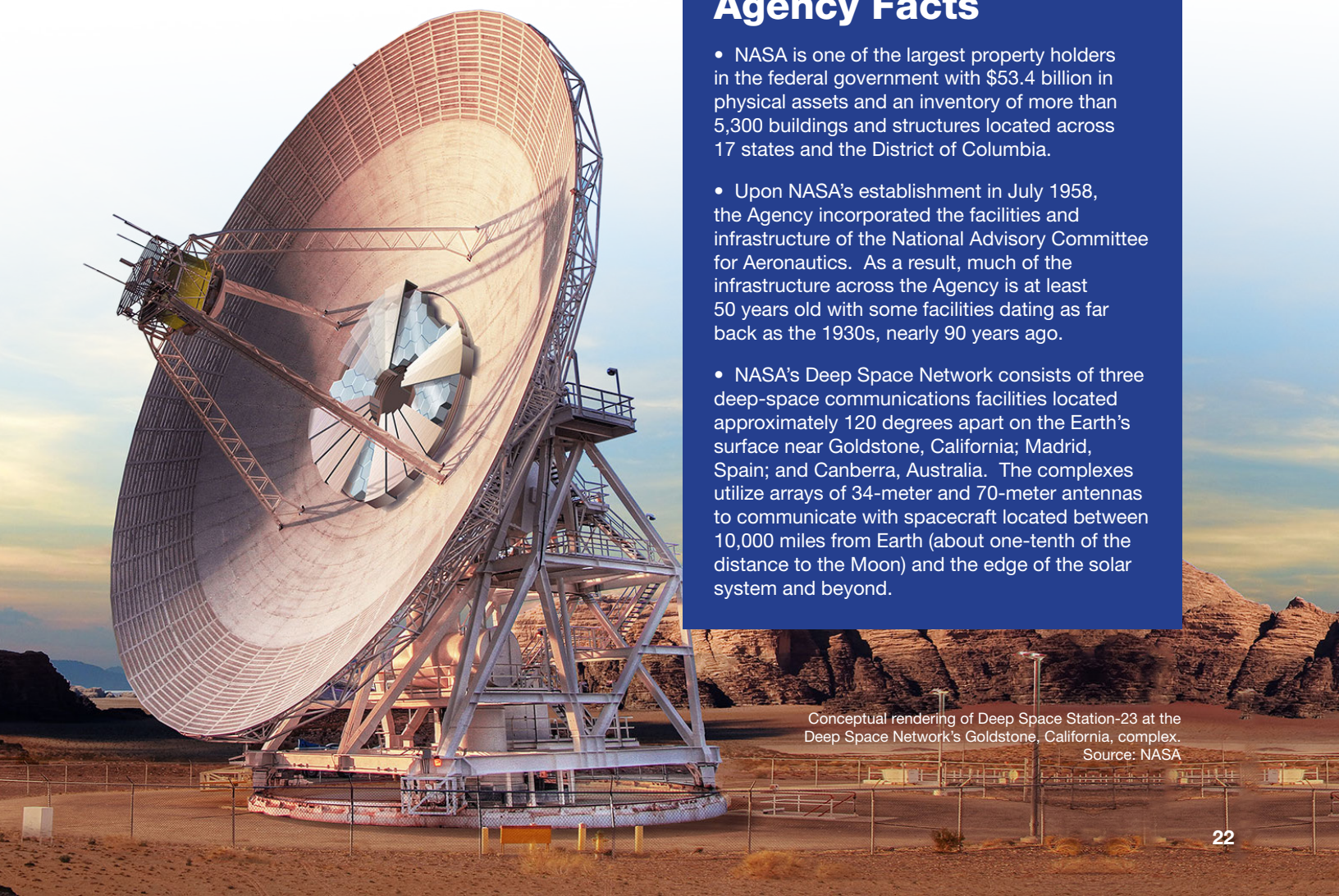
PROGRESS IN ADDRESSING THE CHALLENGE

NASA's CoF program is working to modernize the Agency's infrastructure into fewer, more sustainable facilities and repair, replace, or demolish failing infrastructure to reduce maintenance costs. Between FYs 2019 and 2023, NASA received more than $1.7 billion in CoF funding that it used for construction projects and facility upgrades. For example, NASA's Space Communications and Navigation program office utilized CoF funds in combination with funds carved out from its budget to fund the Deep Space Network Aperture Enhancement Project. NASA initiated the project in 2010 to construct six new antennas for its Deep Space Network, an international array of giant radio antennas that support communication and data exchange for interplanetary spacecraft. During this period, the Agency also made other significant investments in facilities and infrastructure such as laboratories, launch complexes, office buildings, and test facilities at Centers across the country and satellite locations around the world.

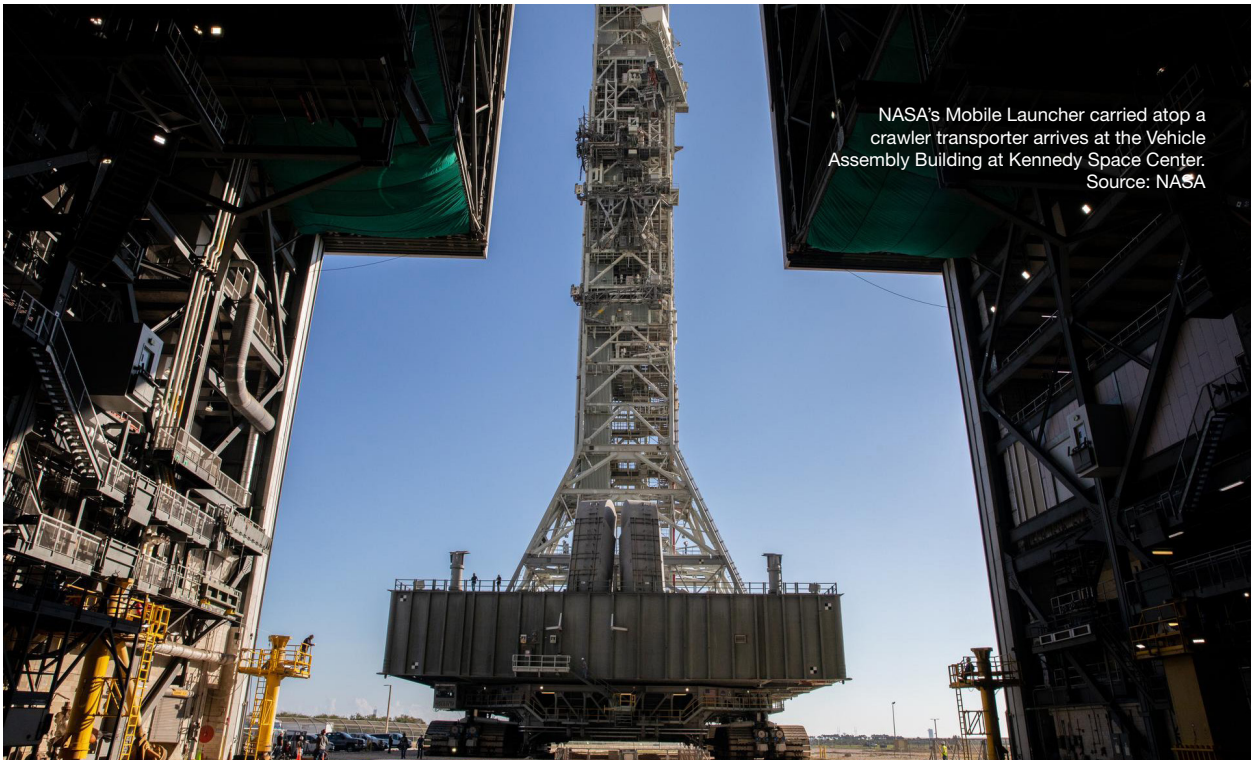
NASA is also working to reduce or eliminate facilities for which there is no current or future mission need. The Agency has options to retain the property in its present state, demolish the property, transfer the property to the General Services Administration (GSA) for sale, or lease the property. Leasing is an option that has the benefit of generating revenue the Agency can use to help reduce expenses and defray the costs of maintaining facilities. Since 2003, NASA has been congressionally authorized to develop underutilized property using enhanced use leases and retain the proceeds from cash and in-kind consideration from real property leases. The proceeds may be used for maintenance, revitalization, and improvements of real property assets. In FY 2022, NASA utilized 47 enhanced use leases to generate $9.2 million in cash and in-kind consideration. And since 2010, the Agency divested 7.2 million square feet of real estate and transferred 51 properties to the GSA.

Agency Facts

- NASA is one of the largest property holders in the federal government with $53.4 billion in physical assets and an inventory of more than 5,300 buildings and structures located across 17 states and the District of Columbia.
- Upon NASA's establishment in July 1958, the Agency incorporated the facilities and infrastructure of the National Advisory Committee for Aeronautics. As a result, much of the infrastructure across the Agency is at least 50 years old with some facilities dating as far back as the 1930s, nearly 90 years ago.
- NASA's Deep Space Network consists of three deep-space communications facilities located approximately 120 degrees apart on the Earth's surface near Goldstone, California; Madrid, Spain; and Canberra, Australia. The complexes utilize arrays of 34-meter and 70-meter antennas to communicate with spacecraft located between 10,000 miles from Earth (about one-tenth of the distance to the Moon) and the edge of the solar system and beyond.



Conceptual rendering of Deep Space Station-23 at the Deep Space Network's Goldstone, California, complex. Source: NASA



NASA's Mobile Launcher carried atop a crawler transporter arrives at the Vehicle Assembly Building at Kennedy Space Center. Source: NASA

WORK REMAINING TO ADDRESS CHALLENGE

As NASA upgrades its facilities and infrastructure, including those required for critical Artemis missions, the Agency has struggled with poor project management leading to substantial cost increases and schedule delays. In July 2023, we reported that NASA has made limited progress upgrading the Agency's Deep Space Network, the critical communication link between spacecraft beyond LEO and Earth.[40] NASA completed the installation of four of six antennas, but the Agency does not expect the fifth and sixth to be complete until 2025 and 2029, nearly 4 years behind its initial schedule. In addition, the expected life cycle cost for this upgrade project will increase from $419 million to $706 million, a $287 million or 68 percent increase. We found similar delays and cost increases in our assessment of NASA's modifications and construction of its two mobile launchers.[41] In March 2020, we reported the first mobile launcher modified to accommodate the SLS cost $693 million—$308 million more than the Agency's March 2014 budget estimate—and was running more than 3 years behind schedule. And in June 2022, we estimated NASA would spend approximately a billion dollars or at least 2.5 times more than initially planned for the second mobile launcher contract, with final delivery expected at least 2.5 years later than initially planned.

NASA also continues to face challenges with rebuilding and fortifying its facilities and infrastructure following natural disasters such as hurricanes and other weather-related events. Up to two-thirds of NASA's infrastructure lies within feet of sea level along coastlines. However, as sea levels rise, so does the potential damage from storms, storm surges, and extreme weather events. In the past decade, NASA has rebuilt infrastructure affected by disasters such as Hurricanes Sandy and Matthew that swept away protective sand dunes at Kennedy Space Center in Florida, Hurricane Harvey, which flooded the Sonny Carter Training Facility where astronauts train at Johnson Space Center in Houston, and Hurricane Ida that caused extensive damage to the roof of a building where the SLS main propulsion system is manufactured and assembled at the Michoud Assembly Facility in New Orleans, Louisiana.

Overall, NASA continues to have difficulty deciding how best to invest, divest, lease, or consolidate unneeded infrastructure; conduct upgrades of key facilities in a cost-effective manner; and rebuild and protect infrastructure affected by natural disasters. As it moves forward with executing important decisions about the future of its facilities, the Agency must effectively communicate those decisions to stakeholders and be prepared to withstand the inevitable political pressure to retain unnecessary capabilities and facilities at Centers throughout the country.

40. NASA OIG, *Audit of NASA's Deep Space Network*, (IG-23-016, July 12, 2023).

41. NASA OIG, *Audit of NASA's Development of It's Mobile Launchers* (IG-20-013, March 13, 2020) and IG-22-012.

APPENDIX A: ACRONYMS

ABC	Agency Baseline Commitment
AI	Artificial Intelligence
Ax-1	Axiom Space Mission 1
Ax-2	Axiom Space Mission 2
Ax-3	Axiom Space Mission 3
CHIPS	Creating Helpful Incentives to Produce Semiconductors
CLPS	Commercial Lunar Payload Services
CoF	Construction of Facilities
CyPrESS	Cybersecurity and Privacy Enterprise Solutions and Services
DEIA	Diversity, Equity, Inclusion, and Accessibility
DST	Deep Space Transport
EPOC	Exploration Production and Operations Contract
ESDMD	Exploration Systems Development Mission Directorate
FY	Fiscal Year
GAO	Government Accountability Office
GSA	General Services Administration
HLS	Human Landing System
IRB	Independent Review Board
ISS	International Space Station
IT	Information Technology
JCL	Joint Cost and Schedule Confidence Level
LEO	Low Earth Orbit
ML-2	Mobile Launcher-2
OCIO	Office of the Chief Information Officer
OSAM-1	On-orbit Servicing, Assembly, and Manufacturing 1
OSTEM	Office of STEM Engagement
SLS	Space Launch System
SpaceX	Space Exploration Technology Corporation
STEM	Science, Technology, Engineering, and Mathematics
VERITAS	Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy
VIPER	Volatiles Investigating Polar Exploration Rover

APPENDIX B: MANAGEMENT COMMENTS

National Aeronautics and Space Administration

Office of the Administrator
Mary W. Jackson NASA Headquarters
Washington, DC 20546-0001

October 13, 2023

TO: Inspector General

FROM: Administrator

SUBJECT: Agency Response to Office of Inspector General Report, "2023 Report on NASA's Top Management and Performance Challenges"

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review and comment on the Office of Inspector General (OIG) report entitled, "2023 Report on NASA's Top Management and Performance Challenges" (Q-23-04-00-AOQA), issued September 11, 2023.

The audits and investigations conducted by your office provide NASA's leadership and management with valuable contributions to the collective effort to provide oversight and gain insight into NASA's broad portfolio of programs, projects, and mission support activities with which it is entrusted. The efforts expended by your office during this past year have furthered the cause of providing the taxpayer with maximum value for each dollar invested in NASA's wide-ranging, ambitious, and challenging portfolio. As an Agency, we continue to aggressively pursue the mitigation and remediation of findings related to the audit recommendations issued by your office, including those which form the underpinnings of your observations as cited in your 2023 Report on NASA's Top Management and Performance Challenges.

While we fundamentally agree that the seven areas outlined in your 2023 report constitute significant challenges for the Agency, we would like to highlight the following mitigation and remediation efforts relative to each challenge outlined in your report that have either been taken or are currently underway. We believe these efforts substantively demonstrate NASA's commitment to addressing its most significant management and performance challenges faced by the Agency:

Challenge 1: Returning Humans to the Moon

NASA continues to make significant progress towards returning humans to the Moon through the Artemis campaign. NASA's uncrewed 25.5-day Artemis I flight test proved the Space Launch System (SLS) rocket, Orion spacecraft, and the Exploration Ground Systems (EGS) needed for launch and recovery are ready to fly astronauts on missions to the Moon. Engineers conducted analysis of flight data during the mission from November 16 – December 11, 2022, and, afterwards, have continued to assess data and hardware to validate system performance ahead of Artemis II. On the debut flight of SLS, the rocket flew as designed and with precision, with all systems meeting, and in many cases exceeding, performance expectations. Following a near-perfect trans-lunar injection burn, the rocket's

interim cryogenic propulsion stage and Orion successfully separated, delivering Orion to its initial target orbit and then on a trajectory toward the Moon. Meanwhile, engineers with the EGS program completed detailed assessments of Mobile Launcher (ML-1) shortly after launch and determined ML-1 sustained more damage than initially expected from the 8.8 million pounds of thrust generated at liftoff by SLS on Artemis. NASA repaired damaged components and completed modifications for the first crewed mission on Artemis II, including verification and validation of the Crew Access Arm and fabrication, installation, and commissioning of the emergency egress system. Teams also are extensively reviewing more than 155 gigabytes of Orion data to confirm the spacecraft's successful performance during its journey nearly 270,000 miles beyond the Moon. Orion accomplished 161 test objectives to fully demonstrate every aspect of the spacecraft, including 20 objectives added mid-flight. Data shows the European-built service module generated 20 percent more power than initial expectations and consumed about 25 percent less power than predicted. All the spacecraft's dynamic separation events were completed without issue and splashdown occurred 2.4 miles from the target landing spot, well within requirements. Upon return to Kennedy Space Center (KSC) in Florida, avionics components earmarked for reuse on Artemis II have been removed, refurbished, and integrated into the Artemis II crew module. NASA also continues to review data from reentry and post-flight inspections to understand differences between the demonstrated performance of Orion's Avcoat heatshield on this test flight compared to predictions made before the flight.

NASA has also made steady progress towards Artemis II. In April 2023, NASA named the Artemis II crew of Americans Christina Hammock Koch, Reid Wiseman, and Victor Glover, and Canadian Space Agency astronaut Jeremy Hansen. The five SLS core stage elements for Artemis II are mated, and the stage is going through final integration and testing at the Michoud Assembly Facility in Louisiana. The SLS solid boosters and interim cryogenic propulsion stage have been delivered to the KSC in preparation for vehicle stacking. ML-1 repairs are ongoing, Crew Access Arm functional testing completed, and launch pad 39B upgrades (including a new 1.4 million gallon liquid hydrogen sphere that will increase launch availability and support the tanking needs of SLS Block 1B) at KSC are progressing. Orion Crew Module (CM) and Service Module (SM) are preparing for mate.

NASA will follow the Artemis II crewed test flight with the first human lunar return mission on Artemis III. NASA convened a lunar surface science workshop in April 2022 to gather data and points of interest within thirteen potential landing sights at the Moon's south pole. Manufacturing is underway on all SLS Artemis II hardware with a new core stage production flow planned to balance integration tasks between the Michoud Assembly Facility and the KSC. Orion Artemis III hardware is also in production, the first crew module being built under the Orion Production and Operations Contract (OPOC) and European service module integration in progress in Bremen, Germany. SpaceX, on contract with NASA to provide the Human Landing System for Artemis III, attempted a flight test of the integrated Starship/Super Heavy in April 2023 that ended prematurely approximately four minutes into the flight; a SpaceX-led investigation has completed with Federal Aviation Administration (FAA) oversight and NASA participation ahead of a second planned test.
NASA is organized to ensure the success of the lunar return mission, a sustainable program of lunar exploration, and preparations for human missions to Mars. On March 23, 2023, NASA announced the establishment of the Moon to Mars Program Office within the

Exploration Systems Development Mission Directorate (ESDMD). As directed by the NASA Authorization Act of 2022, the Moon to Mars Program Office focuses on hardware development, mission integration, and risk management functions for programs critical to the Agency's exploration approach. The Moon to Mars Program Office consolidates the management of programs (including the Space Launch System rocket; the Orion spacecraft; exploration ground systems; the lunar Human Landing System; spacesuits, rovers, and lunar surface habitats; and the lunar orbiting Gateway platform) and cross-program integration functions (including systems engineering, program planning and control, safety, and exploration operations) into a single organization with clear responsibility and authority for conducting Artemis missions. The office also leads planning and analysis for long-lead developments to support human Mars missions.

The Moon to Mars Program Office has streamlined governance through such measures as consolidating decision-making through a single Moon to Mars control board. NASA manages the Artemis manifest and the associated integrated mission schedules at the enterprise level ensuring a single effort towards schedule management. This integrated mission schedule approach increases program and contractor accountability and risk mitigation for elements along and near the critical path. Top technical concerns and issues, tracked by mission, are continuously monitored and progress is reported through a series of Moon to Mars, ESDMD, and Agency quarterly reviews, management councils, and baseline performance reviews.

NASA is working closely with the Artemis contractors to ensure their performance and mission success. NASA is increasing prime contractor participation in Quarterly Program Status Reviews, control boards, and other integrated forums with the Moon to Mars programs. This also includes contractors actively participating in flight readiness assessments, sharing of integration tasks where applicable, and exchanging lessons learned. With an acquisition approach aligned to risk management, NASA utilizes a wide variety of contract mechanisms tailored to the specific technical and programmatic conditions for each program. NASA's exploration program, for example, leverages a mix of cost-plus contracts as well as utilization of firm-fixed price contracts that reflect the growing maturity, innovation, and diversity of the United States (U.S.) space industry.

Challenge 2: Improving Management of Major Projects and Projects

NASA recognizes the inherent challenges of managing large, complex, often first-of-their-kind space flight and aeronautics programs and has worked over many years to improve policies and processes that control cost and schedule while ensuring mission success. These efforts coincide with NASA's continued observance of sound financial practices and programmatic rigor as good stewards of taxpayer dollars.

The Agency has pursued improvements in acquisition and project management to further strengthen program formulation, approval, implementation, and ongoing evaluation. We appreciate that this report highlighted the Government Accountability Office's (GAO) recognition of NASA's continued improvement in acquisition management and its assessment that NASA has fully met four out of five criteria to be removed from GAO's Acquisition High Risk List and is partially met on the final criterion. Further, in August 2021, the NASA Deputy Administrator initiated a Tiger Team whose recommendations

created a more robust structure for acquisition planning. A key initiative was the elevation of the Chief Acquisition Officer (CAO) role to the NASA Deputy Administrator, raising acquisition planning to the attention of the Agency's most senior officials. In December 2022, the CAO released a memorandum of intent to Agency leaders detailing acquisition priorities to enhance agency insight, oversight, and project performance. The CAO later hosted a series of town hall meetings across NASA headquarters and its nine Centers to communicate the Agency's commitment to improved acquisition outcomes. These CAO actions emphasized the importance of ensuring rigorous acquisition approaches are aligned with best practices and the value of an acquisition workforce to advancing these objectives.

NASA leadership also leveraged the Tiger Team findings by establishing a Chief Program Management Officer (CPMO) to enact measurable, enduring improvement in program and project performance through cross-enterprise coordination. Among the CPMO's responsibilities is providing executive guidance as NASA works to mitigate high-risk areas identified through its Corrective Action Plan (CAP). As OIG recognizes in the report, the Agency has made substantial progress in the implementation of its CAP, including the improvements highlighted in the most recent update approved by NASA leadership in summer 2022. Additional initiatives from the Tiger Team included the promotion of early discussions on acquisition strategies and plans; requiring an Analysis of Alternatives for Acquisition Strategy Meetings to address acquisition options measured against an established set of key drivers such as performance, cost, schedule, ownership, policy, and workforce; and initiating in-depth reviews of major programs at a monthly assessment to ensure senior leadership maintains situational awareness of program performance.

These efforts are reinforced by NASA's sustained commitment to providing transparent and accountable communication in accordance with our statutory obligations. NASA is fully compliant with Title 51 by having all major development activities subject to congressional reporting and performance thresholds. For programs and projects with an unspecified Phase E scope and duration, the initial capability cost estimate and other parameters become the Agency Baseline Commitment (ABC). In addition, NASA establishes ABCs for all future major upgrade development activities and communicates an annually updated five-year operations cost estimate starting prior to Phase E. This approach complies with Title 51 and ensures the Agency consistently and effectively communicates estimates of Phase E operations as the mission cadence matures.

Regarding the report's comments about the Agency's application of the Joint Cost and Schedule Confidence Level (JCL) and consideration of external risks as part of the analysis, it is important to note that NASA appropriately applies the JCL in alignment with the established Agency commitments pursuant to Title 51. Commitments at the mission level are not required by Title 51 since missions consist of multiple elements, and these costs are captured in their individual element Phase E costs, which may be five-year estimates for systems with unspecified operational scope and duration, as mentioned above. Therefore, even though the Agency actively manages technical and operational requirements and risks across Artemis missions, NASA does not plan to make formal commitments at the mission level—as such, confidence-level analysis is not provided by mission. While the Agency does not have a formalized requirement to perform risk analysis by mission specifically, it does

have formal processes to inform management of global and interdependency risks across major programs and projects as it relates to their commitments.

Major programs are already required to address potential externality risks by identifying and estimating the cost and schedule impacts. For projects and single-project programs, a JCL analysis is required to support the ABC in accordance with NASA Procedural Requirements (NPR) 7120.5F. The JCL calculation includes consideration of the risk associated with all elements. JCL analysis derived from a probabilistic cost and loaded probabilistic schedule approach typically includes content only through the completion of Phase D, which, by definition, is not representational of the total life-cycle cost or operational life of a project. While NPR 7120.5F does not require tightly coupled, loosely coupled, and uncoupled programs to develop program cost and schedule confidence levels, they must provide analysis of the program's risk posture as each new project reaches KDP-B and C, or when a project is re-baselined. NASA continues to promote consistency as well as identify opportunities to improve how management policies are applied across mission areas while also implementing performance metrics informed by proven analytical techniques.

Specific to the report's encouragement for enhanced visibility into the investments of the Artemis campaign, costs of newly developed capabilities will be provided in addition to production and operation cost estimates for any hardware in the mission that has been previously produced and operated.

NASA is at a historic inflection point, poised to advance the most significant series of science and human exploration missions in over a generation. The Agency continues to optimize the use of available resources in the pursuit of effective and efficient solutions that improve project management and support the advancement of ingenuity and innovation in space science, human exploration, and aerospace technology.

Challenge 3: Sustaining a Human Presence in Low Earth Orbit

NASA recognizes that forward work remains to avoid a gap between the initial operations of commercial LEO destinations (CLDs) and the retirement of the International Space Station (ISS) by 2030. NASA's Commercial LEO Development Program (CLDP), Commercial Crew Program (CCP), and International Space Station (ISS) Program work together as parts of a LEO ecosystem. NASA has aligned the activities of these programs to ensure that the U.S. continues to provide leadership in developing the LEO economy while continuing the uninterrupted human presence in LEO. NASA also agrees that the Agency will need to continue balancing multiple priorities including maintaining ISS operations, stimulating a commercial LEO economy, ensuring sufficient crew and cargo capabilities, managing orbital debris, and planning for ISS deorbit.

Stimulating a LEO economy

NASA is continuing to safely maintain operations aboard the ISS while also enabling the development of the LEO economy. During FY23, NASA successfully executed Expeditions 68 and 69 which supported over 17 US Orbital Segment (USOS) crewmembers, conducted over 265 investigations, of which over 180 were NASA-led. In May 2023, the ISS also hosted the second private astronaut mission, Axiom Space's Ax-2. These private astronaut missions represent both a culmination of NASA's efforts to foster a commercial market in

LEO and the beginning of a new era of space exploration. NASA also announced the selection of Axiom Space for private astronaut missions, Ax-3 and Ax-4, respectively. Ax-3 is set to launch no earlier than January 2024 and Ax-4 no earlier than August 2024 from KSC. These additional missions are opening access to LEO and the ISS to more international partners, people, science, and commercial opportunities.

In October 2023, Nanoracks, part of Voyager Space's Exploration Segment, and Northrop Grumman announced that they are teaming up to support Nanoracks' development of the Starlab commercial space station. Rather than developing its own destination as planned under a separate Space Act Agreement (SAA) with NASA, the Agency and Northrop Grumman agreed to withdraw from its agreement so the company can join Voyager Space and Nanoracks in providing cargo logistics services and engineering services to support the Starlab station. This was a positive development for the commercial low Earth orbit destinations effort. Refining strategies and evolving partnerships are part of the process as NASA enables the development of a robust low Earth orbit economy where NASA is one of many customers. NASA plans to take the remaining funding associated with Northrop Grumman's withdrawal and other program funding to add milestones to the Agency's existing agreements with the other funded destination partners including Voyager Space/Nanoracks, Blue Origin, and Axiom Space, assuming NASA and the companies can agree on the additional milestones and value. This opportunity will provide NASA the ability to reduce risk and have additional insight into the partners' technical designs. NASA has quarterly meetings with industry partners to assess their progress and gain insight into their development schedule. The CLD partners are strongly incentivized to be first-to-market, particularly for their commercial customers. NASA continues to refine its acquisition strategy for the eventual certification and services purchases for CLDs.

In June 2023, NASA partnered with seven U.S. companies to meet future commercial and Government needs through the second Collaborations for Commercial Space Capabilities-2 (CCSC-2) initiative. Using unfunded Space Act Agreements (SAAs), CCSC-2 is designed to advance commercial space-related efforts through NASA contributions of technical expertise, assessments, lessons learned, technologies, and data. Sharing of NASA expertise utilizes minimal Government resources but fosters development of capabilities that can be crucial to development of a robust LEO economy.

Ensuring crew/cargo transportation

CCP is continuing to provide crew transportation services to the ISS from U.S. Commercial Space Transportation service providers. SpaceX successfully launched Crew-6 and Crew-7 to the ISS and is targeting to launch Crew-8 in February 2024. Boeing's latest crewed flight, CFT, was scheduled for July 2023 but was deferred due to emerging parachute issues. Boeing has made significant progress on CFT hardware processing and product closure and is continuing to work through spacecraft issues. Ninety-eight percent of the certification products required for the CFT are complete. The CFT launch date is currently under review with a spacecraft readiness date of no earlier than March 2024.

NASA issued a sole source modification to SpaceX to acquire up to three additional crew flights to the ISS, as part of its Commercial Crew Transportation Capabilities (CCtCap) contract, which will allow NASA to maintain an uninterrupted U.S. capability for human access to space. Currently, the SpaceX crew transportation system is the only one certified to

meet NASA's safety requirements to transport crew to the space station, and the additional award maintains the Agency's obligation to its international partners.

NASA also ordered 12 additional missions under the Commercial Resupply Services-2 (CRS-2) contracts. The 12 additional missions ordered – six each to Northrop Grumman and SpaceX – will provide resupply services to the station through 2026. NASA continues to work with Sierra Space on their Dream Chaser spacecraft which could be certified as another cargo resupply vehicle.

Orbital debris mitigation

NASA is highly aware that orbital debris created by objects, such as abandoned vehicle stages, non-functional satellites, and fragments of launched materials, impedes our ability to use space by increasing the cost of space operations (maneuvering around debris), threatening the safety of astronauts and satellites, limiting the ability to launch spacecraft, and potentially rendering entire orbits unusable for a generation or more. Small debris are the most likely source of collisions with spacecraft due to the overall amount and current inability to track and avoid them.

Currently, NASA's Space Technology Mission Directorate (STMD) has multiple investments in low technology readiness level (TRL) orbital debris mitigation, detection, and remediation technologies across several programs, including the Small Spacecraft Technology (SST) and the Early-Stage Innovations and Partnerships (ESIP) portfolio through various mechanisms such as: Space Technology Research Grants (STRG's); Small Business Innovation/Small Business Tech Transfer (SBIR/STTR); and Prizes, Challenges, and Crowdsourcing (PCC).

In August 2023, as a part of STMD's SBIR Ignite initiative, a pilot solicitation which aims to increase participation from product-driven small business, startup, and entrepreneur companies that are *not* looking at NASA as their primary customer, NASA awarded 2 Phase II awards to companies for concepts dealing with orbital debris. These are:

- *Trans Astronautica Corporation, Los Angeles: Mini Bee Capture Bag for Active Debris Remediation.*
- *Turion Space Corp., Irvine, California: Low-Cost CubeSat for Active Removal of Sizable Space Debris Utilizing a Mothership Architecture.*

In FY23, NASA developed and initiated a small orbital debris challenge through its Early-Stage Innovation Program (ESIP) with the objective of identifying, tracking, and remediating small debris by honing concepts already proposed and generating additional ideas. The challenge will also provide NASA with insight into how such technologies could be deployed, the scalability and costs of various remediation approaches, the pool of innovators from known and adjacent areas of expertise who are capable and/or willing to work on small debris mitigation, and technology gaps that could be addressed by other funded efforts.

Deorbit planning

During FY23, NASA developed requirements for a commercial U.S. Deorbit Vehicle (USDV) based on industry responses and released a request for U.S. industry proposals for a

USDV that safely deorbits the ISS as part of its planned retirement after 2030. Proposals are due in November 2023, with a subsequent award expected in 2024.

Challenge 4: Managing and Mitigating Cybersecurity Risk

In 2023, the Office of the Chief Information Officer (OCIO) participated in a months-long National Security Council (NSC) directed effort to improve Agency use of multi-factor authentication (MFA) and encryption of data-in-transit (DIT) and data-at-rest (DAR). Although NASA has not reached the numeric goals set by the NSC, OCIO is working on a detailed plan of action to improve these results. To achieve Executive Order (EO) 14028 goals, NASA assembled a Cybersecurity Improvement Portfolio (CIP) with a near-term focus of achieving Zero Trust Architecture within three years on the corporate network.

The OCIO Software Licensing and Asset Management (SLAM) team is working the seven recommendations from the recent audit, including implementation of enhanced policy, training, and software management tools.

NASA's responsible Artificial Intelligence (AI) officials have approved NASA adoption of the definition of AI from the 2019 National Defense Authorization Act. The responsible AI team has begun promulgation of the use of this definition, and it will be used in future AI inventories and responsible AI governance work.

As noted in the closure of the NASA OIG audit, "NASA's Cybersecurity Readiness," OCIO has established an Agency-level office led by the NASA Chief Enterprise Architect with direct oversight of the Enterprise Cybersecurity Architect, with all requisite organizational structure, roles and responsibilities, supporting governance, Agency-level strategic direction, and metrics that evaluate the effectiveness and success of the overall Environmental Assessment program.

Challenge 5: Improving Oversight of Contracts, Grants, and Cooperative Agreements

NASA continues to make meaningful progress in addressing contracts, grants, and cooperative agreement oversight challenges and continues to strengthen its overall procurement processes and policy.

NASA Office of Procurement (OP) collaborated closely via regular weekly engagements with technical, program, legal, and financial stakeholders to enhance transparency, accountability, and oversight of Category 1 contracts to ensure quality, timeliness of delivery, and cost control.

NASA OP procurement analysts advised and assisted Centers through Procurement Strategy Meetings (PSMs) to conduct risk analyses to best determine appropriate contract type. NASA OP advised and assisted on six major programs/activities (SEWP VI Governmentwide Acquisition Contract (GWAC) for Commercial IT Products and Services; Lunar Terrain Vehicle Services; GeoXO Spacecraft; SLS, Pre-SLS Exploration Production and Operations Contract (Pre-EPOC); LaRC Center Maintenance Operations and Engineering (CMOE III) Contract; and U.S. ISS Deorbit Vehicle (USDV)) to ensure the

contract type determination was justified and supported by historic data, market research, and appropriately considered performance risk.

Additionally, NASA OP added increased rigor to its review of contractor performance to ensure assigned ratings accurately reflected past performance and were well documented. Similar enhanced reviews were conducted for award-term and award-fee determinations to more appropriately incentivize contractor performance. OP procurement analysts and leadership were included in meaningful deliberations with Centers to finalize ratings and fee determinations to ensure consistent standards across the NASA enterprise with particular attention given to cost and schedule concerns.

With respect to grants and cooperative agreements, this monitoring plan includes:

- Pre-award risk assessment: Determines the level of risk associated with the recipient managing an award, as well as the award type. Assessment results determine the level of required monitoring to mitigate areas of high risks.
- Routine monitoring: An observation of award compliance through the review of recipient drawdowns and costs charged to an award. Recipient drawdowns are monitored quarterly through an analysis of the Federal Cash Transaction Report in accordance with 2 CFR § 200.328, Financial Reporting. In addition to Federal Cash Transaction Report, Grant Officers are charged with performing a systematic test of grantee expenditures from a selected quarter to identify potential unallowable, or unreasonable costs to assess the likelihood that recipients' errors would result in a material effect on Federal awards.
- Advanced monitoring: Focuses on an inclusion of award-specific terms and conditions, including more frequent reporting, to provide reasonable assurance that recipient entities managing the higher-risk awards have increased awareness of project goals and potential shortfalls.

Challenge 6: Attracting and Retaining a Highly Skilled and Diverse Workforce

The Agency remains committed to tackling workforce issues and to building an even stronger talent pipeline to accomplish NASA missions. NASA's Office of the Chief Human Capital Officer modernized the recruiting process and developed a coordinated recruitment strategy using a standardized approach and leveraging digital platforms to engage with prospective candidates. A critical piece of the recruitment strategy focuses on increasing workforce diversity by reaching new talent communities and establishing NASA as an employer that celebrates diversity and inclusion as keys to success. NASA has received multiple awards in 2022 and 2023 in recognition for our outreach and employment of under-represented groups: Ranked #1 Most Prestigious Internships (Vault/Firsthand, 2023), Top 20 Government Employers (Woman Engineer Magazine, 2023), Top 20 Government Employers (STEM Workforce Diversity Magazine, 2023), America's Best Employer for Veterans (Forbes, 2022), and America's Best Employers For Women (Forbes, 2022, 2023). NASA continually measures efforts and iterates on its recruitment strategy to ensure success. Multiple hiring authorities are utilized to quickly fill positions as well as pay incentives to recruit the right skills into the Agency.

NASA's workforce planning includes all NASA Mission Directorates, NASA Centers, and Mission Support Enterprise Organizations (MSEOs). NASA Mission Directorates develop guidance that provides clarity on future work content engaging with Centers and MSEO in demand-driven workforce planning activities to ensure the workforce is sufficiently agile in size and mix. This process positions NASA to continue global leadership in space science, human exploration, aerospace innovation, and technology development and effectively respond to both known and uncertain mission demands. Annual workforce plans for both Centers and MSEOs include projections of workforce size over a five-year time horizon, future composition of the workforce and expected hiring patterns, strategies for shaping and managing the workforce, and risk assessment. This strategic planning process helps NASA to shape the future by defining clear and challenging workforce roles needed to enable long-term goals in science, exploration, aerospace, technology, and innovation.

NASA 2040 was launched in June 2023 to bring a new focus to aligning our institutional operations to our priority mission needs. This initiative aims to drive meaningful changes that ensure NASA in the year 2040 remains the global leader in aerospace and science. A specific area of focus includes shaping an Agency workforce strategy.

Challenge 7: Managing NASA's Outdated Infrastructure and Facilities

To address the challenges with aging infrastructure and facilities, NASA is implementing a top-down, mission-driven Agency Master Plan (AMP). This plan ensures that the required infrastructure is available and affordable, guides Agency investments to prioritize mission critical assets, reduces the risk of unplanned failures, and guides divestment of assets not needed for the Agency's missions. The AMP will establish a 20-year vision for physical infrastructure and real property assets that aligns with current, evolving, and future mission requirements. NASA will use this process to identify critical capabilities and areas for asset sustainment, investment, repurposing/out granting, or divestment of infrastructure.

To alleviate the maintenance burden, NASA's Office of Strategic Infrastructure (OSI) will continue to strongly advocate to increase its funding for demolition of unneeded facilities. NASA released NPR 8820.2 Revision H, "Facility Project Requirements," on September 27, 2022. This revision includes parameters for the assignment and use of institutional and programmatic Construction of Facilities (CoF) funds, the ability to identify cost-sharing as a funding method, a requirement for energy savings projects to conduct life-cycle cost analyses, requirements to reduce and consolidate the Agency's footprint, tools to assist in the development of project requirements, and definition of new Headquarters roles that will improve oversight of the implementation of CoF projects.

In 2019, OSI began to conduct an analysis on the Agency's leasing policies, procedures, and practices. As a result of this analysis, in 2020, NASA decided to centralize real estate functions across all Centers to OSI-FRED (OSI-Facilities and Real Estate Division). Additionally, OSI-FRED is in the process of updating the NPR 8800.15, "Real Estate Management Program" and is conducting a complete analysis of the Agency's Enhanced Use Lease Program to ensure that internal controls are established, real estate agreements are properly coordinated with all stakeholders, and are compliant with all rules, regulations, and laws. NASA has also identified investment strategies using Reliability Centered Maintenance (RCM) principles to stave off the increasing deferred maintenance liability

within the Agency. OSI-FRED is implementing a Tiered Maintenance approach with foundations of Condition-Based Maintenance principles for relevant and critical assets. These efforts will lead to optimized maintenance programs and prioritization of available operations and maintenance resources.

OSI leadership continues to inform and carry forward advocacy for additional investments necessary to improve the condition of important building systems and facilities across the Agency. Ultimately, this will increase the availability and reliability of these critical assets to meet current, emerging, and future mission needs. Implementation of these RCM principles ensures that the right type of maintenance is performed on the most critical assets, at the right time, and for the right reasons. RCM, paired with immediate investments in the replacement of obsolete items associated with the Agency's higher-criticality assets, can provide near-term corrective mitigation for known risks and avoid mission/schedule impacts. These maintenance strategies focus on increasing equipment availability and avoiding disruptive failures and unplanned repair costs. These initiatives will mitigate the Agency's ongoing challenge of aging and outdated infrastructure and facilities.

Through the implementation of the AMP and the ongoing investments in maintenance, demolition, repair, recapitalization, and out-granting, NASA continually strives to right-size the Agency's infrastructure toward more modern and efficient facilities that will continue to provide a robust real property asset portfolio for NASA mission objectives.

If you have any questions regarding NASA's response to the 2023 Top Management and Performance Challenges, please contact Anthony Mitchell, Audit Liaison Project Manager, at (202) 358-1758.

Bill Nelson

cc:
Chief Financial Officer/Ms. Vo Shaus
Chief Information Officer/Mr. Seaton
Associate Administrator Space Operations Mission Directorate/Mr. Bowersox
Assistant Administrator for Procurement/Ms. Smith Jackson
Assistant Administrator for Strategic Infrastructure/Mr. Carney
Chief Human Capital Officer/Ms. Elliott (Acting)

2023 Report on NASA's

TOP MANAGEMENT and PERFORMANCE CHALLENGES

To report fraud, waste, abuse, or mismanagement, contact the NASA OIG Hotline at 800-424-9183 or 800-535-8134 (TDD) or visit https://oig.nasa.gov/hotline.html. You can also write to NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, .Washington, D.C. 20026. The identity of each writer and caller can be kept confidential, upon request, to the extent permitted by law.

To suggest ideas or request future audits, contact the Assistant Inspector General for Audits at https://oig.nasa.gov/aboutAll.html.