National Aeronautics and Space Administration

FY 2015
Annual Performance Report
FY 2017
Annual Performance Plan

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Introduction

The *NASA 2014 Strategic Plan* established a framework of long-term goals for all of the Agency's activities. The *FY 2015 Annual Performance Report and FY 2017 Annual Performance Plan*[1] builds upon the Strategic Plan framework. This document is a companion to NASA's FY 2017 President's Budget Request,[2] in accordance with the requirements of the *Government Performance and Results Act Modernization Act of 2010*.

The *FY 2015 Annual Performance Report and FY 2017 Annual Performance Plan* integrates reporting of NASA's prior year (FY 2015) performance with its updated performance plan for the current fiscal year (FY 2016), as well as its proposed performance plan for the requested budget fiscal year (FY 2017). Together, this holistic approach provides a retrospective and prospective view of NASA's performance, consistent with Office and Management and Budget guidelines. The document is organized into the following sections:

- **Part 1—Performance Management at NASA** summarizes how the Agency is organized, governed, and managed. It explains NASA as an organization and its approach to performance management, strategic planning, and performance reporting, and how the Agency uses data, evidence, evaluations, and reporting to manage performance. It concludes with a high-level summary of performance for FY 2015.
- **Part 2—Performance Priorities and Management Challenges** describes how NASA prioritizes select performance objectives, in response to both federal and internal Agency mandates. Examples include NASA's approach to the Strategic Review process, NASA's FY 2014–FY 2015 and FY 2016–FY 2017 agency priority goals, and NASA's contributions to the FY 2014–FY 2017 cross-agency priority goals. It concludes by describing how NASA leverages internal reviews to address various management challenges and includes a discussion of NASA's response to the management challenges recently identified by NASA's Office of Inspector General (full response published in NASA's *FY 2015 Agency Financial Report*) and the Government Accountability Office's High Risk List.
- **Part 3—Performance Reporting and Planning** presents NASA's FY 2015 Annual Performance Report and FY 2016 updated and FY 2017 Annual Performance Plan by strategic goal and strategic objective. It shows up to six years of historical performance alongside two years of plans for future performance. This presentation provides a unique opportunity to see performance trends across multiple years within a program, as well as the linkages between multiyear performance goals and their annual components and how these performance measures in turn support the strategic objectives. Where NASA may not be on target to meet a performance goal, or did not achieve an annual performance indicator, a rating explanation or explanation of performance has been provided describing the corrective actions the Agency intends to take in the future. In addition, this section incorporates a summary of the annual Strategic Review by strategic objective and includes tables capturing total budget authority for each strategic objective.
- **Part 4—Supporting Information** comprises all of the supplemental information, including a list identifying the changes made to the updated FY 2016 Annual Performance Plan and captions and credits for the images used in Parts 1, 2, and 3.

[1] The *FY 2015 Annual Performance Report and FY 2017 Annual Performance Plan* is produced by NASA's Office of the Chief Financial Officer with contractor support provided by The Tauri Group.

[2] The FY 2017 President's Budget Request (see the NASA FY 2017 Budget Estimates and related documents) can be found on NASA's Budget Documents, Strategic Plans and Performance Reports website.

The *FY 2015 Annual Performance Report and FY 2017 Annual Performance Plan* captures the full spectrum of NASA's activities to accomplish national priorities in civil aeronautics research, space exploration, science, and advanced research and development.

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Part 1
Performance Management at NASA



Part 1 summarizes NASA as an organization and its approach to strategic planning, performance management, and performance reporting. It also explains how the Agency is organized, including the governance and management structure, and how it uses data, evaluations, and reporting to manage performance. Parts 2 and 3 describe NASA's performance priorities and management challenges, its reported performance for FY 2015, and its annual performance plans for FY 2016 and FY 2017.

A Performance-Based Organization

NASA is a performance-based organization, as defined and described by the Office of Management and Budget's *Circular A-11*. A performance-based organization commits to manage towards specific, measurable goals derived from a defined mission, using performance data to continually improve operations. The concept of a performance-based organization was codified in the *Government Performance and Results Act (GPRA) of 1993* and updated in the *GPRA Modernization Act of 2010*. As a performance-based organization, NASA is dedicated to results-driven management focused on optimizing value to the American public. NASA sets concrete goals and holds itself accountable to those goals through a transparent framework that guides how it measures progress.

NASA Vision and Mission

NASA's Vision and Mission are defined collaboratively through internal and external stakeholder input. NASA last revised its Vision and Mission statements in the *NASA 2014 Strategic Plan*.

NASA's Vision is:

> We reach for new heights and reveal the unknown for the benefit of humankind.

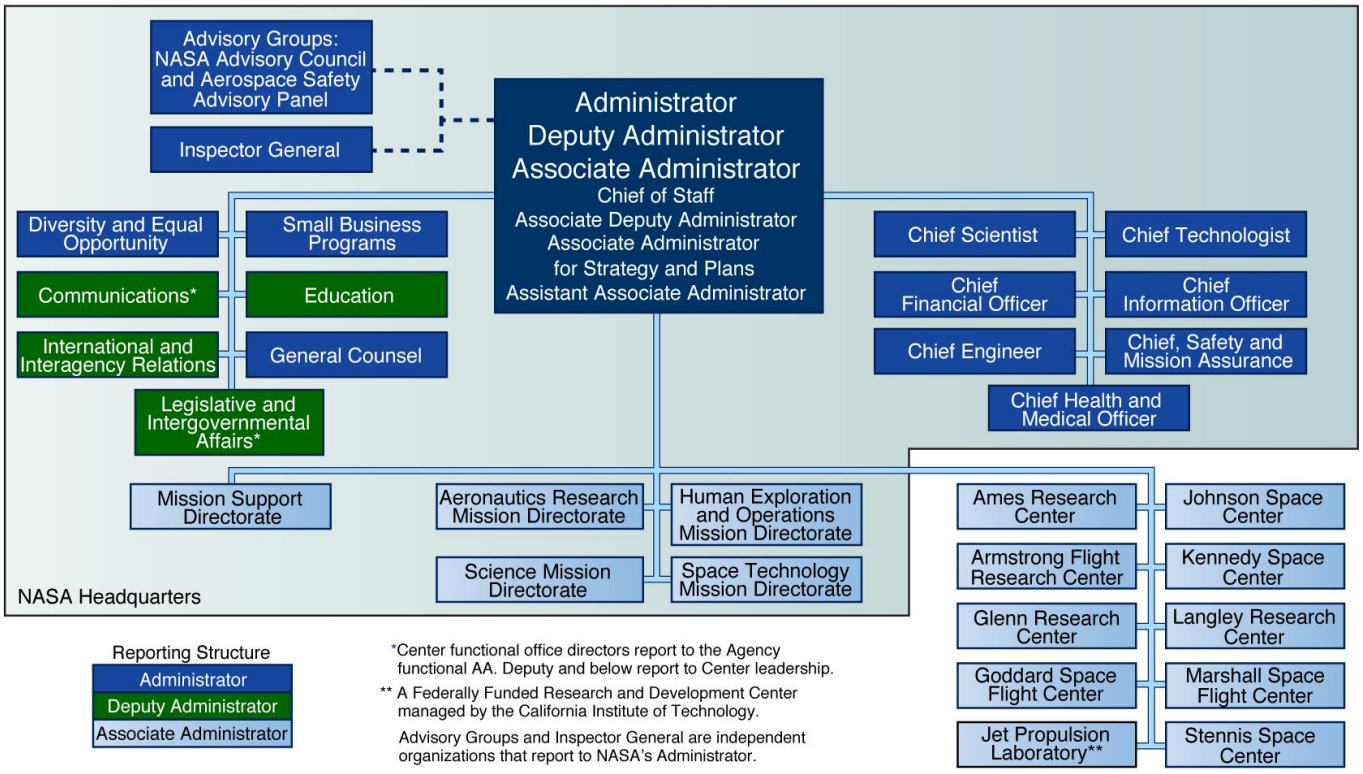
NASA's Mission is to:

> Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth.

Organizational Structure

NASA's organizational structure is designed to accomplish its Mission through sound business, management, and safety oversight. Under the leadership of the Administrator, NASA offices at Headquarters in Washington, DC, guide and direct the Agency. The Office of the Administrator provides top-level strategy and direction for the Agency. The Administrator and his staff give programmatic direction for NASA's missions and guide the operations of the Centers. NASA's Centers and facilities execute the mission work—engineering, operations, science, technology development—and supporting activities. Figure 1 depicts NASA's organizational structure, current as of February 2016.

Figure 1: NASA's Organization



The *NASA Organization* (NASA Policy Directive 1000.3E) establishes components that have budget oversight and performance management responsibilities for distinct portfolios that support NASA's Mission. These components include mission support offices, the Administrator's staff offices, and NASA's Office of Inspector General, and the Administrator's staff offices, as described below.

- The **Science Mission Directorate (SMD)** carries out the scientific exploration of Earth and space to expand the frontiers of Earth science, heliophysics, planetary science, and astrophysics. Through a variety of robotic observatory and explorer craft and through sponsored research, the directorate provides virtual human access to the farthest reaches of space and time, as well as practical information about changes on Earth.
- The **Aeronautics Research Mission Directorate (ARMD)** conducts cutting-edge research that generates innovative concepts, tools, and technologies to transfer to the aviation community for further development. Every U.S. commercial aircraft and U.S. air traffic control tower has NASA-developed technology in use. ARMD is committed to transforming aviation by dramatically reducing its environmental impact, improving efficiency while maintaining safety in more crowded skies, and paving the way to revolutionary aircraft shapes and propulsion.
- The **Space Technology Mission Directorate (STMD)** rapidly develops, demonstrates, and infuses revolutionary, high-payoff technologies through transparent, collaborative partnerships, expanding the boundaries of the aerospace enterprise. This organization employs a merit-based competition model with a portfolio approach spanning a range of discipline areas and technology readiness levels to advance technologies for the benefit of NASA, the aerospace industry, and other government agencies, and to address national needs. To conduct research and technology development, STMD works with NASA's Centers, academia, and industry, and leverages partnerships with other government agencies and international partners. STMD invests in bold, broadly applicable, transformational technologies that have high potential for offsetting mission risk, reducing cost, and advancing existing capabilities, thereby executing more challenging missions and capabilities for NASA and the Nation. STMD engages and

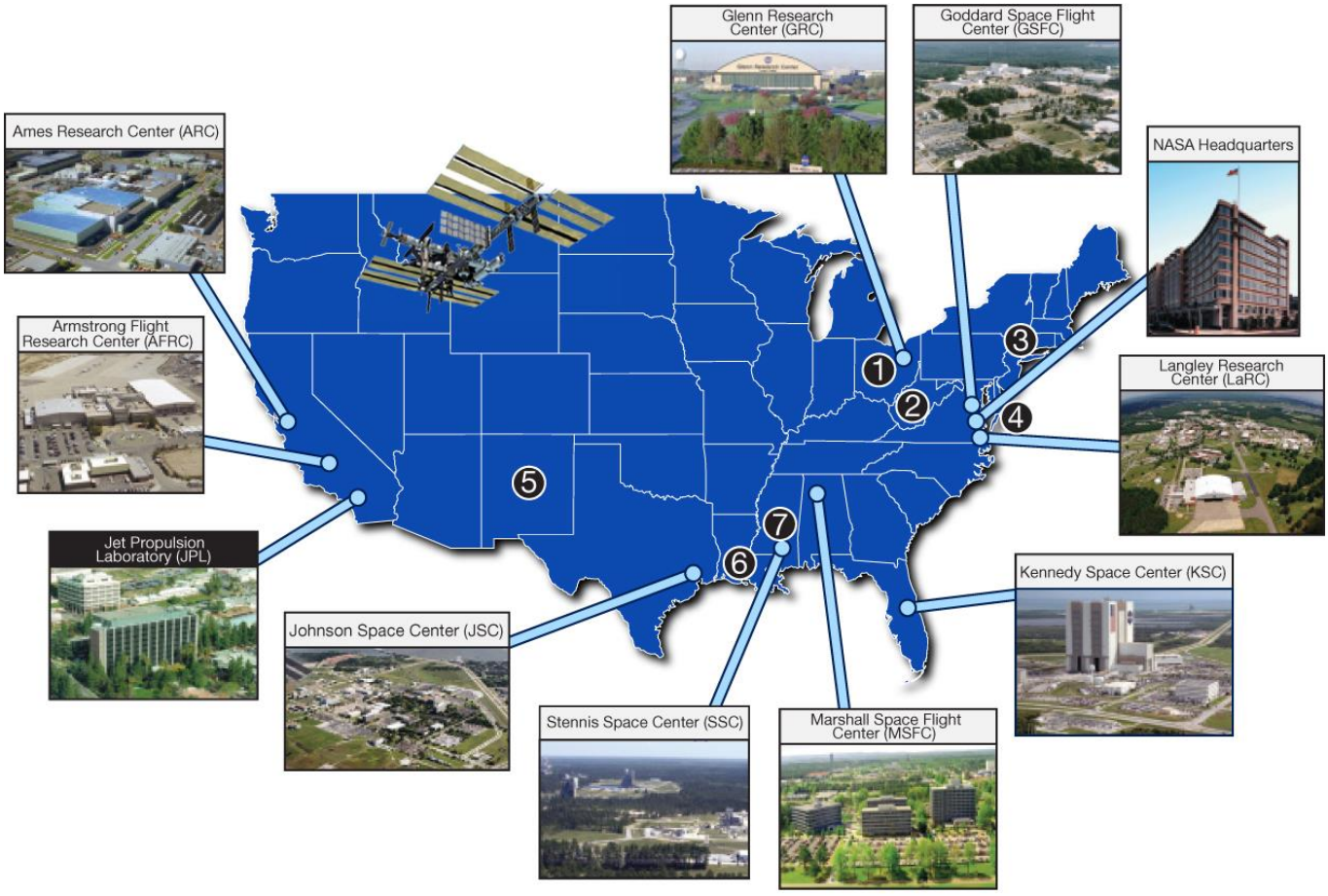
inspires thousands of technologists and innovators creating a community of NASA's best and brightest working on the Nation's toughest challenges.

- The **Human Exploration and Operations Mission Directorate (HEOMD)** is responsible for NASA space operations in and beyond low Earth orbit, developing new exploration and transportation systems, and performing scientific research to enable sustained and affordable human exploration. HEOMD manages Launch Services and Space Communications and Navigation for the Agency, and works with the Mission Support Directorate to develop supporting capabilities to ensure the availability of appropriate Rocket Propulsion Test capabilities that support human and robotic exploration requirements.
- The **Office of the Chief Technologist (OCT)** serves as the NASA Administrator's principal advisor and advocate on matters concerning Agency-wide technology policy and programs. OCT provides the strategy, leadership, and coordination that guide NASA's technology and associated innovation activities. OCT documents and analyzes NASA's technology investments and tracks their progress, aligning them with NASA's Strategic Plan. OCT leads technology transfer and technology commercialization activities, extending the benefits of NASA's technology investments to have a direct and measurable impact on everyday life. The office employs principles that encourage partnerships, technology use, and commercialization, ensuring NASA technologies energize the commercial space sector and provide the greatest benefit to the Nation.
- The **Mission Support Directorate (MSD)** provides effective and efficient institutional support to enable the Agency to successfully accomplish its missions. It focuses on reducing institutional risk to NASA's current and future missions by improving processes, stimulating efficiency, and providing consistency and uniformity across institutional capabilities and services.
- The **Office of Education (Education)** provides Agency leadership and programmatic oversight for NASA's external educational programs. Education has the responsibility to leverage NASA's unique mission content, facilities, and workforce. Education is a crosscutting process that engages the public in shaping and sharing the experience of exploration and discovery.
- The **Administrator's Staff Offices** support the Administrator's responsibilities by providing a range of high-level guidance and support in critical areas like safety and mission assurance, technology planning, equal opportunity, information technology, financial administration, small business administration, international relations, and legislative and intergovernmental affairs.
- The **Office of Inspector General (OIG)** is an independent and objective unit, created by Public Law 95-452, the Inspector General Act. The OIG conducts independent and objective audits and investigations and other evaluations of Agency programs and operations; promotes economy, effectiveness, and efficiency within the Agency; prevents and detects crimes, fraud, waste, and abuse; reviews and makes recommendations regarding existing and proposed legislation and regulations; and keeps the NASA Administrator and Congress fully and currently informed of problems in Agency programs and operations.

NASA's workforce transforms NASA's Mission into reality. NASA employs about 17,300[3] civil servants at Headquarters in Washington, DC, its Centers, and other facilities across the country. NASA staffs each location with a contractor workforce for technical and business operations support. Figure 2 shows the distribution of NASA's Centers and major facilities. NASA also has many other facilities throughout the country and around the world.

[3] This number includes civil servants on duty and extended leave at the beginning of FY 2016.

Figure 2: NASA Centers and Facilities Nationwide



Select NASA Facilities
(noted by numbers on map)

1) Plum Brook Station, Sandusky, OH, managed by GRC
2) Software Independent Verification and Validation Facility, Fairmont, WV, managed by GSFC
3) Goddard Institute for Space Studies, New York, NY, managed by GSFC
4) Wallops Flight Facility, Wallops, VA, managed by GSFC
5) White Sands Test Facility and Space Network, White Sands, NM, managed by JSC
6) Michoud Assembly Facility, New Orleans, LA, managed by MSFC
7) NASA Shared Services Center, Stennis Space Center, MS, managed by SSC

Note: JPL is a Federally Funded Research and Development Center in Pasadena, California. The California Institute of Technology manages JPL.

Governance and Strategic Management

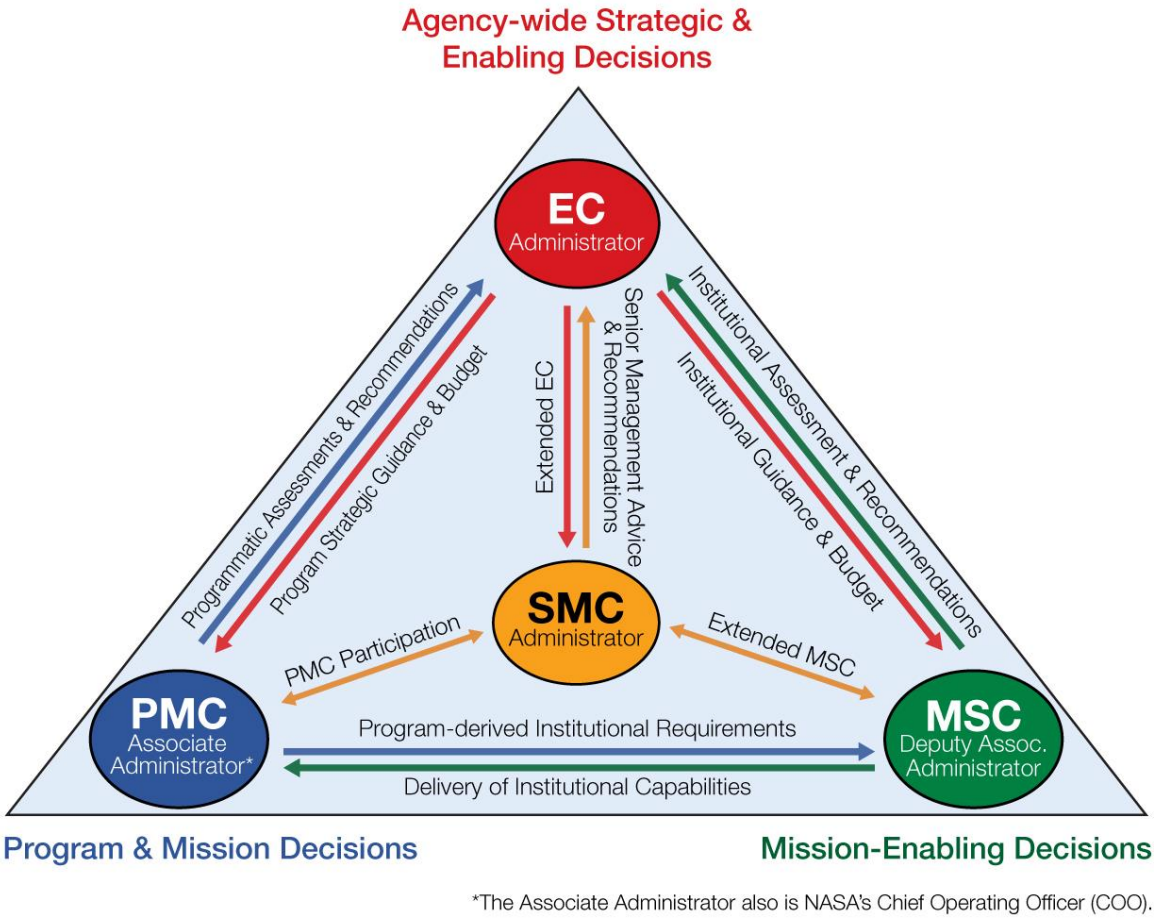
Governance

NASA governs with three Agency-level councils. Each council has a distinct charter and responsibility. The Executive Council (EC) focuses on major Agency-wide decisions and provides strategic guidance and top-level planning. The Mission Support Council (MSC) is a functional council, focused on mission-enabling decisions. The Program Management Council (PMC) is an integral part of NASA's program and mission decisions, with emphasis on managing performance as programs reach Key Decision Points.

In addition to the governing councils, NASA has a Senior Management Council (SMC), which is a body of NASA senior leadership that provides advice and counsel to the Executive Council on key issues of the Agency and provides input on the formulation of Agency strategy.

Figure 3 is a visual representation of the relationships between the councils.

Figure 3: Functional Relationships between NASA's Governing Councils



The GPRA Modernization Act requires all agencies to designate a Chief Operating Officer (COO) and a Performance Improvement Officer (PIO) for managing Agency performance. The Administrator appoints the COO and PIO. Currently, NASA's Associate Administrator and Deputy Chief Financial Officer serve as the COO and PIO, respectively. They set goals; assure timely, actionable performance information is available to decision-makers at all levels of the organization; and conduct frequent data-driven reviews that guide decisions and actions to improve performance outcomes and reduce costs. NASA's COO provides organizational leadership to improve overall Agency performance; helps the Agency meet its Mission and goals through performance planning, measurement, analysis, and regular assessment of programs; chairs data-driven performance reviews, including Strategic Reviews; and aligns resources to priorities, including budget and staffing, to improve performance.

The PIO supports the Administrator and COO by leading efforts to set goals; conducting quarterly, data-driven performance reviews and analysis; coordinating cross-agency collaboration and Agency leadership on performance; ensuring alignment of personnel performance; communicating performance goals; and collaborating with mission directorates, mission support offices, leadership, and the Office of Management and Budget to set meaningful goals.

NASA leadership receives performance information from a variety of sources, including the Baseline Performance Review, the Strategic Reviews, and executive reviews. Each month, NASA conducts an internal assessment and reporting forum, the Baseline Performance Review, which tracks performance against Agency plans. The Baseline Performance Review, led by the COO, is a bottom-up review of how well the Agency has performed against its strategic goals and other performance metrics, such as cost, schedule, contract, and technical commitments. NASA annually reviews progress towards strategic objectives by assessing the impact of strategies and the implementation of key activities, including multiyear performance goals, annual performance indicators, agency priority goals, and cross-agency priority goals. NASA also identifies mission challenges, risks, and opportunities using a variety of evidence, evaluations, studies, and analysis.

Strategic Management

NASA's performance management activities follow a continuous cycle that ensures strategic management and accountability. Figure 4 depicts the relationship between the three phases of NASA's performance management cycle.

Figure 4: Performance Management Cycle

Planning Phase

During the planning phase, NASA assesses and, as necessary, adjusts its mission objectives at both the strategic and detailed levels. NASA accounts for national priorities, laws, and other stakeholder input in its strategic long- and near-term planning. Planning takes into account differing time spans and the complex interactions of guidance and requirements, independent assessments and analyses, and the specific needs of a multi-faceted

organization. Strategic long-term planning analyses and initiatives are focused on timeframes of 10 years or beyond, and provide context and input to the NASA Strategic Plan and near-term planning efforts.

Evaluation Phase

In the evaluation phase, NASA holds leadership accountable for near-term performance standards and metrics, as well as progress towards long-term objectives. Program authorities hold internal reviews on a regular basis to monitor and evaluate performance. The results support internal management processes and decision-making. The COO reviews progress towards the Agency program and project plans and addresses crosscutting concerns that may affect performance. In addition, on an annual basis, NASA's COO and PIO review progress towards the Agency's strategic objectives.

Reporting Phase

The reporting phase connects evaluation to planning efforts. NASA managers present performance information to senior leaders, such as council members, and other stakeholders. Performance results inform investment, policy, and performance decisions made in the planning phase of the next performance management cycle.

Figure 5 depicts the strategic plan performance framework, consisting of strategic goals and strategic objectives from the *NASA 2014 Strategic Plan*. (See Figure 6 for a complete list of NASA's strategic goals and strategic objectives.) In its Annual Performance Plan, NASA sets both its short-term performance goals, which are targets within the four-year span of the Strategic Plan, and its annual performance indicators, which are designed to show progress achieved during the budget year. The Annual Performance Plan measures and communicates NASA's progress towards achieving its Vision and Mission. Agency priority goals and cross-agency priority goals are a subset of performance goals that receive additional senior management focus. These are described in further detail in "Part 2: Performance Priorities and Management Challenges."

Figure 5: 2014 Strategic Plan Performance Framework

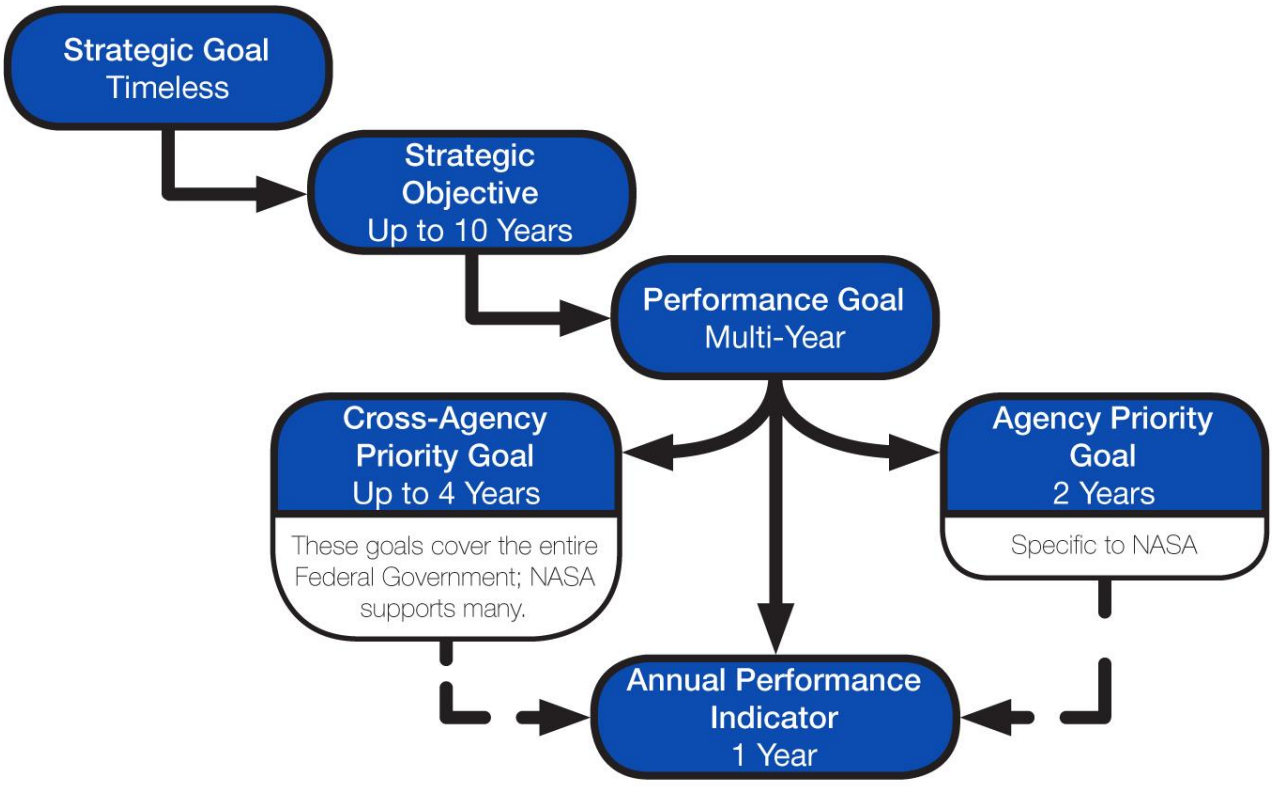
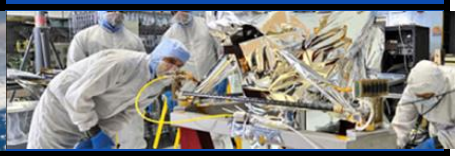


Figure 6: NASA's Strategic Goals and Strategic Objectives

Strategic Goal 1	Strategic Goal 2	Strategic Goal 3
		
Expand the frontiers of knowledge, capability, and opportunity in space.	**Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.**	**Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.**
By empowering the NASA community to...	By engaging our workforce and partners to...	By working together to...
Objective 1.1: Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration. **Objective 1.2:** Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity. **Objective 1.3:** Facilitate and utilize U.S. commercial capabilities to deliver cargo and crew to space. **Objective 1.4:** Understand the Sun and its interactions with Earth and the solar system, including space weather. **Objective 1.5:** Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere. **Objective 1.6:** Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars. **Objective 1.7:** Transform NASA missions and advance the Nation's capabilities by maturing crosscutting and innovative space technologies.	**Objective 2.1:** Enable a revolutionary transformation for safe and sustainable U.S. and global aviation by advancing aeronautics research. **Objective 2.2:** Advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet. **Objective 2.3:** Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit. **Objective 2.4:** Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets.	**Objective 3.1:** Attract and advance a highly skilled, competent, and diverse workforce, cultivate an innovative work environment, and provide the facilities, tools, and services needed to conduct NASA's missions. **Objective 3.2:** Ensure the availability and continued advancement of strategic, technical, and programmatic capabilities to sustain NASA's Mission. **Objective 3.3:** Provide secure, effective, and affordable information technologies and services that enable NASA's Mission. **Objective 3.4:** Ensure effective management of NASA programs and operations to complete the mission safely and successfully.

Performance Management

NASA has a culture of data-driven performance management. The Agency continually improves its performance management system, through increasingly sophisticated design and applications and more disciplined processes, to improve accountability, transparency, and oversight. This leads to more consistent performance results across NASA's missions and ensures the optimal use of the resources entrusted to the Agency by its stakeholders.

Performance Planning and Evaluation

NASA evaluates its performance in a continuous cycle that spans fiscal years. Each year, NASA defines its multi-year and annual goals—the performance goals and annual performance indicators—in the Agency's Annual Performance Plan. NASA develops its Annual Performance Plan alongside the upcoming fiscal year budget request. To ensure integration of performance and budget information, both documents are organized around similar mission areas and themes. NASA releases its Annual Performance Plan to the public on the same date as the release of the President's Budget Request.

NASA releases its upcoming Annual Performance Plan while it is assessing its performance for the current fiscal year (also known as the execution fiscal year). Once NASA organizations begin executing against the commitments in the Strategic Plan and Annual Performance Plan, Agency managers and performance analysts monitor and evaluate performance. NASA assesses the Agency's progress toward achieving its strategic objectives, performance goals, and annual performance indicators. NASA also evaluates the efficacy of its execution fiscal year measures, as well as planned measures for the upcoming fiscal year. The Annual Performance Plan Update reflects any measure revisions, additions, or deletions resulting from these evaluations or due to strategic, budgetary, or programmatic changes that have occurred during budget execution.

Each November, NASA publishes its Agency Financial Report, which contains a preliminary performance summary with early indicators of the execution of the prior fiscal year's performance. NASA's Annual Performance Report provides the final performance summary, addresses how well NASA met the performance goals and annual performance indicators set in the Annual Performance Plan, and highlights advancement toward long-term strategic objectives. The Agency integrates this report with future Annual Performance Plans to show a holistic view of NASA's performance. NASA publishes the Annual Performance Report concurrently with the Annual Performance Plan Update, the Budget Estimates, and that budget year's Annual Performance Plan.

The Agency monitors and evaluates performance toward its plans and commitments using ongoing, periodic, and one-time assessments, through which managers identify issues, gauge programmatic and organizational health, and provide appropriate data and evidence to NASA decision-makers. Assessments include the following:

- Ongoing monthly and quarterly analysis and reviews of Agency activities;
- Annual program and project assessments in support of budget formulation;
- Annual reporting of performance, management issues, and financial position;
- Annual Strategic Reviews of each strategic objective;
- Periodic, in-depth program or special purpose assessments; and
- Recurring or special assessment reports to internal and external organizations.
  Please see Figure 4 for a visual representation of NASA's performance cycle.

Performance Assessments

During the third and fourth quarters of each fiscal year, program officials submit to NASA management a self-evaluation, which includes a rating for each performance measure and the supporting information that justifies the rating. The results of the performance assessments are presented to NASA's COO and PIO in an Executive Review, which keeps them informed of NASA's performance progress, allows them to make course corrections

throughout the year to maintain alignment with the strategic goals, and informs budget discussions. The COO and PIO review and approve the performance ratings before they are published in the Agency Financial Report. The process culminates with the Annual Performance Report, comprising the ratings (including any changes made after the publication of the Agency Financial Report), rating explanations, and performance improvement plans, where necessary.

Using Evidence, Evaluation, and Research to Set Strategies and Measure Progress

Given the constrained fiscal environment and the need to ensure that taxpayer resources are expended appropriately, NASA must ensure that its programs and activities are managed and operated effectively and efficiently. To that end, the Agency uses laws, executive orders, governance, and management best practices to promote a strong culture of results and accountability. This is done through a dynamic, dialog-driven process of collecting evidence (data, research, or end product) and conducting rigorous independent evaluations, both internal and external to NASA, of that evidence. In many cases, these evaluations assess progress against a pre-determined set of indicators or other targets so that deviations can easily be identified and addressed.

NASA uses several different types of metrics to assess performance, given the goals of a specific program or project. For example, progress towards key milestones can be an effective way to determine whether a flight project is on track. Verification and validation of data supports strategic planning and determines the general accuracy and reliability of performance information. These processes provide a level of confidence to stakeholders that the information the Agency provides is credible.

Internal Reviews

Program and Project Technical Reviews

NASA monitors and assesses the engineering process of designing, building, and operating spacecraft and other major assets. Performance metrics for such investments focus, in part, on comparisons of actual versus planned schedule and cost, which can be assessed on a monthly basis using tools such as Earned Value Management. As detailed in *NASA Space Flight Program and Project Management Requirements* (NASA Procedural Requirements 7120.5E) and *NASA Research and Technology Program and Project Management Requirements* (NASA Procedural Requirements 7120.8), the Agency holds formal internal independent assessments as programs and projects progress through a series of gatekeeping Key Decision Points. Such Key Decision Points provide managers time to review all aspects of technical progress and project performance in order to promote thoughtful work on a project or to delay or terminate work if needed. The Key Decision Point reviews focus on the program or project's assessment of status, as well as that of the Standing Review Board or Center independent review team, and multiple organizations have the opportunity to weigh in on the information that is presented. Key Decision Points may be scheduled at any time of the year, in accordance with the lifecycle schedule, depending on the formulation, development, or construction plan. NASA conducts additional technical reviews between the Key Decision Points to assess progress and continually monitors overall performance through the Baseline Performance Review. Project performance is independently assessed on a monthly basis and is reported quarterly at the Baseline Performance Review.

In FY 2015, NASA streamlined the Baseline Performance Review process to make it more dialog-driven and collaborative. This approach provides senior leadership with an opportunity to focus on program and project performance issues, rather than on reporting status. Under the new paradigm, mission directorates have the responsibility to present program and project performance information. The majority of the discussion then focuses on those programs or projects where concerns have been identified before a final rating is determined.

The reporting cadence has also been modified, going forward, to better align with functional reviews at the program or project level.

Technology Readiness Levels

NASA assesses technology development programs against incremental milestones (technology readiness levels). It regularly measures the technology readiness level advancement of an individual technology investment, with overall technology portfolio assessments occurring each year.

Operations and Mission Support Assessments

The Agency's operational, or support- and service-type, programs generally assess progress on meeting their specific objectives against targets for output or capacity of the activity, quantifiable estimates of improvement with aggressive targets (e.g., reducing operating costs by two percent in two years), customer satisfaction, or routine on-site assessments. These assessments are often done annually.

External Reviews and Assessments

NASA Science Advisory Subcommittee Strategic Reviews

NASA's research programs often have broad objectives, such as "understand how the universe works." To measure the performance of these types of investments, NASA establishes and measures performance against smaller, achievable goals to help demonstrate impact and overall contribution to the knowledge on the subject. It conducts assessments on these programs yearly, and it captures lessons learned as part of an annual strategic process. These assessments are done in coordination with the NASA Advisory Council Science Subcommittees.

NASA's Aeronautics Research Mission Directorate enlists experts in the aeronautics community to assess progress along six major research thrusts to ensure that NASA is developing and maturing the technologies and capabilities according to the blueprint. See the *NASA Aeronautics Strategic Implementation Plan* for more information.

Peer and Subject Community Review

NASA relies on evaluations by the external community. Papers from NASA-supported research undergo independent peer review for publication in professional journals. The Agency uses external peer review panels to objectively assess and evaluate proposals for new work in its science areas, technology development, and education. NASA often leverages internal and external evaluators to assess strategies, impact, implementation, efficiency and effectiveness, cost-to-benefit ratio, and relevance of work being performed. NASA relies on senior reviews by external scientists for advice on the most productive use of funding for science missions that have completed their primary missions and have entered extended operations.

The National Academies of Sciences, Engineering, and Medicine

A series of decadal surveys and other analyses, conducted by the National Academies, help inform decisions about the Science Mission Directorate's investment portfolio and other aspects of NASA's research and development efforts. These external evaluations of user needs and requirements, in combination with performance assessments of ongoing activities, help ensure that NASA's research priorities and investments stay current with the needs of the research community. The Space Technology Roadmaps are a similar planning tool, reflecting the research and development and technology needs of NASA, the government, and industry.

Verification and Validation of Performance Information

During the development of the Annual Performance Plan, NASA's mission directorates and mission support offices provide detailed information for each of their performance goals and annual performance indicators, including the frequency of data collection, any data limitations, and known internal or external performance challenges. In addition, program officials provide a brief description of the internal procedures that they will use to determine the end-of-year rating, including the identification of any NASA governance bodies involved in assigning the rating, and list the materials that they will use at the end of the year to verify and validate their performance.

Each year, NASA follows a systematic process to validate its annual performance indicators during the preparation of the Annual Performance Plan. NASA uses an "alternative form," or milestone-based, approach to its performance reporting. In practice, this means that the majority of NASA's annual performance indicators are unique to each fiscal year. During the development of the Annual Performance Plan, program officials submit rationales for inclusion for each of their proposed annual performance indicators, which provide background and explain why a particular indicator is critical to NASA.

Following the end of each fiscal year, NASA selects a subset of its annual performance indicators for verification. The assessment is conducted independently by the NASA Office of the Chief Financial Officer, not by the mission directorate or mission support office with reporting responsibility for the annual performance indicator. NASA uses the results of these assessments to improve the quality of its data reporting, and to inform the development of its Annual Performance Plan during the following year.

Summary of Performance

NASA evaluates progress towards achieving its performance measures on a traffic light rating system (i.e., the green, yellow, and red color ratings). In collaboration with NASA management, program officials define their own parameters for the success criteria during the development of their performance measures. NASA uses these success criteria, combined with explanations of the ratings and sources provided by the program officials, to review and validate each rating, as described in the "Performance Management" section. NASA bases many of the performance ratings on internal assessments. External entities, such as science review committees and aeronautics technical evaluation bodies, validate select ratings prior to publication by NASA.

On occasion, NASA will assign a white rating to a performance measure that cannot be assessed against its success criteria. White ratings are reserved for performance measures that are cancelled or postponed. Program officials do not develop measure-specific success criteria for white ratings. Only senior management can assign white ratings.

While the success criteria are specific to each performance measure, Figure 7 provides high-level examples of the types of criteria that may be used to determine performance measure ratings. The generic success criteria in the figure are illustrative of the types of individualized criteria assigned to each performance measure and broadly apply to the performance measures.

Figure 7: Generic Performance Goal and Annual Performance Indicator Success Criteria[4]

Rating	Status	Examples of Success Criteria
Green	On Track or Complete	NASA completed or expects to complete this performance measure within the estimated timeframe.
Yellow	Slightly Below Target and/or Behind Schedule	NASA completed or expects to complete this performance measure, but is slightly below the target and/or moderately behind schedule.
Red	Significantly Below Target and/or Behind Schedule	NASA did not or does not expect to complete this performance measure within the estimated timeframe. The program is substantially below the target and/or significantly behind schedule.
White	Cancelled or Postponed	NASA senior management cancelled or postponed this performance measure. The Agency no longer is pursuing activities related to this performance measure, or the program did not have activities during the fiscal year.

The summary of NASA's assessment of progress by strategic objective is provided in Figures 8-10. Additional information regarding the performance goals and annual performance indicators, including explanations for those rated yellow or red, is available in "Part 3: Performance Reporting and Planning."

Figure 8: Summary of FY 2015 Ratings for All Performance Measures

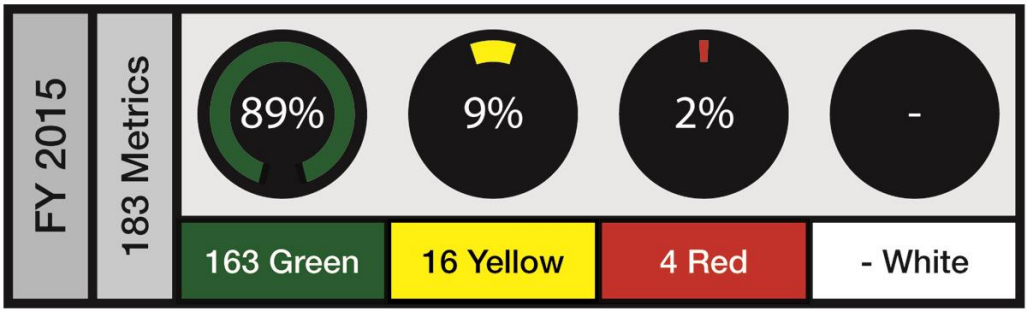


Figure 9: Summary of FY 2014 Ratings for All Performance Measures

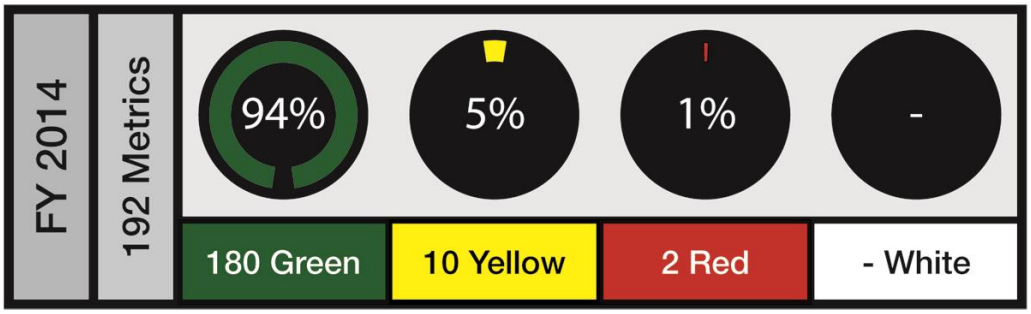


Figure 10: Summary of FY 2015 Ratings for All Performance Measures by Strategic Goal

Strategic Goal 1			Strategic Goal 2			Strategic Goal 3		
Number of Performance Measures								
76			47			60		
Green	Yellow	Red	Green	Yellow	Red	Green	Yellow	Red
64	11	1	46	1	0	53	4	3
84%	15%	1%	98%	2%	0%	88%	7%	5%

[4] These are generic criteria provided for informational purposes only. NASA develops measure-specific criteria to rate all of the Agency's performance goals and annual performance indicators.

Part 2
Performance Priorities and Management Challenges




Strategic Reviews

As of 2014, all major federal agencies are required to perform Strategic Reviews. Congress provides direction for these reviews through the *Government Performance and Results Act (GPRA) Modernization Act of 2010* and the Office of Management and Budget provides implementation guidance. The Strategic Reviews are an annual assessment of each strategic objective, with an analysis of an agency's progress toward its strategic direction.

Per the *NASA 2014 Strategic Plan*, NASA has 3 strategic goals and 15 strategic objectives. NASA developed its Strategic Review process and methodology in late calendar year 2013 and conducted its first annual Strategic Review in spring 2014 in accordance with Office of Management and Budget guidance. This report contains the results of NASA's second Strategic Review, conducted in spring 2015.

Process

Each strategic objective leader conducts a self-assessment of the impact (looking at the long-term outlook) and implementation (given near-term plans and performance) for their strategic objective. They also identify risks, challenges, and opportunities. Based on this self-assessment, the strategic objective leader provides a rating for the strategic objective: noteworthy progress, demonstrating satisfactory performance, or being a focus area for improvement.

NASA's Performance Improvement Officer and staff perform a crosscutting assessment to identify common themes and issues. The Performance Improvement Officer's crosscutting assessment also analyzes each strategic objective, validates self-assessment inputs, and performs a relative characterization across all 15 strategic objectives. Based on this assessment, the Performance Improvement Officer recommends an independent rating to NASA's Chief Operating Officer for each strategic objective. Both the self-assessment and the crosscutting assessment use a variety of sources of evidence and inputs.

Results and Impacts

For the 2015 Strategic Review, the Chief Operating Officer reviewed the summary of the self-assessments and the crosscutting assessment at the end of April 2015 and decided on final ratings for the strategic objectives and next steps for NASA. As a result of the 2015 Strategic Review, NASA determined that 7 out of 15 strategic objectives demonstrated satisfactory performance. Four strategic objectives are considered as making noteworthy progress, and four strategic objectives are focus areas for improvement. These ratings represent NASA's assessment of performance and expectations for future outcomes as of May 2015. Full details, including these ratings, progress updates, and next steps, are provided in "Part 3: Performance Reporting and Planning."

NASA uses Strategic Review inputs, findings, and results throughout the Agency's budget process and as an input to the annual performance planning process. The Government Accountability Office highlighted, in their 2015 report *Managing for Results: Practices for Effective Agency Strategic Reviews* (GAO-15-602), NASA's approach for conducting Strategic Reviews as an example of an effective agency process and for clearly defining measurable outcomes for each strategic objective.

Agency Priority Goals

In accordance with the GPRA Modernization Act, NASA identifies agency priority goals that represent important near-term priorities every two years. The agency priority goals do not provide a complete picture of every high-profile activity within NASA, but they do represent several key projects.

The agency priority goals that NASA is currently working on will benefit the U.S. people in the areas of space operations, human spaceflight, and astrophysics. Figure 11 lists NASA's goal statements for both the FY 2014-FY 2015 and the FY 2016-FY 2017 reporting cycles. For the FY 2016-FY 2017 reporting cycle, NASA will continue to report its progress against the same four themes as it reported during the FY 2014-FY 2015 cycle.

Figure 11: Goal Statements for NASA's Agency Priority Goals

Responsible Organization	Goal Statement	
	FY 2014 FY 2015	FY 2016 FY 2017
Human Exploration Operations Mission Directorate, Exploration Systems Division	By September 30, 2015, NASA will complete the Space Launch System, Orion, and Exploration Ground Systems Critical Design Reviews (CDRs), allowing the programs to continue to progress toward Exploration Mission (EM)-1 and EM-2 missions.	Achieve critical milestones in development of new systems for the human exploration of deep space. By September 30, 2017, NASA will have begun integration and testing of the Exploration Mission (EM)-1 Orion Crew Module (CM), including the first power-on of the vehicle; delivered all four EM-1 Space Launch System (SLS) Core Stage RS-25 engines to the Michoud Assembly Facility in preparation for integration into the Core Stage; and completed construction of Exploration Ground Systems (EGS) Pad B.
Human Exploration Operations Mission Directorate, International Space Station Program	By September 30, 2015, NASA will increase the utilization of the International Space Station internal and external research facility sites with science and technology payload hardware to 70 percent.	Increase the occupancy of the International Space Station's (ISS's) internal and external research facilities by adding new instruments and capabilities. By September 30, 2017, NASA will increase the occupancy of the ISS internal and external research facility sites with science and technology payload hardware to 75 percent.
Human Exploration Operations Mission Directorate, Commercial Crew Program	By September 30, 2015, the Commercial Crew Program will complete the first phase of certification efforts with Commercial Crew Transportation partners, and will make measurable progress toward the second certification phase with industry partners while maintaining competition.	Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition, returning International Space Station crew transportation to the United States. By September 30, 2017, the Commercial Crew Program (CCP), along with its industry partners, will make measurable technical and programmatic progress toward the certification of commercial crew transportation systems, including the completion of at least one Design Certification Review.

Responsible Organization	Goal Statement	
	FY 2014 FY 2015	FY 2016 FY 2017
Science Mission Directorate, James Webb Space Telescope Program	By October 2018, NASA will launch the James Webb Space Telescope, the premier space-based observatory. To enable this launch date, NASA will complete the James Webb Space Telescope primary mirror backplane and backplane support structures and deliver them to the Goddard Space Flight Center for integration with the mirror segments by September 30, 2015.	Revolutionize humankind's understanding of the Cosmos and humanity's place in it. By October 2018, NASA will launch the James Webb Space Telescope (Webb). To enable this launch date, NASA will complete the testing of the Webb Optical Telescope Element plus Integrated Science Instrument Module by September 30, 2017.

Results and Impacts

The tables on the following pages provide background information, progress summaries, and, for the FY 2016-FY 2017 reporting cycle, explain how NASA ensures the quality of the performance information it uses to measure progress toward its agency priority goals. More detailed information on each of NASA's agency priority goals, including overviews and contributing programs, is available at http://performance.gov.

Agency Priority Goal: Exploration Systems Development

Mission Directorate

Human Exploration and Operations Mission Directorate

Goal Leader

William Hill, Assistant Deputy Associate Administrator for Exploration Systems Development

Contributing Programs

Space Launch System, Orion Spacecraft, Exploration Ground Systems

FY 2014-FY 2015 Goal Statement

By September 30, 2015, NASA will complete the Space Launch System, Orion, and Exploration Ground Systems Critical Design Reviews (CDRs), allowing the programs to continue to progress toward Exploration Mission (EM)-1 and EM-2 missions.

FY 2016-FY 2017 Goal Statement

Achieve critical milestones in development of new systems for the human exploration of deep space. By September 30, 2017, NASA will have begun integration and testing of the Exploration Mission (EM)-1 Orion Crew Module (CM), including the first power-on of the vehicle; delivered all four EM-1 Space Launch System (SLS) Core Stage RS-25 engines to the Michoud Assembly Facility in preparation for integration into the Core Stage; and completed construction of Exploration Ground Systems (EGS) Pad B.

FY 2014-FY 2015 Progress Summary

Over the last two years, NASA made extensive progress towards its Orion, Space Launch System, and Exploration Ground Systems Programs:

Orion Program

A major milestone for the Orion Program was the successful flight of Exploration Flight Test 1 (EFT-1) in December 2014. EFT-1 was designed to take the Crew Module further from Earth than any human-rated spacecraft has traveled since Apollo, testing the capsule's primary reentry systems, including the heat shield and parachute systems, at conditions far exceeding those experienced during return from low Earth orbit. EFT-1 was fitted with hundreds of sensors to provide information on loads, acceleration, acoustics, vibration, and other factors that affect vehicle performance and crew survival. The mission also allowed the Orion and Ground Systems Development and Operations teams to experience the process of working together throughout Assembly, Test, and Launch Operations, and for the Mission Control teams at the Kennedy Space Center and Johnson Space

Center to test procedures and hand-offs. The results of EFT-1 produced specific improvements in the design and manufacturing process for both the heat shield and pressure vessel, as well as enhancements in control of the parachute motion upon reentry, and the evaluation of improvements to the Crew Module Uprighting System.

Orion also made major progress on flight hardware and test capabilities. In FY 2015, the Orion Program began machining the Exploration Mission 1 (EM-1) Crew Module primary structure or Pressure Vessel—the living space within Orion. Machining of the final EM-1 flight component was completed in the first quarter of FY 2016. Ahead of the machining and welding of each EM-1 flight part, a pathfinder version was machined and then welded to test the design and procedures. All pathfinder and flight Pressure Vessel parts have been delivered to Michoud Assembly Facility, pathfinder article welds are nearly complete, and the first flight weld was completed in the first quarter of FY 2016. A major test facility, the Integrated Test Laboratory, was completed and opened in Denver in 4th quarter FY 2015. The Integrated Test Laboratory will be a critical facility not only for Orion, but for the Space Launch System.

In the 4th quarter of FY 2015, Orion passed its Key Decision Point C (KDP-C) review. The data gained from EFT-1 was critical to maturing the preliminary design, allowing the team to advance to its Critical Design Review (CDR) Board, which was completed October 21, 2015.

Space Launch System (SLS) Program

The SLS Program continues to make substantial and sustained progress toward first flight on EM-1. Two major propulsion test milestones were accomplished during the reporting period. In January 2015, SLS conducted a test of the RS-25 core stage engine, the first in a series of seven development tests in FY 2015 and the first test of an RS-25 since the Space Shuttle program completed engine testing in 2010. In March 2015, SLS also successfully conducted the first of two planned booster qualification motor test firings, QM-1.

The SLS Program also made progress on the production capability of the 217-foot-tall core stage flight articles. NASA's SLS Program began delivery and assembly of the Vertical Assembly Center (VAC) welding tool at the Michoud Assembly Facility in New Orleans, Louisiana, in the second quarter of FY 2014. The VAC was officially activated in September 2014, and NASA began welding of the pathfinder barrel sections in the last quarter of FY 2014. In January 2015, a tool alignment problem was discovered, but is on track for remediation; the new date for VAC tool acceptance is now in the first quarter of FY 2016. The VAC is the largest welding tool of its kind in the world and will enable assembly of the SLS Core Stage barrel sections using advanced friction stir welding.

SLS has successfully met major design review milestones with successful completion of element CDRs for SLS elements, including the Core Stage (July 2014), Booster (August 2014), Engines (December 2014), and Spacecraft Payload Integration and Evolution CDR-1 (April 2015), and culminating with the successful completion of the SLS program-level CDR in July 2015. NASA confidence in the SLS Program was affirmed when the program cleared the Agency's KDP-C milestone in August 2014, marking the transition from development into implementation and setting the program's baseline cost and schedule commitments.

Exploration Ground Systems (EGS) Program

For the EGS Program, modernization and compatibility efforts continued in FY 2015 to support the EM-1 launch. EGS completed major infrastructure enhancements to prepare launch pad 39B for the EM-1 mission and future flights. Enhancements such as the flame trench, flame deflector, ignition overpressure, and sound suppression system, will safely channel the extraordinary energy released by the rocket away from critical systems. To provide ground crew access to the launch vehicle and Orion while on the mobile launcher, upgrades continue to the aging ground support equipment and umbilical outfitting on the upper stage, core stage, and crew access arm. NASA completed the design for the new adjustable high-bay access in the Vehicle Assembly Building and awarded a construction contract.

As noted earlier, EGS supported Orion EFT-1 landing and recovery operations in FY 2015. EFT-1 completed the underway recovery tests of the EFT-1 mission Crew Module, while ongoing landing recovery planning and design continue in support of EM-1. End-to end spaceport command and control system applications and displays were worked along with transmission, imagery, and voice communication. Integrated verification and validation activity began, in order to ensure mission success and seamless integration and launch site processing during EM-1.

The EGS Program entered the implementation phase of its lifecycle, where final designs and initial fabrication take place. In January 2014, EGS successfully completed its Preliminary Design Review, and in May 2014, KDP-C, which confirmed the project had achieved stable design requirements and was authorized to proceed to the next level of developmental readiness.

The EGS Program was scheduled to complete its CDR to evaluate the integrity of the ground system design, and its ability to meet mission requirements within available resources and with appropriate margins and acceptable risk. This review will determine if the design is appropriately mature to continue to the final design and fabrication phase. As a result of efforts to synchronize the three programs, the Ground Systems Development and Operations CDR was rescheduled to December 15, 2015. The program is on track to complete the review according to the new direction.

Summary of Progress

While NASA did not fully complete its agency priority goal during FY 2015, it made significant progress towards the goal, and is on track to complete it by March 2016. NASA completed the SLS CDR on July 22, 2015. The Orion CDR Board, scheduled for late FY 2015, was completed in October 2015; and the EGS Program CDR is now scheduled for FY 2016. For its FY 2016-17 agency priority goal, NASA will begin integration and testing of the EM-1 Orion Crew Module, including the first power-on of the vehicle; deliver all four EM-1 SLS Core Stage RS-25 engines to the Michoud Assembly Facility in preparation for integration into the Core Stage; and complete construction of EGS Pad B.

Strategies

To successfully achieve the first flight of the Space Launch System (SLS) and Orion, NASA will systematically progress through several major qualification, testing, and production milestones.

- The three individual programs will continue to conduct monthly program reviews to assess the development progress, risks, and technical and programmatic issues.
- The Exploration Ground Systems (EGS) Critical Design Review (CDR) was kicked off and the CDR Board completed in Q1 of FY 2016, and the EGS System Integration Review (SIR) is scheduled to be complete in Q4 of FY 2016.
- The Orion CDR kicked off in August 2015, and Orion held its CDR Board in Q1 of FY 2016.

NASA monitors and tracks its progress towards this goal using various Agency documents and reports, including Directorate Program Management Council materials, Quarterly Program Status Report packages, CDR Board minutes, project schedules, and other program-internal documents. The Exploration Systems Integration office focuses on requirements development, management approaches, and procurement strategies across the SLS, Orion, and EGS programs, and helps to ensure that activities are well-integrated across the programs. NASA has not identified any data limitations that would preclude it from reporting accurate, reliable, and timely performance information. NASA follows an “alternative form,” or milestone-based, approach to reporting on its goals. Using the documents and reports referenced above, the Agency is able to accurately report at the end of each quarter on whether or not it has met its planned milestones.

Next Steps

FY 2016

- Q1: Complete the lengthening of the Space Launch System (SLS) core stage transportation barge Pegasus.
- Q1: Complete the Orion Critical Design Review. The Critical Design Review is a significant review that will demonstrate that the Orion project design has the ability to meet requirements with appropriate margins and acceptable risk within defined project constraints, including available resources to determine if the design is appropriately mature to continue with the final design and fabrication phase.
- Q2: Complete the manufacturing of the SLS interim cryogenic propulsion stage structural test article. A structural test article is hardware built to replicate conditions and behaviors of flight ready versions for ground testing.
- Q2: Complete the Exploration Ground Systems Critical Design Review. The Critical Design Review is a significant review that will demonstrate that the Exploration Ground Systems design has the ability to meet requirements with appropriate margins and acceptable risk within defined project constraints, including available resources to determine if the design is appropriately mature to continue with the final design and fabrication phase.
- Q3: Commence testing of first Exploration Mission-1 flight support RS-25 engine.
- Q4: Complete SLS booster qualification motor 2 test firing.
- Q4: Begin assembly of the Orion Exploration Mission-1 Crew Module at Kennedy Space Center.
- Q4: Complete Exploration Ground Systems System Integration Review. The System Integration Review is a significant review to evaluate the readiness of the project and associated supporting infrastructure to begin system assembly, integration, and testing.

FY 2017

- Q1: Complete the core stage engine controller unit flight software build to support engine hot fire testing. The engine controller unit allows communication between the vehicle and the engine, relaying commands to the engine and transmitting data back to the vehicle.
- Q2: Complete the manufacturing of the SLS stages liquid hydrogen tank structural test article. A structural test article is hardware built to replicate conditions and behaviors of flight ready versions for ground testing.
- Q2: Complete testing of the Exploration Ground Systems umbilical.
- Q2: Complete construction of the flame trench, which is designed to deflect the rocket exhaust away from the launch vehicle and launch pad to reduce the potential for damage.
- Q3: Conduct structural testing of the Orion European Service Module.
- Q3: Ready the Exploration Ground Systems crawler-transporter, which will carry the SLS and Orion spacecraft to the launch pad, available for operations.
- Q3: Ready Exploration Ground Systems Pad B for the mobile launcher.
- Q4: Make available SLS flight software for Exploration Mission-1 mission.

More information on NASA's agency priority goals is available on http://performance.gov.

Agency Priority Goal: International Space Station

Mission Directorate

Human Exploration and Operations Mission Directorate

Goal Leader

Sam Scimemi, Director for International Space Station Division

Contributing Programs

International Space Station

FY 2014-FY 2015 Goal Statement

By September 30, 2015, NASA will increase the utilization of the International Space Station internal and external research facility sites with science and technology payload hardware to 70 percent.

FY 2016-FY 2017 Goal Statement

Increase the occupancy of the International Space Station's (ISS's) internal and external research facilities by adding new instruments and capabilities. By September 30, 2017, NASA will increase the occupancy of the ISS internal and external research facility sites with science and technology payload hardware to 75 percent.

FY 2014-FY 2015 Progress Summary

Over the last two years, NASA and its U.S. domestic commercial resupply service providers made great progress in establishing routine resupply to the ISS, through the successful launches of several commercial cargo flights to the station from the United States. In addition to delivering science and technology development hardware, crew supplies, and vehicle spares to the ISS, the resupply missions also served as an opportunity for the astronauts aboard the station to return research investigation samples to the Earth for analysis. These capabilities will ensure a robust national capability to deliver critical science research to and from orbit, allowing us to maximize the potential of the ISS, deliver critical benefits to our Nation and the world, and maintain American leadership in space.

The announcement by the Obama Administration to support the extension of the orbiting laboratory to at least 2024 provides NASA with an additional decade to help transition low Earth orbit from exclusive to accessible, and offers scientists and engineers the time they need to ensure the future of exploration, scientific discoveries, and economic development. The ability to extend our window of discovery with the ISS through at least 2024 presents important new opportunities to develop the tools we need for future missions to deep space, while reaping large benefits for humanity. Expanding the timeframe for testing essential technologies and hardware related to long-duration journeys, such as to an asteroid or Mars, is the first step in exploration.

During FY 2014, NASA made progress towards achieving this agency priority goal, broadening ISS utilization to capitalize on its external unpressurized capabilities, and paving the way for NASA's first use of the station as a 24/7 Earth-observing and technology demonstration platform:

- On January 7, 2014, Orbital Sciences Corporation's Orbital-1 launched with six CubeSats (i.e., miniaturized satellites for space research) and science resupply.
- On April 18, 2014, Space Exploration Technologies Corporation's (SpaceX) SpaceX-3 launched with science resupply and two unpressurized payloads, the High Definition Earth Viewing (HDEV) camera and the Optical PAyload for Lasercomm Science (OPALS) laser communications system.
- On July 12, 2014, Orbital-2 launched with more CubeSats and science resupply.
- On July 29, 2014, the European Space Agency's Automated Transfer Vehicle (ATV5) launched with science resupply and two new facilities, a new handrail exposure facility and an electromagnetic levitator.
- On September 22, 2014, SpaceX-4 launched with the ISS-Rapid Scatterometer (RapidScat) designed to measure near-surface ocean wind speed and direction; new Rodent Research Hardware to study the effects of bone and muscle loss in in space; and a three-dimensional (3-D) printer, which is the first step towards establishing an on-demand machine shop in space.
- With the launch of the RapidScat unpressurized payload on SpaceX-4, the ISS achieved 65 percent occupancy, exceeding the 60 percent occupancy baseline from FY 2013.

During FY 2015, NASA continued to support a robust research and development program, as well as increased the facility occupancy by adding new science hardware on orbit. NASA began a one-year US-Russian joint human health and performance research project with the launch of Astronaut Scott Kelly and Cosmonaut Mikhail Kornienko to the ISS on March 27, 2015. Kelly and Kornienko will stay aboard the ISS for one year, the longest space mission ever assigned to a NASA astronaut, to examine the effects of long-term spaceflight on human physiology. While Kelly is on board the space station, his identical twin brother, retired NASA astronaut Mark Kelly, will participate in the study on Earth, allowing NASA to better isolate the deleterious effects of spaceflight on the human body, and to aid in the development of countermeasures for these effects. This research will be invaluable to the preparation for future long-duration spaceflight missions to study the effects of long duration space missions on the human body.

The ISS also continued to make progress toward achieving the agency priority goal by launching new external unpressurized science instruments:

- On October 28, 2014, Orbital-3 launched, but failed to reach orbit, resulting in a loss of all cargo onboard.
- On January 10, 2015, SpaceX-5 launched with science resupply; the Cloud-Aerosol Transport System (CATS), designed to study the atmospheric constituents that impact the Earth's climate; and an IMAX camera to film ISS-based video designed to showcase the ISS as a research and technology platform.
- On April 14, 2015, SpaceX-6 launched with science resupply and the second Center for the Advancement of Science in Space (CASIS) Rodent Research investigation.
- On June 28, 2015 SpaceX-7 launched, but failed to reach orbit, resulting in a loss of all cargo onboard.
- On August 19, 2015, Japan's H-II Transfer Vehicle (HTV5) launched with science resupply and the CALorimetric Electron Telescope (CALET), designed to search for dark matter and measure high energy particles and cosmic rays.
- SpaceX-8 with a new external payload was targeted for September 2015, but was delayed until 2016 because of the SpaceX-7 incident investigation.

With the loss of SpaceX-7 and delay of SpaceX-8 into FY 2016, the ISS was unable to reach the target of 70 percent occupancy, and instead ended FY 2015 with 67 percent occupancy. For its FY 2016-17 APG, NASA has set a target to increase the occupancy of the ISS's internal and external research facilities to 75 percent.

Strategies

Increasing facility utilization (subsequently referred to as “occupancy”) is a function of the demand for the use of the International Space Station (ISS) and the supply or capacity of the laboratory to support research. The supply or capacity of the laboratory to support research is determined by the infrastructure in orbit, the transportation system, and the crew availability. The demand for use of the ISS for research is driven by the funding of research by NASA, other government agencies and the private sector. Continued funding and development of new research and technology instruments and the continued availability of the commercial cargo vehicles and International Partner vehicles is required to increase ISS utilization.

At this time, commercial cargo transportation capability is not expected to limit the research use of the ISS in FY 2017; however, actual launch dates and cargo capacity for new research payloads may affect the progress toward increasing utilization if the flights flow into subsequent years. As long as transportation is not a limiting factor, the progress toward increasing utilization can be measured in two dimensions: facility occupancy, and use of available crew time for research. These are measured every six months based on the ISS research planning cycle.

The level of facility utilization is measured by the combination of occupancy of internal research facility sites, occupancy of external research facilities, and the use of available duty cycles of operational facilities. A combination of occupancy of multi-user rack facilities at the sub-rack-level, instruments occupying external sites, and facility-class rack use are averaged together to determine the overall facility occupancy. The baseline for estimating the percentage occupancy is the NASA facilities at assembly complete.

Crew time for research is the percentage of crew time available for research that was used in a given planning period. Crew time is used to maintain the ISS systems, for sleep and hygiene, and to complete ISS research tasks. Many experiments require little or no crew time, but it is a constraining factor for research that needs a human operator, particularly in the internal research facilities and duty cycles to successfully complete research objectives.

Based on the overall program requirements for safe operations with six crew, a minimum of 35 hours per week used for research is treated as the US segment crew time baseline. This is a minimal number of hours when a crewmember is specifically scheduled to complete a research activity during the work day. To ensure maximum use of crew time for research, a set of reserve activities are always available on orbit, and if mission changes allow additional research to be completed, the scheduling of these activities can increase crew time use in a given period to slightly greater than 100 percent (i.e., more than the planned 35 hours per week).

Because it is a limiting factor, the ISS Program is working to expand the availability of crew time for research through efficiencies, and through future augmentation to seven crew planned with the arrival of commercial crew capability in 2017/2018. This will allow increased facility occupancy by relaxing crew time constraints for facility installation, operations, and maintenance.

NASA monitors and tracks its progress towards this goal using various Agency documents and reports, including Directorate Program Management Council and Program Management Council materials, project schedules, and other program-internal documents. The ISS Program tracks occupancy using reports on downlink hours, research reports, and launch manifests. The only possible data limitation that NASA has identified would be an interruption in the computer communication downlink from the ISS, which could delay gathering these data. Otherwise, NASA has not identified any data limitations that would preclude it from reporting accurate, reliable, and timely performance information. NASA follows an “alternative form,” or milestone-based, approach to reporting on its goals. Using the documents and reports referenced above, the Agency is able to accurately report at the end of each quarter on whether or not it has met its planned milestones.

Next Steps

FY 2016

- Q1: Launch payload hardware and resupply on one or more commercial cargo vehicles.
- Q2: Launch payload hardware and resupply on one or more commercial cargo vehicles.
- Q3: Launch payload hardware and resupply on one or more commercial cargo vehicles.
- Q3: Support the 5th ISS Research and Development Conference, San Diego, CA.
- Q4: Launch payload hardware and resupply on one or more commercial cargo vehicles.

FY 2017

- Q1: Launch payload hardware and resupply on one or more commercial cargo vehicles.
- Q2: Launch payload hardware and resupply on one or more commercial cargo vehicles.
- Q3: Launch payload hardware and resupply on one or more commercial cargo vehicles.
- Q3: Support the 6th ISS Research and Development Conference, location TBD.
- Q4: Launch payload hardware and resupply on one or more commercial cargo vehicles.

More information on NASA's agency priority goals is available on http://performance.gov.

Agency Priority Goal: Commercial Crew Transportation

Mission Directorate

Human Exploration and Operations Mission Directorate

Goal Leader

Philip McAlister, Director, Commercial Spaceflight Development

Contributing Programs

Commercial Crew

FY 2014-FY 2015 Goal Statement

By September 30, 2015, the Commercial Crew Program will complete the first phase of certification efforts with Commercial Crew Transportation partners, and will make measurable progress toward the second certification phase with industry partners while maintaining competition.

FY 2016-FY 2017 Goal Statement

Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition, returning International Space Station crew transportation to the United States. By September 30, 2017, the Commercial Crew Program (CCP), along with its industry partners, will make measurable technical and programmatic progress toward the certification of commercial crew transportation systems, including the completion of at least one Design Certification Review.

FY 2014-FY 2015 Progress Summary

During the last two years, the Commercial Crew Program completed the first certification phase of commercial crew development with its industry partners, and has made extensive programmatic progress towards the second phase.

All partners continued making technical and programmatic progress under their respective Commercial Crew Transportation Capability Space Act Agreements:

- Blue Origin completed the pusher escape system ground firing and a pad abort test. These tests are designed to demonstrate that a launch escape system can get the crew to safety in the event of an emergency on the launch pad.
- The Boeing Company (Boeing) accomplished several Critical Design Reviews (CDRs), including of the primary structures, the launch vehicle adapter, and software, as well as their integrated CDR. CDRs are significant reviews that demonstrate that a design is mature enough for production.
- The Sierra Nevada Corporation completed their integrated system safety review #2, main propulsion risk reduction testing, and continued preparation for their Engineering Test Article drop test.

- The Space Exploration Technologies Corporation (SpaceX) conducted a pad abort test of the Crew Dragon spacecraft, integrated crew vehicle CDR, and primary structure qualification testing.

Under Certification Products Contracts (CPC), NASA's industry partners began the next step in their plans to launch American astronauts from U.S. soil:

- Under CPC, NASA's partners developed early lifecycle certification and verification products needed to start the process of certifying the crew transportation systems to carry NASA personnel to the International Space Station (ISS).
- All partners completed their respective CPC contract elements.
- In the third quarter of FY 2014, NASA finalized and closed out CPC, marking the end of the first certification phase of its commercial crew development efforts.

In September 2014, as part of the second phase of commercial crew development, NASA announced selection of its Commercial Crew Transportation Capability (CCtCap) industry partners, Boeing and SpaceX, to continue development and certification efforts for their respective commercial crew transportation systems. The award was protested and, in January 2015, the Government Accountability Office rendered a decision in favor of NASA, allowing NASA and its industry partners to begin work in earnest. During FY 2015, NASA's CCtCap partners continued making technical and programmatic progress maturing their crew transportation systems:

- Both partners completed their respective Certification Baseline Reviews early in their CCtCap effort. The Certification Baseline Reviews were among earliest major milestones on the CCtCap contracts, and included detailed plans for how NASA's industry partners intend to achieve NASA certification of their launch systems.
- Boeing completed the Phase 2 Safety Review (Part B), delta Integrated CDR, Launch Segment CDR, and Qualification Test Vehicle production readiness review; and began modifications to Launch Pad 41, required to support crew ingress and egress.
- SpaceX completed their avionics test bed activation, and continue their Launch Pad 39A modification efforts, required to support commercial crew missions, as well as other SpaceX missions.
- SpaceX continues planning for their delta CDRs for this fall. SpaceX has dropped review products for their launch vehicle and ground systems CDR, scheduled for October.
- Both partners continue identifying and submitting variances, alternate standards, and hazard reports, necessary for the NASA's crew transportation system certification effort.

NASA met its agency priority goal by the end of FY 2015. For its FY 2016-17 agency priority goal, the Commercial Crew Program, along with its industry partners, will continue to make measurable technical and programmatic progress toward the certification of commercial crew transportation systems, including the completion of at least one Design Certification Review.

Strategies

On September 16, 2014, NASA announced the selection of the Boeing Company and Space Explorations Technologies Corporation (SpaceX) to continue development and certification efforts under Commercial Crew Transportation Capability (CCtCap) contracts, with the goal of transporting crews to the International Space Station (ISS) from U.S. soil.

- NASA and its partners are working to define verification closure items, alternate standards, and variances needed to complete certification efforts.
- NASA's partners are identifying safety hazards and closures needed to ensure crew safety through all mission phases.
- NASA's partners are continuing systems development efforts, including subsystem and system level testing.

- Both of NASA's partners have chosen to fly two pre-certification missions to the ISS, one uncrewed and one crewed.

Partner progress is reported regularly to the Commercial Crew Program Control Board, at the Human Exploration and Operations Directorate Program Management Council (DPMC), and at the Agency Baseline Performance Review.

NASA monitors and tracks its progress towards this goal using various Agency documents and reports, including DPMC materials, reports from the CCtCap industry partners, and other program-internal documents. The only possible data limitation that NASA has identified would be that the materials from the industry partners may include company proprietary information, which could not be released publically. Otherwise, NASA has not identified any data limitations that would preclude it from reporting accurate, reliable, and timely performance information. NASA follows an "alternative form," or milestone-based, approach to reporting on its goals. Using the documents and reports referenced above, the Agency is able to accurately report at the end of each quarter on whether or not it has met its planned milestones.

Next Steps

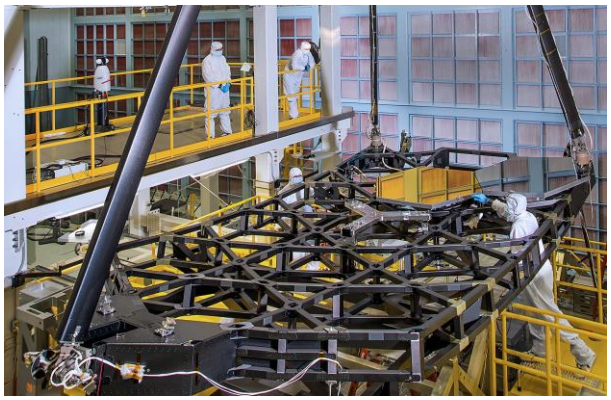
FY 2016

- Q1: Boeing will conduct its Qualification Test Vehicle, Integrated Readiness Review.
- Q2: SpaceX will conduct its delta Critical Design Review (dCDR).
- Q3: SpaceX will conduct its Propulsive Descent Test of the Dragon 2 spacecraft.
- Q4: Boeing will conduct its initial Integrated Parachute System Drop Test.

FY 2017

- Q1: SpaceX will complete its Launch Site Operational Readiness Review (LSORR).
- Q2: Boeing will provide updated system hazard closure inputs for NASA review.
- Q3: SpaceX will conduct Verification Closure Events in alignment with their Verification Plan.
- Q4: Partners will conduct hardware qualification and acceptance testing per their respective Verification Plans.

More information on NASA's agency priority goals is available on http://performance.gov.



Agency Priority Goal: James Webb Space Telescope

Mission Directorate

Science Mission Directorate

Goal Leader

Dr. Eric P. Smith, Program Director, James Webb Space Telescope Program Office

Contributing Programs

James Webb Space Telescope

FY 2014-FY 2015 Goal Statement

By October 2018, NASA will launch the James Webb Space Telescope, the premier space-based observatory. To enable this launch date, NASA will complete the James Webb Space Telescope primary mirror backplane and backplane support structures and deliver them to the Goddard Space Flight Center for integration with the mirror segments by September 30, 2015.

FY 2016-FY 2017 Goal Statement

Revolutionize humankind's understanding of the Cosmos and humanity's place in it. By October 2018, NASA will launch the James Webb Space Telescope (Webb). To enable this launch date, NASA will complete the testing of the Webb Optical Telescope Element plus Integrated Science Instrument Module by September 30, 2017.

FY 2014-FY 2015 Progress Summary

The James Webb Space Telescope (Webb) Program achieved its priority goal, the delivery of the completed telescope structure (flight backplane) from Northrop-Grumman to NASA, on schedule in August 2015. Along the way toward this critical milestone, NASA completed all of its intermediate (quarterly) goals on or ahead of schedule. Below are some of the highlights from these quarterly goals, as well as select others.

In early 2014, Webb completed its spacecraft Critical Design Review. This review was the final major design review for the program, and demonstrated that the design of the spacecraft element (spacecraft bus and sunshield) was mature enough to proceed to production.

As it made progress toward delivering the flight backplane, the Webb program completed the Pathfinder Telescope (or "Pathfinder"), comprised of a flight-like telescope center section, two mirror segments and a secondary mirror. That Pathfinder has subsequently undergone two successful cryovacuum tests at the Johnson Space Center and has provided important lessons for when the flight telescope and science instruments are tested there.

The science instruments have undergone a second cryovacuum test at the Goddard Space Flight Center. Several hardware elements (including the heat straps and sensor chips for one of the instruments) were found to be

operating suboptimally and replaced after the test. Uncovering issues is precisely the point of hardware testing. The science instruments with updated hardware are now undergoing their third and final cryovacuum test before being mated to the telescope. Program reserves and funded schedule reserve are held in order to keep the total program within its appropriated budget and on track for the October 2018 launch. Webb is still well within its cost and schedule reserves to meet its planned launch date.

A particularly challenging technical element of the mission, a cryocooler for one of the science instruments, presented the program with problems during the performance period. Webb was able to absorb the cost and schedule impacts of the cryocooler. These manufacturing problems have been overcome, and the flight system is now undergoing acceptance testing and is performing well.

The Webb Program continues to be an agency priority goal for the FY 2016-FY 2017 reporting cycle. Over this period, NASA plans to complete science instrument testing, populate the telescope structure with mirrors, join the instruments and telescope together, and deliver the combination for testing prior to joining them with the spacecraft.

Strategies

In order to monitor progress toward the Webb APG, the program employs earned value management (EVM) practices, Estimate-at-Complete analyses that incorporate the current risk posture, independent analysis of those data, detailed tracking of lower-level milestones that lead up to the APG, as well as schedule health assessments. The project receives monthly EVM and schedule health reports that detail how the work is progressing with respect to the plan and budget.

Members of the Webb Standing Review Board (SRB) participate in key reviews for the elements of this APG. These SRB subject matter experts provide independent assessments of the project's readiness to support the next activities along the APG schedule. Examples of such reviews include the Integrated Science Instrument Module pre-shipment review in FY 2016 Q2, and the pre- and post-test OTIS reviews in FY 2016 Q3 and FY 2017 Q2, respectively.

Several of the milestones along the path towards this APG are designated as “Headquarters milestones” and are tracked and reported monthly to the NASA Associate Administrator. These milestones are also reported externally to stakeholders within the Administration (the Office of Management and Budget and the Office of Science and Technology Policy) and Congress.

The sources of earned value management (EVM) and milestone progress data include contractor monthly EVM reports, NASA analyses of contractor earned value reports, and NASA analyses of schedule and cost performance of Webb overall. While there are no significant limitations on the level of accuracy of the information used to assess performance, approximately two-to-three weeks are required for contractors to collect and assemble earned value data into the monthly reports to NASA. This delay does not impede NASA’s ability to determine when schedule milestones have been completed, and NASA has not identified any data limitations that would preclude it from reporting accurate, reliable, and timely performance information. NASA follows an “alternative form,” or milestone-based, approach to reporting on its goals. Using the documents and reports referenced above, the Agency is able to accurately report at the end of each quarter on whether or not it has met its planned milestones.

Next Steps

FY 2016

- Q1: Initiate installation of mirror segments onto Flight Backplane.

- Q2: Complete Pathfinder Telescope test #2 at the Johnson Space Center (JSC).
- Q3: Deliver completed Integrated Science Instrument Module (ISIM) to OTIS Integration team.
- Q4: Integrate Optical Telescope Element (OTE) and ISIM to form OTIS.

FY 2017

- Q1: Complete vibration testing of OTIS.
- Q2: Ship OTIS to JSC.
- Q3: Start cryovacuum testing of OTIS.
- Q4: Complete cryovacuum testing of OTIS.

More information on NASA's agency priority goals is available on http://performance.gov.

Cross-Agency Priority Goals

Cross-agency priority (CAP) goals focus on major issues that require active collaboration between multiple federal agencies to implement and are intended to accelerate progress on a limited number of Presidential priority areas. The original set of CAP goals covered the FY 2012-FY 2013 reporting period. In FY 2014, the Office of Management and Budget designated 15 new CAP goals to cover the FY 2014-FY 2017 reporting period.

Per the GPRA Modernization Act requirement to address CAP goals in the Agency Strategic Plan, the Annual Performance Plan, and the Annual Performance Report, please refer to http://www.performance.gov for the Agency's contributions to those goals and progress, where applicable. NASA currently contributes to the CAP goals noted in Figure 12.

To ensure effective leadership and accountability across the Federal Government, each CAP goal has a named senior leader both within the Executive Office of the President and within one or more of the key delivery agencies. NASA is not a goal leader for any of the FY 2014-FY 2017 CAP goals, but does contribute to the 10 CAP goals noted below.

Figure 12: Cross-Agency Priority Goals Supported by NASA, FY 2014-FY 2017

Cybersecurity
Climate Change (Federal Actions)
Science, Technology, Engineering, and Mathematics (STEM) Education
Efficiency: Category Management (formerly Strategic Sourcing)
Effectiveness: Smarter IT Delivery
Efficiency: Shared Services
Efficiency: Benchmark and Improve Mission-Support Operations
Economic Growth: Open Data
Economic Growth: Lab-to-Market
People and Culture

As part of the CAP goal requirements, agencies complete internal, data-driven reviews of their progress in implementing each of the goals. To meet this requirement, NASA leverages its Baseline Performance Review, which is described in more detail in "Part 1: Performance Management at NASA." The Baseline Performance Review is a monthly forum for the program offices and mission-support offices to report on their performance results to NASA leadership. The meetings are results-oriented and ensure that performance information is communicated regularly across the Agency. During its highlighted Baseline Performance Review month, the responsible organization for each CAP goal within NASA reports on its progress towards the goal to the Chief Operating Officer, Performance Improvement Officer, and other senior NASA leadership.

Results and Impacts

The following pages provide the overall Federal Government goal statement and sub-goals, where available, from http://performance.gov for each of the CAP goals that NASA supports, a brief section describing some of the significant contributions that NASA has made or is making to each of the CAP goals, and, where appropriate, linkages to performance goals and annual performance indicators in NASA's Annual Performance Plan.

Cybersecurity

Government-wide Goal Statement
Improve cybersecurity performance through ongoing awareness of information security, vulnerabilities, and threats impacting the operating information environment, ensuring that only authorized users have access to resources and information; and the implementation of technologies and processes that reduce the risk of malware.

Government-wide Sub-Goals or Focus Areas

- Information Security Continuous Monitoring (ISCM): Provide ongoing observation, assessment, analysis, and diagnosis of an organization's cybersecurity posture and operational readiness.
- Identity, Credential, and Access Management (ICAM/Strong Authentication): Implement a set of capabilities that ensure users must authenticate information technology (IT) resources and have access to only those resources that are required for their job function.
- Anti-Phishing and Malware Defense (APMD): Implement technologies, processes, and training to reduce the risk of malware being introduced through email and malicious or compromised Web sites.

NASA Contribution to the CAP Goal
NASA submits data on all three of the cybersecurity priority areas as part of its required reporting in response to the Federal Information Security Management Act. In addition, one of the three information technology (IT) strategic goals in the *2014 Information Resources Management (IRM) Strategic Plan*, which NASA released in March 2014, is specifically focused on cybersecurity:

Strategic Goal 2—Enhance and strengthen IT security and cybersecurity to ensure the integrity, availability, and confidentiality of NASA's critical data and IT assets.

Cybersecurity is critical to protect the intellectual property, power of invention, and natural ingenuity that is at the heart of NASA. NASA works to provide timely, reliable, and cost-effective enterprise security to protect its information systems, in alignment with federal cybersecurity priorities. IT threats are evolving globally, and NASA's capabilities to protect information assets need to evolve accordingly. To this end, the Agency will anticipate and defend against these changing threats to enable the continued success of NASA's missions. NASA is in the process of transforming its cybersecurity capabilities and integrating cybersecurity as a vital part of its cultural identity. Achieving full awareness of an Agency-wide IT security posture will complement approaches to improve NASA's capability to combat sophisticated cyber-attacks. NASA also will ensure that it integrates the appropriate level of security needed to safely unlock the value of innovation, such as increasing end user mobility and burgeoning cloud computing capabilities. These cybersecurity challenges demand balanced collaboration, resources, and communication to proactively defend against the ever-changing threat environment.

In order to increase cybersecurity awareness, NASA held a kickoff event for National Cyber Security Awareness Month on October 1, 2015. This year marks the fifth anniversary of the "Stop. Think. Connect" campaign, which is designed to raise awareness of best practices that will help safeguard vital IT equipment against cyber attacks. The NASA Office of the Chief Information Officer (OCIO) is encouraging all NASA personnel to "Stop. Think. Connect."

- STOP: Before you use the Internet, take time to understand the risks and learn how to spot potential problems.
- THINK: Take a moment to be certain the path ahead is clear. Consider how your actions online could impact your safety, or your family's.
- CONNECT: Enjoy the Internet with greater confidence, knowing you've taken the right steps to safeguard yourself and your computer.

During FY 2015, OCIO made significant progress in ensuring the security of its networks:

- As part of a "30-day cybersecurity sprint," OCIO strengthened access for the NASA Consolidated Active Directory (NCAD) to 100 percent of privileged users and 76.7 percent of desktop users.
- OCIO included 100 percent of Agency users in a phishing exercise in 4th quarter FY 2015.

OCIO operated Information Security Continuous Monitoring (ISCM) at 96.9 percent, surpassing the federal goal of 95 percent, and closing out a performance improvement plan item from FY 2014.

Linkages to the NASA Annual Performance Plan(s)	
Performance Goal	**FY 2015**
3.3.1: Enhance NASA's information security posture through implementation of automated security and privacy tools and technologies.	**Green**
Annual Performance Indicator	**FY 2015**
AMO-15-25: Increase the security of NASA's information operations by implementing the FY 2015 target cross-agency priority cybersecurity capabilities, including Information Security Continuous Monitoring (ISCM), Identity, Credential, and Access Management (ICAM), and Anti-Phishing & malware defense.	**Green**
For FY 2016: AMO-16-25: Increase the security of NASA's information operations by implementing the FY 2016 target cross-agency priority cybersecurity capabilities, including Information Security Continuous Monitoring (ISCM); Identity, Credential, and Access Management (ICAM); and anti-phishing and malware defense.	
For FY 2017: AMO-17-25: Increase the security of NASA's information operations by implementing the FY 2017 target cross-agency priority cybersecurity capabilities, including Information Security Continuous Monitoring (ISCM); Identity, Credential, and Access Management (ICAM); and anti-phishing and malware defense.	

Climate Change (Federal Actions)

Government-wide Goal Statement

More than double Federal Government consumption of electricity from renewable sources to 30 percent by 2050 and improve energy efficiency at Federal facilities as part of the wider strategy to reduce the Federal Government's direct greenhouse gas emissions by 40 percent by 2025 (2008 baseline).

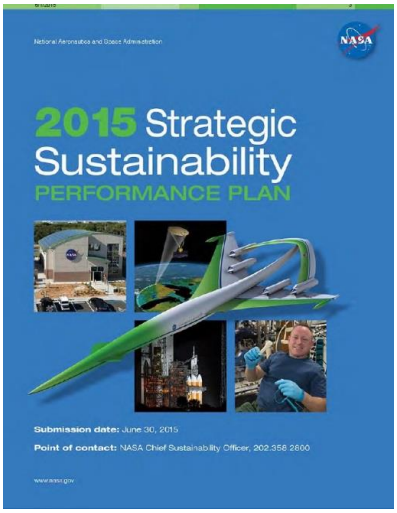
Government-wide Sub-Goals or Focus Areas

- Greenhouse Gas (GHG) Emissions: Reduce GHG emissions by the Federal Government for Scope 1 and 2 by 28 percent by 2020, and for Scope 3 by 8 percent by 2020.
  - Scope 1 includes direct GHG emissions from sources owned by NASA.
  - Scope 2 includes indirect GHG emissions from purchased electricity, heat, or steam.
  - Scope 3 includes other indirect GHG emissions; e.g., travel in non-NASA vehicles.
- Renewable Energy: Increase renewable energy consumed by the Federal Government to 30 percent by 2025.
- Performance Contracting: Improve energy and water efficiency in Federal buildings through the use of Energy Savings Performance Contracts (ESPCs) or Utility Energy Service Contracts (UESCs).

NASA Contribution to the CAP Goal

NASA's sustainability policy is to execute its Mission without compromising the Earth's resources, so that future generations can meet their needs. Sustainability also involves taking action now to provide a future where the environment and living conditions are protected and enhanced. In implementing sustainability practices, NASA manages risks to its missions, risks to the environment, and risks to local communities. To this end, NASA seeks to use public funds efficiently and effectively, promote the health of the planet, and operate in a way that benefits its neighbors.

NASA continues to devote significant effort towards meeting its sustainability goals. NASA was awarded green ratings in five out of seven focus areas of the *January 2015 Office of Management and Budget (OMB) Scorecard on Sustainability/Energy*. In addition, NASA received green ratings in all three goals that directly relate to the focus areas for the Climate Change CAP goal in its *2015 Strategic Sustainability Performance Plan (SSPP)*, which was released in November 2015. Some highlights of NASA's sustainability efforts are as follows:



- NASA awarded ESPCs and UESCs totaling $99.5 million, which surpassed its President's Performance Contracting Challenge target of $73.9 million by the end of 2016. These contract mechanisms enable energy service companies and utility companies to finance energy projects that NASA repays over time from avoided utility costs.
- NASA is implementing an Agency-wide strategy that emphasizes the identification of large renewable energy projects that can make a significant difference for the Agency as a whole, in addition to smaller projects at each Center. In keeping with this strategy, NASA contracted with the National Renewable Energy Laboratory (NREL) to perform a feasibility study at the White Sands Test Facility (WSTF) for a solar plant installation, and also contacted the Environmental Protection Agency (EPA) Combined Heat and Power (CHP) Partnership to support an initial CHP feasibility study for the Goddard Space Flight Center. This CHP could be designed to use natural gas and landfill gas to generate electricity.
- NASA continues to increase its inventory of sustainable buildings, adding six more buildings in FY 2014 that achieved platinum, gold, or silver Leadership in Energy and Environmental Design (LEED) certification, exemplifying NASA's use of creative thinking and ingenuity to incorporate reuse of deconstructed building and NASA space technology into new structures.

More examples of NASA's recent successes and planned actions are included in the 2015 SSPP.

Linkages to the NASA Annual Performance Plan(s)	
Performance Goal	**FY 2015**
3.1.7: Ensure that NASA continues progress towards implementing statutory or Executive Order targets and goals reflected in its annual Sustainability Plan.	**Yellow**
Annual Performance Indicator	**FY 2015**
AMO-15-12: Ensure that at least 10 percent of electricity is consumed from renewable energy sources.	**Green**
For FY 2016: AMO-16-10: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) to meet the target set by the Office of Management and Budget for FY 2016 in the Sustainability and Energy Scorecard.	
For FY 2017: AMO-17-10: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) to meet the target set by the Office of Management and Budget for FY 2017 in the Sustainability and Energy Scorecard.	

STEM Education

Government-wide Goal Statement
Improve Science, Technology, Engineering, and Mathematics (STEM) Education by implementing the *Federal STEM Education 5-Year Strategic Plan*.

Government-wide Sub-Goals or Focus Areas

- Improve STEM instruction.
- Increase and sustain youth and public engagement in STEM.
- Enhance STEM experience of undergraduate student.
- Better serve groups historically under-represented in STEM fields.
- Design graduate education for tomorrow's STEM workforce.
- Build new models for leveraging assets and expertise.
- Build and use evidence-based approaches.

NASA Contribution to the CAP Goal
NASA's STEM education expertise and assets play a unique role in the Nation's STEM education portfolio. The Agency aims to increase both the effectiveness and utilization of NASA resources to achieve the Administration's STEM education goals through interagency efforts. The Agency also aims to increase the reach of its programs, including engaging a diverse audience of educators and students, including women, minorities, and persons with disabilities.

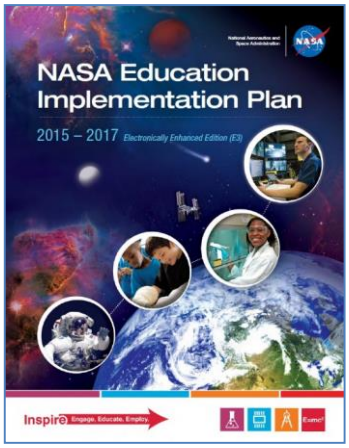
NASA actively contributes to federal-wide efforts to advance collaboration among government agencies to deliver compelling STEM content. In addition to its membership on the Committee on STEM (CoSTEM), NASA is a co-chair of the Federal Coordination in STEM Education Task Force (FC-STEM) along with the National Science Foundation. FC-STEM is tasked with overseeing the implementation of the *Federal STEM Education 5-Year Strategic Plan* through five Interagency Working Groups (IWGs) aligned to the five priority investment areas of the strategic plan. NASA participates in all of the IWGs and, in FY 2015, was named co-chair with the Smithsonian Institution for the STEM Engagement IWG. In FY 2016, NASA will continue its work the IWG-created infrastructure, policies, and practices. More information is available in the *Progress Report on Coordinating Federal STEM Education*, released in March 2015 by the Office of Science and Technology Policy.

In September 2015, NASA released its *NASA Education Implementation Plan: 2015-2017*, which describes the Agency's efforts to advance high-quality STEM education using NASA's unique capabilities. NASA Education programs provide opportunities for learners, educators, and institutions that are consistent with the goals,

objectives, and strategies of the CoSTEM 5-Year Strategic Plan. NASA Education also works closely with other federal agencies in the priority areas identified by CoSTEM.

The CoSTEM Strategic Plan identifies five priority investment areas, each with a corresponding national goal that federal agencies, and their partners in state and local entities and the private sector, aspire towards:

- Improve STEM Instruction: Prepare 100,000 excellent new K-12 STEM teachers by 2020, and support the existing STEM teacher workforce.
- Increase and Sustain Youth and Public Engagement in STEM: Support a 50 percent increase in the number of U.S. youth who have an authentic STEM experience each year, prior to completing high school.
- Enhance STEM Experience of Undergraduate Students: Graduate one million additional students with degrees in STEM fields over the next 10 years.
- Better Serve Groups Historically Underrepresented in STEM Fields: Increase the number of students from groups that have been underrepresented in STEM fields that graduate with STEM degrees in the next 10 years, and improve women's participation in areas of STEM where they are significantly underrepresented.
- Design Graduate Education for Tomorrow's STEM Workforce: Provide graduate-trained STEM professionals with basic and applied research expertise, options to acquire specialized skills in areas of national importance, mission-critical workforce needs for the Agency, and ancillary skills needed for success in a broad range of careers.



The CoSTEM Strategic Plan also includes two coordination approaches that span the priority areas above:

- Build New Models for Leveraging Assets and Expertise: Implement a strategy of lead and collaborating agencies to leverage capabilities across agencies to achieve the most significant impact of federal STEM education investments.
- Build and Use Evidence-Based Approaches: Conduct STEM education research and evaluation to build evidence about promising practices and program effectiveness, to be used across agencies and shared with the public to improve the impact of the federal STEM education investment.

The 5-Year CoSTEM Strategic Plan helps guide NASA Education's approach to implementing its strategic objective and aligning with federal STEM efforts through 2017.

Linkages to the NASA Annual Performance Plan(s)
All of the Office of Education performance goals and annual performance indicators under Strategic Objective 2.4 link to the STEM Education CAP goal. Please refer to this section for the complete list of measures.

Smarter IT Delivery

Government-wide Goal Statement

Eliminate barriers and create new incentives to enable the Federal Government to procure, build, and provide world-class, cost-effective information technology (IT) delivery for its citizens, and hold agencies accountable to modern IT development and customer service standards.

Government-wide Sub-Goals or Focus Areas

- Attract, recognize, hire, and retain more of the best talent working inside government in order to increase the government's internal technical capacity and bring federal IT culture in line with private sector best practices.

- Get more of the best companies and partners working with the government to rapidly deliver innovative solutions and systems that meet or exceed customer and Agency expectations in terms of cost, time, experience, and capabilities.
- Put the right processes and practices in place to drive outcomes and accountability through High Impact List (HIL) engagements, PortfolioStat, and Digital Services pilot engagements.

NASA Contribution to the CAP Goal

NASA takes advantage of new technologies to efficiently deliver end user IT services to its workforce. For example, where possible, the Agency is increasing its use of cloud computing, rather than purchasing computer hardware, such as servers. The Smarter IT Delivery CAP goal aligns with Strategic Goal 3 in the *2014 Information Resources Management (IRM) Strategic Plan*:

Strategic Goal 3—Enable innovative, sustainable, and transparent mission support through effective IT planning, enterprise architecture, and governance.

As a united IT community, NASA ensures the financial sustainability of its IT operations by being more responsive and adaptable while making innovative investments to deliver increased value to its customers. Core approaches to providing a responsive, economical enterprise IT platform for NASA include strategic sourcing; buying "services-on-demand" when appropriate, instead of owning infrastructure; and consolidating duplicative services. To improve the effective and efficient use of IT, NASA needs to understand the allocation of its pool of IT resources in order to enable decisions that direct these resources towards achieving agreed-upon architectures and solutions that achieve its mission support commitments. Supporting NASA's Mission demands a high level of performance from its diverse IT workforce, whose knowledge, skills, and dedication form the backbone of its achievements. NASA empowers and relies on its workforce for the timely and effective planning and execution of the strategies defined within the *IRM Strategic Plan*. Collectively, through more effective governance, management discipline, and execution accountability, NASA's IT staff will reduce NASA's IT operations and maintenance costs, improve NASA's information security posture, and better enable mission success.

During FY 2015, NASA Office of the Chief Information Officer (OCIO) made significant progress in efficiently and effectively delivering IT services to its workforce:

- 100 percent of NASA's IT projects reported on the Federal IT Dashboard are within 10 percent of their budgeted cost and delivery schedule.
- OCIO migrated the Web Services cloud environment onto the Agency's Cloud Services Service Office (CSSO) cloud contract with Amazon. NASA also established the Marshall Space Flight Center's Marshall and Agency Computing Services (MACS) Managed Cloud Environment (MCE) in Amazon Web Services.

Linkages to the NASA Annual Performance Plan(s)	
Performance Goal	**FY 2015**
3.3.7: Increase the adoption of technologies and services such as cloud computing throughout NASA's infrastructure and mission, leveraging savings from solutions such as reduced capital expenditures from not owning hardware, benefits from new technology capabilities, and increased computing flexibility available with "pay as you go" services.	**Green**
Annual Performance Indicator	**FY 2015**
AMO-15-29: Onboard two significant communities into the cloud in FY 2015.	Green
For FY 2016: AMO-16-29: Onboard two significant communities into the cloud in FY 2016.	
For FY 2016: AMO-16-30: Implement at least one new technology solution that improves efficiency and the effectiveness of end user service delivery to NASA's workforce.	
For FY 2017: AMO-17-29: Onboard two significant communities into the cloud in FY 2017.	

Category Management (formerly Strategic Sources)

Government-wide Goal Statement
Expand the use of high-quality, high-value strategic sourcing solutions in order to improve the government's buying power and reduce contract duplication.

NASA Contribution to the CAP Goal
Effective in FY 2016, the Office of Management and Budget (OMB) changed the Strategic Sourcing CAP goal into the Category Management CAP goal. Category management is a strategy for implementing strategic sourcing. Category management breaks down purchases into independent offices specializing in specific products, or categories. The ultimate goal is to streamline the acquisition process by identifying experts and responsible individuals and creating teams adept at procurement in their categories. The potential benefits include the following:

- Cost savings.
- Reduction in the number of contracts.
- Reduction in transaction costs.
- Establishment of best practices and knowledge sharing.

This will allow NASA to understand where dollars are spent across the Agency, leveraging the Agency's purchasing power and minimizing duplication of effort. The category manager will be able to take a broad look at the lifecycle of procurements, including not only sourcing, but also logistics, inventory management, accounts payable, and the supply chain, to achieve the largest savings possible.

Linkages to the NASA Annual Performance Plan(s)	
Performance Goal	**FY 2015**
3.1.6: Achieve savings for the Agency through acquisition reforms.	**Green**
Annual Performance Indicator	**FY 2015**
AMO-15-8: Achieve savings through effective use of both Federal-level and Agency-level strategic sourcing approaches.	**Green**
For FY 2016: AMO-16-8: Achieve savings through effective use of both Federal-level and Agency-level strategic sourcing approaches.	
For FY 2017: AMO-17-8: Achieve savings through effective use of both Federal-level and Agency-level strategic sourcing approaches.	

Shared Services

Government-wide Goal Statement
Strategically expand high-quality, high value shared services to improve performance and efficiency throughout government.

NASA Contribution to the CAP Goal
The NASA Shared Services Center (NSSC) was established on March 1, 2006, at the Stennis Space Center. The NSSC performs selected business activities for all NASA Centers in financial management, human resources, information technology, procurement, and business support services. The NSSC is supported in its mission, under contract, by its service provider.

NSSC also runs the Enterprise License Management Team (ELMT), which maintains licenses and maintenance agreements and negotiates economy-of-scale pricing for selected software used by the Agency. The ELMT is a

tool that allows each NASA Center to take advantage of reduced software and procurement costs. Tangible benefits include increased Agency access to vendor software suites, centralized license compliance and audit support gained through leveraged purchasing power, and economies of scale.

Linkages to the NASA Annual Performance Plan(s)
While NASA is undertaking numerous efforts in support of the Shared Services CAP goal, there are no direct linkages to the performance goals or annual performance indicators reported in the NASA Annual Performance Plan.

Benchmark and Improve Mission Support Operations

Government-wide Goal Statement
Improve administrative efficiency and increase the adoption of effective management practices by establishing cost and quality benchmarks of mission-support operations and giving agency decision-makers better data to compare options, allocate resources, and improve processes.

Government-wide Sub-Goals or Focus Areas

- Reduce administrative costs and improve service quality in acquisition functions.
- Reduce administrative costs and improve service quality in financial management functions.
- Reduce administrative costs and improve service quality in human capital functions.
- Reduce administrative costs and improve service quality in information technology (IT) management functions.
- Reduce administrative costs and improve service quality in real property functions.

NASA Contribution to the CAP Goal
NASA is participating in the effort, led by the Office of Management and Budget (OMB) and the General Services Administration (GSA), to develop benchmarks for the administrative functions performed across the Federal Government. During FY 2014, the initial focus of this effort was on the development of efficiency measures. In FY 2015, the effort was expanded to include operational quality and customer satisfaction measures. The quality measures complement the efficiency measures by demonstrating that agencies are not compromising customer service or quality in the pursuit of improved efficiency. NASA reported its results on approximately 100 total measures across five functional areas, including acquisitions, financial management, human capital, IT management, and real property. GSA maintains a website, available to civil servants and support contractors, which consolidates all of the benchmarking data from across the Federal Government.

In June 2015, NASA participated in a FedStat meeting with OMB and GSA, which focused on specific key takeaways from a review of the benchmarking data across agencies, and included an overview of NASA's mission performance, agency priority goals, and Strategic Review findings. The meeting was led by NASA's Chief Operating Officer, with support from the each of the benchmarking leads and their staff from throughout the Agency.

The goal of these efforts is to help senior leadership in each agency better understand the cost and quality of their administrative functions, particularly as they compare to other agencies. At this time, there are still some inconsistencies in how agencies report on these measures, so the data are not always comparable across agencies. NASA will continue working with OMB, GSA, and other participating agencies to resolve these discrepancies. Due to differing business operations and requirements across agencies, even once the data have been made comparable, they may not always be useful in drawing meaningful conclusions or actionable findings. Ideally, however, benchmarking could potentially be used to identify best practices, areas for improvement, and potential solutions or strategies to address underperformance.

Linkages to the NASA Annual Performance Plan(s)
While NASA is undertaking numerous efforts in support of the Benchmark and Improve Mission-Support Operations CAP goal, there are no direct linkages to the performance goals or annual performance indicators reported in the NASA Annual Performance Plan.

Open Data

Government-wide Goal Statement
Fuel entrepreneurship and innovation and improve government efficiency and effectiveness by unlocking the value of government data and adopting management approaches that promote interoperability and openness of these data.

Government-wide Sub-Goals or Focus Areas

- Fuel economic growth and innovation.
- Make open and machine-readable the new default for all government information.

NASA Contribution to the CAP Goal
NASA has a longstanding commitment, central to its founding legislation in 1958, to make its data open and accessible to as wide an audience as possible. Developers, technologists, entrepreneurs, citizen scientists, and others contribute directly to the understanding of the Earth and space by helping to create new ways of looking at this information.

NASA released its *Open Government Plan Version 3.0* in June 2014. As highlighted in the plan, NASA has an open data movement that is multifaceted, and includes the further release of datasets, the publication of datasets to https://www.data.gov, and the development of strategies to process large datasets.

During FY 2015, NASA released over 30,000 datasets and 40 application programming interfaces through its public online portal at https://data.nasa.gov/. Datasets available on NASA's data portal are automatically listed on the government-wide website, data.gov. NASA's data portal also includes developer resources to help users build applications that utilize NASA's data, as well as robust data visualization tools to increase the public understanding of the datasets. NASA's priority is to release as many datasets as possible through its data portal in a machine-readable, intuitive format, with a focus on mission data that can be readily converted for public use. NASA also introduced a new capability at data.nasa.gov that allows the public to request datasets, providing the Agency with a clearer understanding of the demand for NASA's data. In addition, NASA's Office of the Chief Information Officer (OCIO) developed a Data Management Strategy White Paper, with participation from across the Agency, to guide NASA's data management investments.

NASA also encourages the use of its data through open challenge programs (e.g., the flagship Climate Data Initiative and International SpaceApps Challenge).

More information on these and other efforts is available on the Open Government Initiative website and at open.NASA.gov.

Linkages to the NASA Annual Performance Plan(s)	
Performance Goal	**FY 2015**
3.3.6: Enhance NASA's data management through open data actions, research and development data access, and new data modeling and technologies.	**Green**
Annual Performance Indicator	**FY 2015**
AMO-15-27: Provide access to high-quality data that is available and accessible to spur innovation.	**Green**
For FY 2016: AMO-16-27: Provide information architecture to manage NASA's data more efficiently.	
For FY 2016: AMO-16-28: Enable access to NASA R&D data and publications by securely integrating with shared hosting and data infrastructure.	
For FY 2017: AMO-17-27: Enable customers to utilize information architecture to drive opportunities for new insights using NASA data.	
For FY 2017: AMO-17-28: Expand availability of R&D data and publications through secure use of shared hosting and data infrastructure.	

Lab To Market

Government-wide Goal Statement
Increase the economic impact of Federally-funded research and development by accelerating and improving the transfer of new technologies from the laboratory to the commercial marketplace.

Government-wide Sub-Goals or Focus Areas

- Developing Human Capital.
- Empowering Effective Collaborations.
- Opening Research and Development (R&D) Assets.
- Fueling Small Business Innovation.
- Evaluating Impact.

NASA Contribution to the CAP Goal
NASA has a robust Technology Transfer program to ensure that the technologies developed for missions in exploration and discovery are broadly available to the public and private enterprises, maximizing the benefit to the Nation.

In October 2012, NASA released a five-year *Plan for Accelerating Technology Transfer*. NASA reports on its progress towards implementing the objectives of the five-year plan in its Annual Performance Report.

FY 2015 achievements in support of this CAP goal include, but are not limited to, the following:

- Through its Technology Transfer University (T2U), NASA is bringing real-world, proven technologies into the classroom. At the end of FY 2015, NASA had 15 difference business schools engaged in T2U. Three startup companies formed from student groups engaged in T2U during FY 2015.
- NASA contributed best practices to the *Technology Transfer Playbook*, published in July 2015 by the Federal Laboratory Consortium for Technology Transfer.
- Through its Technology Transfer Program, NASA has simplified access to its technology portfolios with a searchable portal that provides easy access to over 1,200 of the Agency's licensable patented technologies. Organized by technical areas, the Technology Transfer Program site is populated with standardized data sheets showing the benefits, applications, and readiness level of each technology. Users can also search NASA's software catalog, with over 1,000 software programs developed by NASA engineers available to industry at no cost.
- NASA introduced its software repository, the backend inventory of the catalog, which allows users to complete the agreement forms and download software in just minutes. These activities resulted in a

significant increase in the amount of technology that NASA has transferred into the hands of American businesses: a 53 percent increase in patent licensing over FY 2014 (and a progressive year-after-year increase since 2011 equal to a 300 percent increase over that year), and a 24 percent increase in software release (again with a progressive increase year-after-year with 2015 being double what NASA accomplished in 2011).

NASA released the second edition of the *NASA Software Catalog*, a downloadable collection of software programs providing cutting-edge solutions for a wide array of industrial, academic, government, and public applications. The catalog includes more than 1,000 software codes organized into 15 categories, available for use at no charge. It enables NASA projects, government agencies, and other users to save money and time by using ready-made coding tools, rather than buying or building their own.

Linkages to the NASA Annual Performance Plan(s)	
Performance Goal	**FY 2015**
2.3.1: Implement the five-year Strategic Plan to improve the ability to transfer NASA-developed technologies.	**Green**
Annual Performance Indicator	**FY 2015**
ST-15-7: Each Center will engage with at least one university business school for technology marketing assessments and encouragement of technology application.	**Green**
For FY 2016: ST-16-8: Streamline, augment, and automate intellectual property and license portfolio management through a licensee monitoring system.	
For FY 2016: ST-16-9: Develop an initiative to encourage and track infusion of NASA-developed technology into NASA missions, and pilot the initiative at three or more NASA Centers.	
For FY 2017: ST-17-8: Develop, launch, and migrate all Agency licensing activities to an online patent licensing portal.	
For FY 2017: ST-17-9: Execute an initiative across seven Centers to encourage and track infusion (use) of NASA-developed technology by NASA missions and other NASA user groups.	

People and Culture

Government-wide Goal Statement
Innovate by unlocking the full potential of the workforce we have today and building the workforce we need for tomorrow.

Sub-Goals or Focus Areas

- Engagement: Driving greater employee engagement.
- SES Leadership: Build a world-class federal management team, starting with the Senior Executive Service.
- Recruitment and Hiring: Enable agencies to recruit and hire the best talent.

NASA Contribution to the CAP Goal
NASA continues to lead the Federal Government in employee engagement, as demonstrated by the results of the 2015 Federal Employee Viewpoint Survey (FEVS). NASA is in a three-way tie with the Federal Trade Commission and Office of Management and Budget for the highest employee engagement score for a large agency, having increased its employee engagement score over the last six years, from 76 percent in 2010 to 78 percent in 2015. Successful agencies foster an engaged working environment that ensures that each employee can reach his or her potential and contribute to the success of the Agency. Amongst large agencies, NASA also has the highest global satisfaction score at 76 percent, and the highest score on the New Inclusion Quotient (IQ) index at 74 percent. The New IQ index measures behaviors that help to create an inclusive, positive work environment.

NASA is also emphasizing innovation when it recognizes and rewards performance. During FY 2014, NASA developed annual NASA Innovation Awards to recognize, encourage, and celebrate a spirit of innovative behavior. There are two categories of awards, the Lean Forward; Fail Smart Award and the Champion of Innovation Award. The NASA workforce selects the winner in each category:

- Lean Forward; Fail Smart Award: As an Agency that welcomes and nurtures a culture of innovation, failure is seen as merely a stepping stone to success. Whenever an employee encounters failure, they should use it as an opportunity for learning. Whether the innovation involves creating something new, improving an existing technology or process, or adapting a tried and true idea to a new context, the purpose of this category is to showcase innovative behavior within NASA.
- Champion of Innovation Award: Supervisors/managers play a unique role in fostering innovation at NASA. In addition to being innovative themselves, they can support and encourage their employees to think outside the box and become creative problem solvers.

During FY 2015, NASA announced the winners of the 2014 Innovation Awards, and solicited nominations for 2015.

Linkages to the NASA Annual Performance Plan(s)
While NASA is undertaking numerous efforts in support of the People and Culture CAP goal, there are no direct linkages to the performance goals or annual performance indicators reported in the NASA Annual Performance Plan.

Management Challenges

NASA leverages its internal reviews to identify management challenges, but also looks to external opinions. NASA's Office of Inspector General (OIG) provides an annual list of the top management and performance challenges. Every year, the Government Accountability Office (GAO) performs numerous audits of NASA's activities. GAO's High Risk List, which is updated every two years, specifically addresses management challenges across the government and has called out NASA acquisition management as a long-standing issue.

Response to OIG Management Challenges

Each fiscal year, as required by the *Reports Consolidation Act of 2000*, NASA's OIG issues a document summarizing what the Inspector General considers to be the most serious management and performance challenges facing the Agency and briefly assesses the Agency's progress in addressing those challenges. The letter, "2015 Report on

NASA's Top Management and Performance Challenges," and NASA's comments on each management challenge raised by OIG are located in NASA's *FY 2015 Agency Financial Report* (see page 170). This listing of NASA's Top Management and Performance Challenges is a key input to the Agency's leadership when evaluating strategies and making adjustments to strategic and performance plans.

Response to GAO Management Challenges (High Risk)

The GAO has identified five criteria that must be met before an agency can remove a focus area from the High Risk List: (1) a demonstrated strong commitment to, and top leadership support for, addressing problems; (2) the capacity to address problems; (3) a corrective action plan; (4) a program to monitor corrective measures; and (5) demonstrated progress in implementing corrective measures. As part of the 2015 High Risk Report, *High-Risk Series: An Update* (GAO-15-290), the GAO for the first time included a scorecard detailing which of these criteria have been met, partially met, or have not been met for each High Risk area. NASA has fully met the leadership, corrective action plan, and monitoring criteria, and has partially met the criteria for capacity and demonstrated progress.

Over the past year, NASA has taken significant steps to address the GAO's concerns with regards to capacity, specifically in the areas of Earned Value Management (EVM), a management tool for measuring project performance and progress, and joint confidence levels (JCLs), a type of analysis that generates a representation of the likelihood a project will achieve its objectives within budget and on time. As of September 2015, NASA closed all open recommendations from the GAO's 2012 report, *NASA: Earned Value Management Implementation across Major Spaceflight Projects Is Uneven* (GAO-13-22). More information on NASA's response to the GAO's recommendations can be found in this 2012 report. Since this report was issued, NASA successfully implemented an EVM capability on four projects at Marshall Space Flight Center, Goddard Space Flight Center, Kennedy Space Center, and Johnson Space Center. These four Centers represent 98 percent of the Agency's dollars in regard to projects with EVM requirements, and future projects at these Centers will be expected to use the EVM capability. NASA also plans to roll out the EVM capability on projects at Glenn Research Center and Langley Research Center, depending on whether there are any existing or planned candidate projects that meet the EVM requirements threshold.

In February 2015, NASA issued an updated version of the *Cost Estimating Handbook*. The handbook provides a summary of the process for developing cost estimates and serves as a resource for a broad audience, beyond the traditional cost estimating community. In addition to reflecting recent changes in NASA policy, one of the most significant differences in this version of the handbook compared to the 2008 edition is the addition of an appendix addressing JCL analyses. This appendix is directly responsive to the GAO's recommendation that NASA should provide such guidance to its workforce. In September 2015, NASA's OIG completed an assessment of the effectiveness of NASA's JCL policy, concluding that "it appears the JCL policy is having a positive impact" and making several recommendations to the Agency to further improve the JCL process.

These changes have yielded more credible cost and schedule baselines and both the GAO and OIG have observed that NASA's management of its major flight projects has improved. The effectiveness of these tools is particularly evident for the smaller (under $1 billion lifecycle costs) projects. For NASA's largest projects, such as the James Webb Space Telescope, the Space Launch System (SLS), and Orion, the GAO has observed that risks remain. Over the past year-and-a-half, SLS, the Ground Systems Development and Operations program, and Orion were confirmed by the Agency and NASA set their cost and schedule baselines. This information will be used to assess whether these programs remain on track going forward.

Part 3
Performance Reporting and Planning





Introduction

Part 3 presents NASA's integrated FY 2015 Annual Performance Report, FY 2016 Annual Performance Plan Update, and FY 2017 Annual Performance Plan, organized by strategic goal and strategic objective. It features the results of NASA's 2015 Strategic Review, including identifying those objectives achieving noteworthy progress and those determined to be focus areas for improvement, selected by NASA in consultation with the Office of Management and Budget (OMB). Together this information provides a retrospective and prospective view of NASA's performance.

The integrated report contains the following:

- Charts summarizing performance goal and annual performance indicator ratings, organized by strategic goal.
- A summary of each Strategic Review for NASA's strategic objectives, including a progress update and next steps.
- Each strategic objective's total budget authority, including actuals for FY 2015, the budget request for FY 2017, and notional funding through FY 2021.
- The performance goals contributing to the strategic objective. Each performance goal includes an FY 2015 performance rating, multiyear performance trends beginning with FY 2011,[5] any planned performance changes for FY 2016 or FY 2017, a narrative describing activities contributing to performance progress in FY 2015, and an improvement plan for performance goals rated yellow or red. See "How to Read the Performance Goal and Annual Performance Indicator Information," below, for a guide to the performance tables.
- The annual performance indicators associated with the performance goal, including the FY 2015 performance rating, multiyear performance trends beginning with FY 2010, the planned performance for FY 2016 and FY 2017, and a performance explanation for annual performance indicators rated yellow or red.

NASA's method for trending multiyear performance data is to show the linkages between measures tracking similar data and annual progress for follow-on program activities. Linked measures, even if revised in subsequent years, are shown as related performance data. In some cases, measures have been updated over the years to improve accuracy and data quality.

[5]NASA introduced performance goals with the *2011 NASA Strategic Plan* and, therefore, the performance goals only trend back to FY 2011. NASA has had annual measures since the *2003 Strategic Plan* and presents actual results for up to six years. Additional years of actual results are maintained in NASA's performance data system.

How to Read the Strategic Objective Information

The information presented below the strategic objectives is the result of NASA's second Strategic Review, completed in spring 2015 in accordance with OMB guidance. In addition, supporting performance goals and annual performance indicators are provided in a table for each strategic objective.

Budget
Each strategic objective consists of Contributing Programs. NASA provides the past and requested budget authority for these programs in its annual President's Budget Request, available at http://www.nasa.gov/news/budget/index.html. Through this budget–performance crosswalk NASA is able to estimate a budget for each strategic objective.

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget							

- The budget totals provided in the table above consist of a summation of the budget authority for each program that contributes to the strategic objective. These programs are provided under the "Contributing Program" header for each strategic objective. The source for the budget data is NASA's FY 2017 President's Budget Request.
- FY 2015 reflects funding amounts specified in the September 2015 Operating Plan per Public Law 113-235.
- Totals for FY 2016 are not available at this time; the initial operating plan is not yet approved.
- FY 2017 reflects both discretionary and mandatory funding.
- Note that totals of all budgets provided for strategic objectives will not add to the NASA total budget request; funds associated with the Inspector General do not map to specific strategic objectives and are not included in any strategic objective budget roll-up.

Strategic Review Assessment Rating
NASA identified a subset of strategic objectives as achieving noteworthy progress or as a focus area for improvement. The "Progress Update" section will note if NASA, in consultation with OMB, assessed the strategic objective as making noteworthy progress or as a focus area for improvement. If the section does not provide a rating, it means that NASA found that the strategic objective is demonstrating satisfactory performance.

How to Read the Performance Goal and Annual Performance Indicator Information

Performance Goal Table and Fiscal Year Results

For each performance goal, NASA provides a table of information summarizing both results and plans. OMB Circular A-11 requires agencies to provide six years of trended ratings, including the reporting fiscal year. NASA introduced performance goals in its 2011 Strategic Plan and, therefore, can only provide up to four years of ratings. Each table also includes "Planned Future Performance" for FY 2016 and FY 2017. The table will note if the performance goal does not continue beyond FY 2015. If NASA is introducing the performance goal in FY 2016 or FY 2017, the performance goal language will be provided in the "Planned Future Performance" field, the FY 2015 rating field will be "None," and the FY 2011 through FY 2014 rating fields will be "No PG this fiscal year."

The table also indicates the "Contributing Theme" and "Contributing Program" responsible for pursuing activities as described in the performance goal.

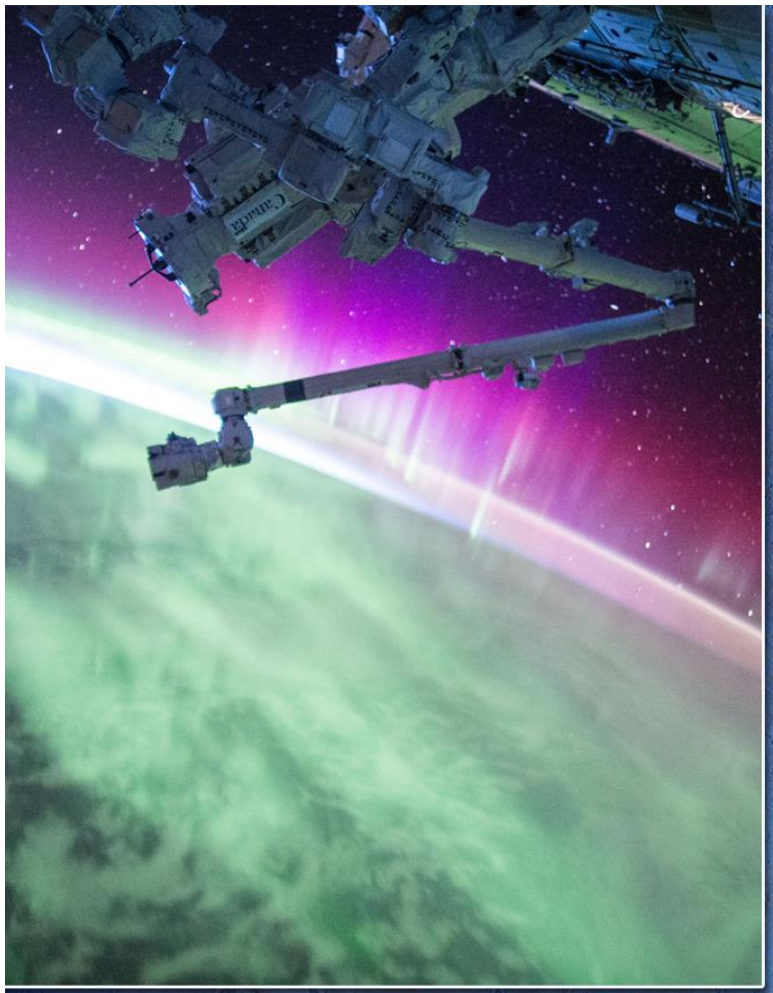
The "FY 2015 Performance Results" summarizes the work related to the performance goal. It includes a performance improvement plan for performance goals rated yellow or red.

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition. (Agency Priority Goal)	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.3.1 Green	1.3.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Commercial Spaceflight	**Contributing Program:** Commercial Crew				

Annual Performance Indicator Table

The annual performance indicator tables follow the same format as those for the performance goals, except that they trend to FY 2010. NASA does not summarize the performance results for the annual performance indicators; however, it provides an "Explanation of Rating" for annual performance indicators rated yellow or red.

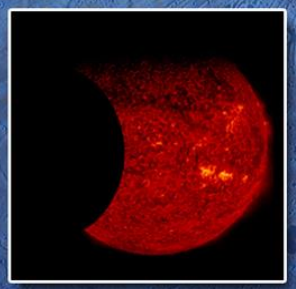
Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Continue monitoring partner milestone progress based on Commercial Crew transportation Capability (CCtCap) contract content.	10CS07 Yellow	CS-11-2 Yellow	No API this fiscal year	CS 13 1 Green	CS 14 1 Green	CS 15 1 Green
Planned Future Performance						
For FY 2016: CS-16-1: Continue monitoring partner milestone progress based on Commercial Crew transportation Capability (CCtCap) contract content.						
For FY 2017: CS-17-1: Continue monitoring partner milestone progress toward identifying and closing certification products, in alignment with negotiated contract milestones.						
Contributing Theme: Commercial Spaceflight	**Contributing Program:** Commercial Crew					



Strategic Goal 1

Expand the frontiers of knowledge, capability, and opportunity in space.

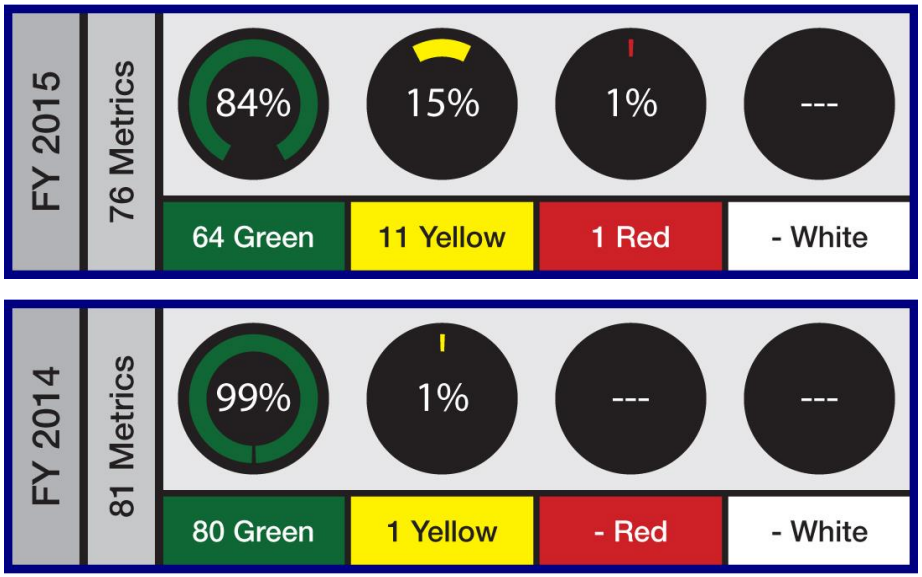





Strategic Goal 1: Expand the frontiers of knowledge, capability, and opportunity in space.						
Strategic Objective 1.1: Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.	Strategic Objective 1.2: Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity.	Strategic Objective 1.3: Facilitate and utilize U.S. commercial capabilities to deliver cargo and crew to space.	Strategic Objective 1.4: Understand the Sun and its interactions with Earth and the solar system, including space weather.	Strategic Objective 1.5: Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.	Strategic Objective 1.6: Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars.	Strategic Objective 1.7: Transform NASA missions and advance the Nation's capabilities by maturing crosscutting and innovative space technologies.
FY 2015 Performance Goals						
• 1.1.1: Achieve critical milestones in development of new systems for the human exploration of deep space. (Agency Priority Goal) • 1.1.2: Complete the Systems Requirements Review by FY 2015 for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020. • 1.1.5: Incorporate autonomous controls in life support subsystems testing to increase reliability.	• 1.2.1: Increase utilization of the International Space Station's internal and external research facilities. (Agency Priority Goal) • 1.2.2: Maintain capability for six on-orbit crew members. • 1.2.3: Advance engineering, technology, and science research. • 1.2.4: Ensure vital assets are ready, available, and appropriately sized to conduct NASA's Mission. • 1.2.5: Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise. • 1.2.6: Provide cargo transportation to support on-orbit crew members and utilization.	• 1.3.1: Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition. (Agency Priority Goal) • 1.3.2: Invest financial and technical resources to stimulate efforts within the private sector to develop and demonstrate safe, reliable, and cost-effective space transportation capabilities.	• 1.4.1: Demonstrate progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system. • 1.4.2: Demonstrate progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system. • 1.4.3: Demonstrate progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth. • 1.4.4: By December 2017, launch two missions in support of Strategic Objective 1.4.	• 1.5.1: Demonstrate progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve. • 1.5.2: Demonstrate progress in exploring and observing the objects in the solar system to understand how they formed and evolve. • 1.5.3: Demonstrate progress in exploring and finding locations where life could have existed or could exist today. • 1.5.4: Demonstrate progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere. • 1.5.5: Demonstrate progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration. • 1.5.6: By December 2017, launch at least two missions in support of Strategic Objective 1.5.	• 1.6.1: Launch the James Webb Space Telescope. (Agency Priority Goal) • 1.6.2: Demonstrate progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity. • 1.6.3: Demonstrate progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe. • 1.6.4: Demonstrate progress in discovering and studying planets around other stars and exploring whether they could harbor life. • 1.6.5: By December 2018, launch at least one mission in support of Strategic Objective 1.6.	• 1.7.1: Explore and advance promising early stage solutions to space technology challenges through investment across the U.S. innovation community. • 1.7.2: Advance technologies that offer significant improvement to existing solutions or enable new space science and exploration capabilities. • 1.7.3: Mature new crosscutting space technology capabilities for demonstration.

Summary of Performance for Strategic Goal 1

Summary of Ratings of All Performance Measures for FY 2015 and 2014



Summary of Ratings for Performance Goals and Annual Performance Indicators by Strategic Objective, FY 2015

Lead	Strategic Objective	Performance Goals					Annual Performance Indicators				
		Total	Green	Yellow	Red	White	Total	Green	Yellow	Red	White
HEOMD	1.1	3	2	1	0	0	6	5	1	0	0
HEOMD	1.2	6	2	4	0	0	10	6	3	1	0
HEOMD	1.3	2	2	0	0	0	3	3	0	0	0
SMD	1.4	4	4	0	0	0	7	7	0	0	0
SMD	1.5	6	6	0	0	0	9	8	1	0	0
SMD	1.6	5	5	0	0	0	6	6	0	0	0
STMD	1.7	3	3	0	0	0	6	5	1	0	0
Total		29	24	5	0	0	47	40	6	1	0
Summary			83%	17%	0%	0%		85%	13%	2%	0%

Strategic Objective 1.1

Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.

Lead Office

Human Exploration and Operations Mission Directorate (HEOMD)

Goal Leader

Greg Williams, Deputy for Policy and Management, HEOMD

Contributing Programs

Advanced Exploration Systems, Exploration Ground Systems, Orion, Space Launch System

Budget for Strategic Objective 1.1

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$3,401	—	$3,184	$3,352	$3,904	$4,064	$4,079

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

Through the Strategic Review and NASA's other performance management processes, NASA reviews recent accomplishments and near-term plans for the Agency's strategic objectives and programs. Under Strategic Objective 1.1, NASA is developing a new human deep-space exploration architecture, consisting of the Space Launch System (SLS), Orion spacecraft, and Exploration Ground Systems (EGS) programs, as well as the Advanced Exploration Systems (AES) program. Under Strategic Objective 1.1, an extremely significant recent accomplishment was the successful Orion Exploration Flight Test-1 in December 2014. This was the first test flight of the Orion spacecraft, which is designed to take humans on deep-space missions in the future. Orion did not carry any people into space on this flight, but it became the first human-rated spacecraft to leave low Earth orbit since the Apollo 17 mission. Over the next several years, NASA's critical next steps include making progress towards Exploration Mission (EM)-1, an uncrewed test flight to distant retrograde

lunar orbit (and the first pairing of Orion with SLS). AES continues to mature enabling technologies critical for exploration missions in such areas as habitation (life support), crew mobility systems (extravehicular activity), and vehicle systems (lander technology). Moreover, AES is developing secondary payloads for the EM-1 mission to address Strategic Knowledge Gaps for future missions. AES is also jointly developing payloads with the Space Technology Mission Directorate to demonstrate in-situ resource utilization on the upcoming Mars 2020 mission. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. A current indicator of challenges for this strategic objective is that NASA did not fully achieve the agency priority goal associated with this strategic objective in FY 2015. In 10 years, NASA plans to have a new human deep-space exploration architecture with SLS, Orion, and other high-priority capabilities needed for human exploration/pioneering. However, NASA has limited strategic indicators beyond Exploration Mission (EM) 2 (in the post-2022 timeframe). To address this, NASA is currently developing an integrated exploration strategy, and these indicators are under development.

For more information, please see http://www.nasa.gov/exploration/systems/index.html and http://www.nasa.gov/directorates/heo/aes/index.html. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Additional details on the FY 2015 performance for supporting performance goals and annual performance indicators are provided in this report. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 1.1: Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.		
Performance Goal 1.1.1: Achieve critical milestones in development of new systems for the human exploration of deep space. (Agency Priority Goal)	Performance Goal 1.1.2: Complete the Systems Requirements Review by FY 2015 for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020.	Performance Goal 1.1.5: Incorporate autonomous controls in life support subsystems testing to increase reliability.
Annual Performance Indicators		
• ESD-15-1: Complete the Space Launch System (SLS) Critical Design Review (CDR) in support of Key Decision Point D. • ESD-15-2: Complete Orion Key Decision Point-C. • ESD-15-3: Complete the Exploration Ground Systems Program Critical Design Review (CDR).	• ERD-15-2: Down-select asteroid capture system for the Asteroid Redirect Mission (ARM). • ERD-15-3: Complete the Systems Requirements Review (SRR) for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020 mission.	• ERD-15-4: Integrate sensors and feedback controls with the air-revitalization subsystem to increase system performance.

Summary of Performance for Strategic Objective 1.1

Performance Goal Ratings for Strategic Objective 1.1, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	3	2	1		--
2014	2	2	--		--
2013	1	1	--		--
2012	1	1	--		--

Annual Performance Indicator Ratings for Strategic Objective 1.1, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	6	5	1		--
2014	5	5	--		--
2013	2	2	--		--
2012	2	2	--		--
2011	2	2	--		--
2010	--		--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 1.1.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Achieve critical milestones in development of new systems for the human exploration of deep space. (Agency Priority Goal)	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.1.1 Green	1.1.1 Yellow
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Exploration Systems Development	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA did not fully complete its agency priority goal (APG) during FY 2015, but it made significant progress towards the goal, and is on track to complete it by March 2016. NASA is developing the Nation's first human deep-space exploration capability with the Space Launch System (SLS) and the Orion crew vehicle. With the support of the Exploration Ground Systems (EGS) program, SLS and Orion will enable astronauts to travel deeper into the solar system than ever before, and are essential for exploration of deep space, including future human exploration of Mars.

NASA completed the SLS Critical Design Review (CDR) on July 22, 2015. The CDR is a significant review that demonstrates that the design of the SLS is mature enough for production. The Orion and EGS Program CDRs are now scheduled for FY 2016.

Orion was approved for Key Decision Point (KDP)-C on September 9, 2015, and is proceeding with its CDR. The KDP-C review is an assessment of a project's readiness to move from formulation into full-scale development.

As noted previously, the EGS program rescheduled its CDR for first quarter of FY 2016, in order to comply with the Design-to-Sync direction. Under Design-to-Sync, the SLS, Orion, and EGS program CDRs each will be completed in sequence.

More detailed information on this agency priority goal is included in Part 2.

Performance Improvement Plan

As noted above, NASA completed the SLS CDR in July 2015 and is on track to complete the Orion and EGS program CDRs by March 2016.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Space Launch System (SLS) Critical Design Review (CDR) in support of Key Decision Point D.	No API this fiscal year	HEC 11 1 Green	ESD 12 1 Green	ESD 13 1 Green	ESD 14 1 Green	ESD 15 1 Green
Planned Future Performance						
For FY 2016: ESD-16-1: Conduct the second of two Space Launch System (SLS) booster qualification motor test firings (QM-2).						
For FY 2017: ESD-17-1: Deliver all four Exploration Mission-1 Space Launch System (SLS) Core Stage RS-25 engines to the Michoud Assembly Facility in preparation for Core Stage integration.						
Contributing Theme: Exploration Systems Development	**Contributing Program:** Space Launch System					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete Orion Key Decision Point-C.	No API this fiscal year	HEC 11 2 Green	ESD 12 2 Green	ESD 13 2 Green	ESD 14 2 Green	ESD 15 2 Green
Planned Future Performance						
For FY 2016: ESD-16-2: Begin assembly and integration of the Orion Exploration Mission-1 flight article in the Armstrong Operations and Checkout Building at the Kennedy Space Center.						
For FY 2017: ESD-17-2: Install avionics and power on Orion Exploration Mission-1 flight article in the Armstrong Operations and Checkout Building at the Kennedy Space Center.						
Contributing Theme: Exploration Systems Development	**Contributing Program:** Orion Multi-Purpose Crew Vehicle					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Exploration Ground Systems Program Critical Design Review (CDR).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ESD 14 3 Green	ESD-15-3 Yellow
Planned Future Performance						
For FY 2016: ESD-16-3: Complete the Exploration Ground Systems Program System Integration Review (SIR).						
For FY 2017: ESD-17-3: Complete construction of Exploration Ground Systems (EGS) Pad B.						
Contributing Theme: Exploration Systems Development	**Contributing Program:** Exploration Ground Systems					

Explanation of Rating
NASA is on schedule to complete the Exploration Ground Systems program CDR by March 2016.

Performance Goal 1.1.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Complete the Systems Requirements Review by FY 2015 for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020.	No PG this fiscal year	1.3.3.1 Green	1.3.3.1 Green	1.1.2 Green	1.1.2 Green
Planned Future Performance					
For FY 2016 and 2017: 1.1.2: Complete Design Reviews for planetary In-Situ Resource Utilization Demonstrations.					
Contributing Theme: Exploration Research and Development	**Contributing Program:** Advanced Exploration Systems				

FY 2015 Performance Results

NASA's Advanced Exploration Systems (AES) program is pioneering new approaches to develop prototype systems, demonstrate key capabilities, and validate operational concepts for future human missions beyond Earth orbit. The AES program focuses on crew safety and mission operations in deep space. Early integration and testing of prototype systems reduces risk and improves the affordability of exploration mission elements.

NASA is planning a robotic mission to Mars in 2020 to further address key questions about the potential for life on Mars. The Mars 2020 mission will explore a site likely to have been habitable, seek signs of past life, fill a returnable cache with the most compelling samples, and demonstrate technology needed for the future human and robotic exploration of Mars. In FY 2015, the AES program completed the Systems Requirement Review (SRR) for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020. An SRR examines a mission's functional and performance requirements to determine whether or not the requirements and the selected concept will satisfy the mission's needs.

In addition, NASA is developing a first-ever Asteroid Redirect Mission (ARM) to visit a large, near-Earth asteroid, collect a multi-ton boulder from its surface, and use it in an enhanced gravity tractor asteroid deflection demonstration. The spacecraft will then redirect the multi-ton boulder into a stable orbit around the Moon, where astronauts will explore it and return with samples in the mid-2020s.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Systems Requirements Review (SRR) for the In-Situ Resource Utilization Demonstration Experiment on Mars 2020 mission.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ERD 14 6 Green	ERD 15 3 Green
Planned Future Performance						
For FY 2016: ERD-16-2: Complete the Critical Design Review (CDR) for the In-Situ Resource Utilization Demonstration Experiment on the Mars 2020 mission.						
For FY 2017: ERD-17-2: Complete the Flight Qualification Review (FQR) and Pre-Ship Review (PSR) for the Mars Oxygen ISRU (In-Situ Resource Utilization) Experiment (MOXIE).						
Contributing Theme: Exploration Research and Development	**Contributing Program:** Advanced Exploration Systems					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Down-select asteroid capture system for the Asteroid Redirect Mission (ARM).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ERD 14 3 Green	ERD 15 2 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Exploration Research and Development	**Contributing Program:** Advanced Exploration Systems					

Performance Goal 1.1.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Incorporate autonomous controls in life support subsystems testing to increase reliability.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.1.5 Green
Planned Future Performance					
For FY 2016 and FY 2017: 1.1.5: Incorporate autonomous controls in life support subsystems testing to increase performance and reliability.					
Contributing Theme: Exploration Research and Development	**Contributing Program:** Advanced Exploration Systems				

FY 2015 Performance Results

NASA's Advanced Exploration Systems (AES) program is developing advanced life support systems that will enable human exploration beyond low Earth orbit. The Autonomous Systems and Operations (ASO) project is working to define vehicle capabilities, roles and responsibilities of ground and crew, and their interactions, in order to enable NASA missions to distant destinations. Future human spaceflight missions will place crews at large distances and light-time delays from Earth. For example, the one-way light-time delay to Mars ranges from 3 minutes (at conjunction) to 22 minutes (at opposition). NASA will require autonomous mission operations when spacecraft crew are far away from Earth, because communication with the ground will incur long latencies.

During FY 2015, the ASO project integrated a variety of autonomous applications with its Core Flight Software to demonstrate the management of advanced life-support hardware. The ASO project developed a controller for the Cascade Distiller System (CDS), which performs a variety of water purification tasks. The controller executes a plan to operate the CDS hardware, monitor its performance, and take different control options if unexpected events occur. The ASO project also developed a fault detection application for the Plasma Pyrolysis Assembly (PPA), which extracts hydrogen from methane and helps to minimize life support resupply costs for extended duration missions. The fault detection application is able to identify possible hardware faults by monitoring data from the PPA and other air revitalization life support performance parameters.

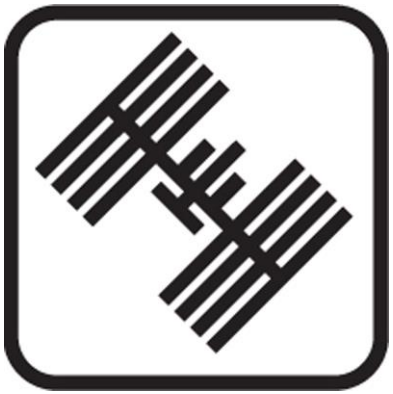
Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Integrate sensors and feedback controls with the air-revitalization subsystem to increase system performance.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ERD 15 4 Green
Planned Future Performance						
For FY 2016: ERD-16-4: Analyze the performance of sensors, controls, and multiple life-support system components in integrated tests.						
For FY 2017: ERD-17-4: Integrate autonomous controls with different life support subsystems and conduct a system-level test to demonstrate increased system efficiency.						
Contributing Theme: Exploration Research and Development	**Contributing Program:** Advanced Exploration Systems					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: ERD-16-3: Demonstrate concepts and technologies for extended extravehicular activity (EVA).
For FY 2017: ERD-17-3: Complete the manufacture and assess the performance of the Portable Life Support System (PLSS) 2.5.
Contributing Theme: Exploration Research and Development | **Contributing Program:** Advanced Exploration Systems

Performance Goal 1.1.6

Does not trend until FY 2016.
Planned Future Performance
For FY 2016 and 2017: 1.1.6: Formulate robotic mission for overall Asteroid Redirect Mission (ARM).
Contributing Theme: Exploration Research and Development | **Contributing Program:** Advanced Exploration Systems

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: ERD-16-1: Complete the Asteroid Redirect Robotic Mission (ARRM) integrated requirements review.
For FY 2017: ERD-17-1: Complete the Asteroid Redirect Robotic Mission (ARRM) early design studies.
Contributing Theme: Exploration Research and Development | **Contributing Program:** Advanced Exploration Systems



Strategic Objective 1.2

Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity.

Lead Office

Human Exploration and Operations Mission Directorate (HEOMD)

Goal Leader

Greg Williams, Deputy for Policy and Management, HEOMD

Contributing Programs

Crew and Cargo Program, Human Research Program, Human Space Flight Operations, International Space Station

Budget for Strategic Objective 1.2

Budget Authority (in $ millions)	Actual FY 2015	Enacted FY 2016	Requested FY 2017	Notional FY 2018	Notional FY 2019	Notional FY 2020	Notional FY 2021
Total Budget	$3,215	—	$3,285	$3,606	$3,800	$3,970	$4,089

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has determined that performance toward this strategic objective is making noteworthy progress.

Through the Strategic Review and NASA's other performance management processes, NASA reviews recent accomplishments and near-term plans for the Agency's strategic objectives and programs. The International Space Station (ISS) Program, Human Research Program, and Human Space Flight Operations Program fall under Strategic Objective 1.2. The ISS is the cornerstone of human exploration and operations, and NASA has made significant progress towards greater research utilization. Commercial companies are also successfully flying payloads. A significant recent accomplishment was U.S. astronaut

Scott Kelly and Russian cosmonaut Mikhail Kornienko starting a one-year mission on the ISS, which is twice as long as typical U.S. missions. The one-year crew mission is the latest step in the ISS's role as a platform for preparing humanity for exploration into deep space. These investigations are expected to yield beneficial knowledge on the medical, psychological, and biomedical challenges faced by astronauts during long-duration spaceflight.

NASA's critical next steps include maintaining the ISS as a safe and functional on-orbit platform, and continuing commercial and International Partner cargo missions to resupply the ISS. NASA will continue to expand the ISS on-orbit research program, including continuing to increase utilization of internal and external research facilities. In FY 2016, NASA will complete the U.S.-Russian joint one-year human health and performance research project and complete the data collection for the Identical Twins Study. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA expects to advance benefits to humanity through research, enable a commercial demand-driven market in low Earth orbit, enable long-duration human spaceflight beyond low Earth orbit, and provide a basis for international exploration partnerships. However, NASA experienced resupply setbacks recently that may impact NASA's agency priority goal for research and utilization of the ISS in the near term. One major challenge for NASA is obtaining a full International Partner agreement for joint operations of the ISS until 2024. Additionally, leveraging the ISS to enable commercialization of low Earth orbit across broad sectors of the U.S. economy is both a challenge and an opportunity for the Agency.

For more information, please see http://www.nasa.gov/mission_pages/station/main/index.html. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 1.2: Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity.					
Performance Goal 1.2.1: Increase utilization of the International Space Station's internal and external research facilities. (Agency Priority Goal)	Performance Goal 1.2.2: Maintain capability for six on-orbit crew members.	Performance Goal 1.2.3: Advance engineering, technology, and science research.	Performance Goal 1.2.4: Ensure vital assets are ready, available, and appropriately sized to conduct NASA's Mission.	Performance Goal 1.2.5: Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.	Performance Goal 1.2.6: Provide cargo transportation to support on-orbit crew members and utilization.
Annual Performance Indicators					
• ISS-15-1: Continue to increase facility occupancy to 70 percent.	• ISS-15-2: In concert with International Partners, maintain a continuous six-crew capability on ISS by coordinating and managing resources, logistics, systems, and operational procedures.	• ERD-15-5: Begin ISS one-year mission joint U.S.-Russian research plan and initiate on-orbit research implementation. • ISS-15-3: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives.	• SFS-15-1: Appropriately size the astronaut corps to provide timely assignments based upon mission needs.	• ISS-15-4: Carry out the first NASA Research Announcement-selected rodent research in the Rodent Research-2 project. • ISS-15-5: Launch three physical science research payloads to ISS; select investigators and conduct the Critical Design Review for the Cold Atom Laboratory. • ISS-15-6: Through the Center for the Advancement of Science in Space (CASIS) cooperative agreement, release two Requests for Proposal, complete proposal evaluation, and select research projects for International Space Station execution in FY 2015. • ISS-15-7: Produce 500 peer-reviewed publications from projects in human research, space biology, and physical sciences.	• ISS-15-8: Complete at least three flights by U.S.-developed cargo delivery systems, delivering research and logistics hardware to ISS.

Summary of Performance for Strategic Objective 1.2

Performance Goal Ratings for Strategic Objective 1.2, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	6	2	4		--
2014	6	6	--		--
2013	4	4	--		--
2012	4	4	--		--

Annual Performance Indicator Ratings for Strategic Objective 1.2, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	10	6	3	1	--
2014	10	10	--		--
2013	7	6	1		--
2012	6	6	--		--
2011	5	5	--		--
2010	3	3	--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 1.2.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Increase utilization of the International Space Station's internal and external research facilities. (Agency Priority Goal)	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.2.1 Green	1.2.1 Yellow
Planned Future Performance					
For FY 2016 and 2017: 1.2.1: Increase the occupancy of the International Space Station's (ISS's) internal and external research facilities by adding new instruments and capabilities. (Agency Priority Goal)					
Contributing Theme: International Space Station	**Contributing Program:** International Space Station				

FY 2015 Performance Results

Due to the loss of the Space Exploration Technologies Corporation's (SpaceX's) SpaceX-7 Commercial Resupply Services (CRS) flight on June 28, 2015, and the delay of the SpaceX-8 CRS flight into FY 2016, NASA did not achieve its agency priority goal during FY 2015. The occupancy of the International Space Station's (ISS's) internal and external research facilities was 65 percent at the end of FY 2014, and 67 percent at the end of FY 2015, falling slightly short of the target of 70 percent.

The ISS is a world-renowned laboratory that performs multidisciplinary research in science and technology. NASA is increasing the utilization of the ISS to conduct scientific research, for exploration-related technology development, and to foster commercial investment in space. Increasing facility utilization is a function of the demand for the use of ISS, which is driven by the funding of research by NASA, other government agencies, and the private sector; and the capacity of the laboratory to support research, which is determined by the infrastructure in orbit, the transportation system, and the crew availability.

During FY 2015, the following payloads were launched to the ISS:

- On January 10, 2015, SpaceX-5 launched with payload and payload resupply for the ISS. Its payload included the new Cloud-Aerosol Transport System (CATS) external payload to study the atmospheric constituents that impact the Earth's climate.
- On April 14, 2015, SpaceX-6 launched with more than 4,300 pounds of supplies and payloads for the ISS, including the second Center for the Advancement of Science in Space (CASIS) Rodent Research investigation.
- On August 19, 2015, the Japanese HII Transfer Vehicle-5 (HTV5), also known as the Kounotori 5, launched with more than 9,500 pounds of payload hardware and resupply for the ISS.

More detailed information on this agency priority goal is included in Part 2.

Performance Improvement Plan

As noted above, NASA missed its target due to the loss of the SpaceX-7 CRS flight on June 28, 2015, and the delay of the SpaceX-8 CRS flight into FY 2016. Prior to the SpaceX-7 accident, NASA expected to reach its occupancy target of 70 percent. While the launch date for SpaceX-8 is under review pending

the investigation into the SpaceX-7 loss, SpaceX is expected to resume commercial resupply flights in FY 2016. For its FY 2016-17 agency priority goal, NASA has set a target to increase the occupancy of the ISS's internal and external research facilities to 75 percent.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Continue to increase facility occupancy to 70 percent.	No API this fiscal year	No API this fiscal year	No API this fiscal year	ISS-13-4 Yellow	ISS 14 4 Green	ISS-15-1 Yellow
Planned Future Performance						
For FY 2016: ISS-16-1: Increase facility occupancy beyond the FY 2015 baseline.						
For FY 2017: ISS-17-1: By the end of FY 2017, increase the occupancy of the International Space Station's internal and external research facilities to 75 percent.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Explanation of Rating
NASA missed its target due to the loss of the SpaceX-7 CRS flight in June 2015 and the delay of the SpaceX-8 CRS flight into FY 2016.

Performance Goal 1.2.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Maintain capability for six on-orbit crew members.	1.1.1.1 Green	1.1.1.1 Green	1.1.1.1 Green	1.2.2 Green	1.2.2 Yellow
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: International Space Station	**Contributing Program:** International Space Station				

FY 2015 Performance Results
The International Space Station (ISS) enables humanity to have an ongoing presence in space, and allows crew members to conduct scientific and technology research that could not be done anywhere else. As NASA prepares for the next great era of space exploration, extending humanity's reach beyond low Earth orbit for long-term research and study of the Moon, Mars, asteroids, and other bodies across the solar system, the ISS is being used to conduct medical and microgravity experiments and to test the systems that will be required for long-durations missions.

NASA maintained a crew of six on board the ISS, except during scheduled crew rotation periods, for most of FY 2015. However, the launch of the 43S Soyuz space capsule was postponed by about two months after the failure in April 2015 of an unmanned Russian cargo ship, resulting in an extended period of three-crew ISS operations of approximately eight weeks. The ISS returned to its full complement of six crew members on July 22, 2015. Crew

members representing the United States, Russia, Japan, Canada, and Europe rotated every six months on the Russian Soyuz spacecraft. All of the required resupply flights, logistics, systems, and operational procedures continued to support a safe and effective ISS platform in space.

Performance Improvement Plan
As noted above, with the rescheduled launch of the 43S Soyuz space capsule, the ISS returned to its full complement of six crew members on July 22, 2015.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: In concert with International Partners, maintain a continuous six-crew capability on ISS by coordinating and managing resources, logistics, systems, and operational procedures.	10ISS07 Green	ISS 11 1 Green	ISS 12 1 Green	ISS 13 1 Green	ISS 14 1 Green	ISS-15-2 Yellow
Planned Future Performance						
For FY 2016: ISS-16-2: In concert with International Partners, maintain a continuous six-crew capability on the International Space Station by coordinating and managing resources, logistics, systems, and operational procedures.						
For FY 2017: ISS-17-2: In concert with International Partners, maintain a continuous six-crew capability on the International Space Station by coordinating and managing resources, logistics, systems, and operational procedures.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Explanation of Rating
The launch of the 43S Soyuz space capsule was postponed by about two months after the failure in April 2015 of an unmanned Russian cargo ship, resulting in an extended period of three-crew ISS operations of approximately eight weeks. The ISS returned to its full complement of six crew members in July 2015.

Performance Goal 1.2.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Advance engineering, technology, and science research.	1.1.2.1 Green	1.1.2.1 Green	1.1.2.1 Green	1.2.3 Green	1.2.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: International Space Station	**Contributing Program:** International Space Station				

FY 2015 Performance Results
During FY 2015, the International Space Station (ISS) supported a robust research and development program, allowing NASA to achieve its planned research objectives to advance engineering, technology, and scientific research.

On July 7-9, 2015, the American Astronautical Society, in cooperation with NASA and the Center for the Advancement of Science in Space, held its fourth annual ISS Research and Development Conference in Boston, MA. The conference had over 700 attendees, as well as thousands who watched the sessions online by live-stream. The conference focused on innovations in microgravity research, life sciences, materials development, technology development, human health, and remote sensing, and included a keynote address from NASA astronauts Sunita ("Suni") Williams and Dr. Karen Nyberg.

In March 2015, NASA began a one-year U.S.-Russian joint human health and performance research project with the launch of astronaut Scott Kelly and cosmonaut Mikhail Kornienko to the ISS. Kelly and Kornienko will stay aboard the ISS for one year, the longest space mission ever assigned to a NASA astronaut, to examine the effects of long-term spaceflight on human physiology. While Kelly is on board the space station, his identical twin brother, retired NASA astronaut Mark Kelly, will participate in the study on Earth, allowing NASA to better isolate the deleterious effects of spaceflight on the human body, and to aid in the development of countermeasures for these effects. This research will be invaluable to the preparation for future long-duration spaceflight missions. During FY 2015, NASA met all of its primary goals planned for the fiscal year.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Begin ISS one-year mission joint U.S.-Russian research plan and initiate on-orbit research implementation.	No API this fiscal year	ERD 11 4 Green	ERD 12 1 Green	ERD 13 1 Green	ERD 14 1 Green	ERD 15 5 Green
Planned Future Performance						
For FY 2016: ERD-16-5: Complete the U.S.-Russian joint human health and performance research project on the International Space Station one-year mission.						
For FY 2017: ERD-17-5: Complete the selection and implementation of the contract for the first year of the Translational Research Institute to support the translation of cutting edge research into risk mitigation systems for human exploration missions.						
Contributing Theme: Exploration Research and Development	**Contributing Program:** Human Research Program					

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives.	No API this fiscal year	ISS 11 5 Green	ISS 12 6 Green	ISS 13 3 Green	ISS 14 3 Green	ISS 15 3 Green
Planned Future Performance						
For FY 2016: ISS-16-3: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives.						
For FY 2017: ISS-17-3: Accomplish a minimum of 90 percent of the on-orbit research and technology development objectives.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Performance Goal 1.2.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Ensure vital assets are ready, available, and appropriately sized to conduct NASA's Mission.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.2.4 Green	1.2.4 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space and Flight Support	**Contributing Program:** Human Space Flight Operations				

FY 2015 Performance Results

The Human Space Flight Operations (HSFO) program supports the training, readiness, and health of crewmembers prior to, during, and after each space flight mission to the International Space Station (ISS). All crews on board the ISS have undergone rigorous preparation, which is critical to mission success. The HSFO program provides astronaut selection and training, and manages all aspects of astronaut crew health, including maintenance of a healthy and productive crew during all phases of space flight missions, implementation of a comprehensive health care program for astronauts, and the prevention and mitigation of negative long-term health consequences of spaceflight.

Throughout FY 2015, the astronaut corps was sized appropriately, met all mission needs, and met all health and training standards.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Appropriately size the astronaut corps to provide timely assignments based upon mission needs.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	SFS 14 7 Green	SFS 15 1 Green
Planned Future Performance						
For FY 2016: SFS-16-1: Ensure the astronaut corps meets all mission-related training requirements and mission-related health standards.						
For FY 2017: SFS-17-1: Ensure the astronaut corps meets all mission-related training requirements and mission-related health standards.						
Contributing Theme: Space and Flight Support	**Contributing Program:** Human Space Flight Operations					

Performance Goal 1.2.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.	1.1.2.2 Green	1.1.2.2 Green	1.1.2.2 Green	1.2.5 Green	1.2.5 Yellow
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: International Space Station	**Contributing Program:** International Space Station				

FY 2015 Performance Results

During FY 2015, NASA completed the majority of its annual performance indicators, demonstrating its focus on conducting basic scientific research aboard the International Space Station (ISS). Following are some of the major accomplishments in biological and physical research completed in FY 2015:

- NASA selected investigators and held a successful Critical Design Review (CDR) for the Cold Atom Laboratory (CAL). The CDR is a significant review that demonstrates that a design is mature enough for production. CAL will be a facility aboard the ISS for the study of ultra-cold quantum gases in microgravity, enabling research in an environment that is inaccessible to Earth-based laboratories.
- NASA launched three physical science research payloads to the ISS.
- The Center for the Advancement of Science in Space (CASIS) released several Requests for Proposals, including on energy technology, the Galactic Grant Competition, and the 2015 Mass Challenge Accelerator Campaign. The solicitations are intended to expand the use of the ISS by public and private organizations other than NASA.

However, NASA did not conduct the planned Rodent Research (RR)-2 investigation in FY 2015. The RR-2 investigation was cancelled after delays in the Soyuz launch schedule, due to failures of the Soyuz rocket, created an extended period of three-crew operations on the ISS, in which necessary experiment support activities exceeded available crew resources. It was not possible to replan the RR-2 investigation within available resources. Space biology is now refocusing rodent research around an “open science” concept that will minimize resource requirements and will emphasize community participation. NASA is planning to coordinate with the CASIS Good Health campaign, which is a science and technology development campaign to enable open source science on the ISS National Laboratory to improve human wellness on Earth. The next opportunity for a rodent research investigation is anticipated to be in 2017.

Performance Improvement Plan

As noted above, NASA is replanning its rodent research investigation, while recognizing the limited availability of crew time until U.S. commercial crew capability is operational. NASA is planning to coordinate with CASIS on joint rodent missions.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Carry out the first NASA Research Announcement-selected rodent research in the Rodent Research-2 project.	10AC03 Green	ERD 11 1 Green	ISS 12 7 Green	ISS 13 6 Green	ISS 14 5 Green	ISS 15 4 Red
Planned Future Performance						
For FY 2016: ISS-16-10: Organize a Science Definition Team and define the research objectives and requirements for a series of experiments to be conducted within the framework of the GeneLab open science concept and complete the definitions for two experiments.						
For FY 2017: ISS-17-10: Complete the design and development of the first community-defined biology experiments for implementation within the GeneLab framework.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Explanation of Rating

The Rodent Research-2 investigation was cancelled after delays in the Soyuz launch schedule created an extended period of three-crew operations on the ISS, in which necessary experiment support activities exceeded available crew resources.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Launch three physical science research payloads to ISS; select investigators and conduct the Critical Design Review for the Cold Atom Laboratory.	10AC02 Green	ERD 11 3 Green	ISS 12 9 Green	ISS 13 8 Green	ISS 14 6 Green	ISS 15 5 Green
Planned Future Performance						
For FY 2016: ISS-16-5: Deliver to the International Space Station three physical sciences payloads and conduct successful Cold Atom Laboratory Pre-Ship Review.						
For FY 2017: ISS-17-5: Deliver the Cold Atom Laboratory facility to the International Space Station and initiate operations on orbit, and complete one flight project in combustion research and one flight project in fluid physics or complex fluids research.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Through the Center for the Advancement of Science in Space (CASIS) cooperative agreement, release two Requests for Proposal, complete proposal evaluation, and select research projects for International Space Station execution in FY 2015.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ISS 14 7 Green	ISS 15 6 Green
Planned Future Performance						
For FY 2016: ISS-16-6: Through the Center for the Advancement of Science in Space (CASIS) cooperative agreement, release two Requests for Proposal, complete proposal evaluation, and select research projects for International Space Station execution in FY 2016.						
For FY 2017: ISS-17-6: Through the Center for the Advancement of Science in Space (CASIS) cooperative agreement, release two solicitations, complete proposal evaluation, and select research projects for International Space Station execution.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Produce 500 peer-reviewed publications from projects in human research, space biology, and physical sciences.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ISS 14 8 Green	ISS 15 7 Green
Planned Future Performance						
For FY 2016: ISS-16-7: Produce 500 peer-reviewed publications from projects in human research, space biology, and physical sciences.						
For FY 2017: ISS-17-7: Produce 500 peer-reviewed publications from projects in human research, space biology, and physical sciences.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Performance Goal 1.2.6

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Provide cargo transportation to support on-orbit crew members and utilization.	1.1.1.3 Green	1.1.1.3 Green	1.1.1.3 Green	1.2.6 Green	1.2.6 Yellow
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: International Space Station	**Contributing Program:** International Space Station				

FY 2015 Performance Results

During FY 2015, NASA continued to provide cargo transportation to the International Space Station (ISS), supporting on-orbit crew operations through agreements with foreign partners and U.S. commercial providers. Cargo transportation was provided by the Russian Federation's Progress expendable

cargo spacecraft, the European Space Agency's Automated Transfer Vehicle (ATV), and the Space Exploration Technologies Corporation's (SpaceX's) Dragon spacecraft.

In FY 2015, U.S. commercial providers completed two cargo flights to the ISS:

- On January 10, 2015, the SpaceX-5 Commercial Resupply Services (CRS) flight launched with payload and payload resupply for the ISS.
- On April 14, 2015, the SpaceX-6 CRS flight launched with more than 4,300 pounds of supplies and payloads for the ISS.

Due to the loss of the SpaceX-7 CRS flight on June 28, 2015, and the delay of the SpaceX-8 CRS flight into FY 2016, three commercial cargo flights were not completed to the ISS during FY 2015.

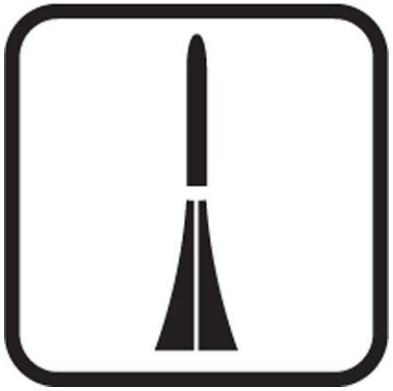
Performance Improvement Plan

As noted above, NASA missed its target due to the loss of the SpaceX-7 CRS flight on June 28, 2015, and the delay of the SpaceX-8 CRS flight into FY 2016. While the launch date for SpaceX-8 is under review pending the investigation into the SpaceX-7 loss, SpaceX is expected to resume commercial resupply flights in FY 2016. In addition, Orbital Sciences Corporation, which temporarily stopped its resupply flights after the loss of Orbital 3 in October 2014, is scheduled to resume commercial resupply flights in December 2015.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete at least three flights by U.S.-developed cargo delivery systems, delivering research and logistics hardware to ISS.	No API this fiscal year	No API this fiscal year	ISS 12 3 Green	ISS 13 2 Green	ISS 14 2 Green	ISS-15-8 Yellow
Planned Future Performance						
For FY 2016: ISS-16-8: Complete at least three flights, delivering research and logistics hardware to the ISS, by U.S.-developed cargo delivery systems.						
For FY 2017: ISS-17-8: Complete at least three flights, delivering research and logistics hardware to the ISS, by U.S.-developed cargo delivery systems.						
Contributing Theme: International Space Station	**Contributing Program:** International Space Station					

Explanation of Rating

NASA missed its target due to the loss of the SpaceX-7 CRS flight in June 2015, and the delay of the SpaceX-8 Crew Resupply Services flight into FY 2016.



Strategic Objective 1.3

Facilitate and utilize U.S. commercial capabilities to deliver cargo and crew to space.

Lead Office

Human Exploration and Operations Mission Directorate (HEOMD)

Goal Leader

Phil McAlister, Division Director, Commercial Systems Development Division, HEOMD

Contributing Programs

Commercial Crew

Budget for Strategic Objective 1.3

Budget Authority (in $ millions)	Actual FY 2015	Enacted FY 2016	Requested FY 2017	Notional FY 2018	Notional FY 2019	Notional FY 2020	Notional FY 2021
Total Budget	$805	—	$1,185	$732	$173	$36	$36

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

Through the Strategic Review and NASA's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Under Strategic Objective 1.3, NASA is supporting the development of U.S. commercial space transportation capabilities to reduce the gap in launching crew and cargo from the United States. NASA selected two U.S. companies as Commercial Crew Transportation contract partners in September 2014, and both partners are making technical and programmatic progress. For example, in May 2015, Agency partner SpaceX conducted a test of their Dragon spacecraft launch escape capabilities, demonstrating the ability to save astronauts in the unlikely event of a life-threatening situation on the launch pad. A major recent accomplishment for Strategic Objective 1.3 is the completion of the first phase of certification

efforts with NASA's Commercial Crew Transportation partners. With this accomplishment, NASA successfully achieved one of its agency priority goals. Over the next several years, the Agency's critical next steps are to monitor partner progress and milestone completion, working towards full certification, including a crew flight test to the International Space Station (ISS) with a NASA astronaut. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA plans that the Agency's current efforts under Strategic Objective 1.3 will lead to the ability to utilize U.S. commercial space transportation capabilities to provide safe, reliable, and cost effective access to and from low Earth orbit and the ISS for crew and cargo. This ability is critical for NASA's integrated space development and exploration plans, but the NASA 2015 Strategic Review noted that the Commercial Crew Program has faced a historical disconnect between requested and appropriated funding. Funding instability can force NASA to continue the Agency's sole reliance on Russia longer for launching its astronauts to the International Space Station.

For more information, please see http://www.nasa.gov/exploration/commercial/crew/index.html. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 1.3: Facilitate and utilize U.S. commercial capabilities to deliver cargo and crew to space.	
Performance Goal 1.3.1: Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition. (Agency Priority Goal)	Performance Goal 1.3.2: Invest financial and technical resources to stimulate efforts within the private sector to develop and demonstrate safe, reliable, and cost-effective space transportation capabilities.
Annual Performance Indicators	
• CS-15-1: Continue monitoring partner milestone progress based on Commercial Crew transportation Capability (CCtCap) contract content. • CS-15-2: Continue monitoring partner milestone progress based on agreement content.	• CS-15-3: Continue monitoring partner milestone progress based on agreement content.

Summary of Performance for Strategic Objective 1.3

Performance Goal Ratings for Strategic Objective 1.3, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	2	2	--		--
2014	2	2	--		--
2013	1	1	--		--
2012	1	1	--		--

Annual Performance Indicator Ratings for Strategic Objective 1.3, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	3	3	--		--
2014	3	3	--		--
2013	2	2	--		--
2012	1	1	--		--
2011	2	1	1		--
2010	1		1		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 1.3.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Facilitate the development of and certify U.S. industry-based crew transportation systems while maintaining competition. (Agency Priority Goal)	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.3.1 Green	1.3.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Commercial Spaceflight	**Contributing Program:** Commercial Crew				

FY 2015 Performance Results

NASA completed the planned work toward its agency priority goal in FY 2015. The NASA Commercial Crew Program is facilitating the development of U.S. commercial crew space transportation capabilities, with the goal of achieving safe, reliable, and cost-effective access to and from low Earth orbit and the International Space Station (ISS). Enabling a U.S. industry-based capability can facilitate the development of a commercial market, providing new high-technology jobs and reducing the cost of human access to space. NASA is working with two commercial partners, the Boeing Company (Boeing) and Space Explorations Technologies Corporation (SpaceX), to complete development and NASA certification for human space transportation systems capable of carrying people into orbit.

In September 2014, NASA awarded Commercial Crew Transportation Capability (CCtCap) contracts to Boeing and SpaceX to transport U.S. crews to and from the ISS by 2017. The contracts include at least one crewed flight test per company, with at least one NASA astronaut on board to verify that the fully integrated rocket and spacecraft system can launch, maneuver in orbit, and dock to the ISS, as well as to validate that all systems perform as expected. Once each company's test program has been completed successfully and its system achieves NASA certification, each contractor will conduct at least two, and as many as six, crewed missions to the ISS.

During FY 2015, both partners continued to identify verification closure items, hazard reports, variances, and alternate standards as they progress toward final design and certification. SpaceX supplied documentation in support of their delta Critical Design Review (CDR). The CDR is a significant review that will demonstrate that the project design has the ability to meet requirements with appropriate margins and acceptable risk within defined project constraints, including available resources to determine if the design is appropriately mature to continue with the final design and fabrication phase. Boeing began moving the Crew Access Tower from its construction yard to Space Launch Complex-41, a launch site at the north end of Cape Canaveral Air Force Station. In addition, Boeing announced that their Crew Space Transportation (CST)-100 spacecraft will be called the Starliner, and unveiled their Commercial Crew and Cargo Processing Facility.

More detailed information on this agency priority goal is included in Part 2.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Continue monitoring partner milestone progress based on Commercial Crew transportation Capability (CCtCap) contract content.	10CS07 Yellow	CS-11-2 Yellow	No API this fiscal year	CS 13 1 Green	CS 14 1 Green	CS 15 1 Green
Planned Future Performance						
For FY 2016: CS-16-1: Continue monitoring partner milestone progress based on Commercial Crew transportation Capability (CCtCap) contract content.						
For FY 2017: CS-17-1: Continue monitoring partner milestone progress toward identifying and closing certification products, in alignment with negotiated contract milestones.						
Contributing Theme: Commercial Spaceflight	**Contributing Program:** Commercial Crew					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Continue monitoring partner milestone progress based on agreement content.	No API this fiscal year	CS 11 4 Green	CS 12 1 Green	CS 13 2 Green	CS 14 2 Green	CS 15 2 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Commercial Spaceflight	**Contributing Program:** Commercial Crew					

Performance Goal 1.3.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Invest financial and technical resources to stimulate efforts within the private sector to develop and demonstrate safe, reliable, and cost-effective space transportation capabilities.	1.2.1.1 Green	1.2.1.1 Green	1.2.1.1 Green	1.3.2 Green	1.3.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Commercial Spaceflight	**Contributing Program:** Commercial Crew				

FY 2015 Performance Results

The NASA Commercial Crew Program is working with multiple U.S. companies that are designing and developing transportation capabilities to and from low Earth orbit and the International Space Station (ISS). By supporting the development by the private sector of human spaceflight capabilities, NASA is laying the foundation for future commercial transportation capabilities.

NASA is continuing to invest financial and technical resources within the private sector. NASA's commercial partners continue to make progress completing planned milestones. For example, on May 6, 2015, the Space Explorations Technologies Corporation (SpaceX) successfully completed a Pad Abort Test of its Dragon spacecraft. A Pad Abort Test is a trial run for a spacecraft's launch abort system, and is designed to get the crew and spacecraft safely away from the rocket in the event of a potential launch failure.

In addition, Final Frontier Design, a private design firm that develops aerospace safety garments, completed the development of System Requirements Review (SRR)-level products. An SRR examines a mission's functional and performance requirements to determine whether or not the requirements and the selected concept will satisfy the mission's needs. NASA and its commercial partners also conducted a number of Technical Interchange Meetings, designed to bring together a small group of experts for the exchange of technical information, and to give NASA a comprehensive understanding of the vehicles being designed and developed by private industry.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Continue monitoring partner milestone progress based on agreement content.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	CS 14 5 Green	CS 15 3 Green
Planned Future Performance						
For FY 2016: CS-16-2: Continue monitoring partner milestone progress based on agreement content.						
For FY 2017: CS-17-2: Continue monitoring partner milestone progress based on agreement content.						
Contributing Theme: Commercial Spaceflight	**Contributing Program:** Commercial Crew					

Strategic Objective 1.4

Understand the Sun and its interactions with Earth and the solar system, including space weather.

Lead Office

Heliophysics Division, Science Mission Directorate (SMD)

Goal Leader

Steven W. Clarke, Director, Heliophysics Division

Contributing Programs

Heliophysics Research, Living With a Star, Solar Terrestrial Probes, Heliophysics Explorer Program

Budget for Strategic Objective 1.4

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$636	—	$699	$684	$698	$715	$724

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has determined that performance toward this strategic objective is making noteworthy progress.

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. NASA's Strategic Objective 1.4 is pursued by the Science Mission Directorate (SMD) Heliophysics Division, which seeks to understand the Sun, the vast extended atmosphere of the Sun (called the heliosphere), and planetary environments as a single connected system. The Heliophysics Division is poised to make significant progress on key Heliophysics science questions, and since the 2014 NASA

Strategic Review, Heliophysics has demonstrated an improvement in the planned cadence of future missions. In addition, the Heliophysics flight program is demonstrating excellent cost and schedule performance following the recent launch of the Magnetospheric Multiscale (MMS) mission, and particularly noteworthy scientific discoveries were announced in the last year. The critical next steps include continuing the development of the next Heliophysics missions, including the Ionospheric Connection Explorer (ICON), Global-scale Observations of the Limb and Disk (GOLD), Solar Probe Plus (SPP), and the Solar Orbiter. NASA is also an agency member of the Space Weather Operations, Research, and Mitigation Task Force that developed and is implementing the *National Space Weather Strategy* and *National Space Weather Action Plan*. This effort will enhance the Nation's space-weather readiness in national preparedness, forecasting, and understanding. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA plans that the Agency's current efforts under Strategic Objective 1.4 will lead to further understanding of what causes the Sun to vary, how the geospace, planetary space environments, and the heliosphere respond to those variations, and impacts on humanity. Future success for this strategic objective requires maintaining and expanding the Heliophysics System Observatory (HSO), the fleet of spacecraft that operate concurrently, providing continuous observations and connected measurements. Maintaining an adequate mission cadence and balance is therefore critical. In addition, many of the key challenges for the Heliophysics Division are common across all of the SMD divisions (access to space; technology development; project technical, cost, and schedule challenges; partnerships; and mission support services and infrastructure) and are articulated in the *2014 Science Plan*.

For more information, please see http://science.nasa.gov/heliophysics/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*. Additional information on strategies, challenges, implementation, and program-specific detail is available in the *NASA 2014 Science Plan*.

FY 2015 Performance Measures

Strategic Objective 1.4: Understand the Sun and its interactions with Earth and the solar system, including space weather.			
Performance Goal 1.4.1: Demonstrate progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.	Performance Goal 1.4.2: Demonstrate progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.	Performance Goal 1.4.3: Demonstrate progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.	Performance Goal 1.4.4: By December 2017, launch two missions in support of Strategic Objective 1.4.
Annual Performance Indicators			
• HE-15-1: Demonstrate planned progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.	• HE-15-2: Demonstrate planned progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.	• HE-15-3: Demonstrate planned progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.	• HE-15-4: Launch the Magnetospheric Multiscale mission. • HE-15-5: Initiate Solar Orbiter Collaboration launch integration activities at Kennedy Space Center. • HE-15-6: Complete Solar Probe Plus (SPP) Critical Design Review (CDR). • HE-15-7: Complete the Ionospheric Connection (ICON) Critical Design Review (CDR).

Summary of Performance for Strategic Objective 1.4

Performance Goal Ratings for Strategic Objective 1.4, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	4	4	--		--
2014	4	4	--		--
2013	3	3	--		--
2012	3	3	--		--

Annual Performance Indicator Ratings for Strategic Objective 1.4, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	7	7	--		--
2014	6	6	--		--
2013	5	5	--		--
2012	4	4	--		--
2011	4	4	--		--
2010	5	5	--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 1.4.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.	2.2.1.1 Green	2.2.1.1 Green	2.2.1.1 Green	1.4.1 Green	1.4.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Heliophysics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Heliophysics Subcommittee of the NASA Advisory Council Science Committee determined in September 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

Coronal Heating Mechanisms Caught in the Act

Scientists have long been puzzled about why the corona, or the upper solar atmosphere, is over a thousand times hotter than the surface of the Sun. Data from several missions of NASA's Heliophysics System Observatory have now provided evidence for two physical mechanisms to explain why the corona is so hot.

Scientists combined data from NASA's Interface Region Imaging Spectrometer (IRIS) and the joint Japanese Aerospace Exploration Agency–NASA Hinode satellite to show how magnetic waves carry energy from the surface to solar filaments, which are suspended in the corona by magnetic fields. Here the wave motions are transformed into heat, a process in which wave interference heats the gas from 20,000 to at least 200,000 degrees Celsius.

In another study of hotter regions on the Sun, scientists used data from IRIS and NASA's Solar Dynamics Observatory (SDO) to reveal evidence for an alternative heating mechanism in which magnetic energy is released in small events called nanoflares. Comparisons between numerical models and high-resolution observations of these nanoflares show how particles are accelerated to very high energies and speeds, which heat small pockets of gas to temperatures of millions of degrees and propel the gas upward into the corona.

These new results show that coronal heating is more complex than originally thought, with the dominant mechanisms likely dependent on local conditions. The results enable a deeper understanding of the fundamental physical processes that underlie Earth's space environment.

Solar Wind Interactions in Near-Earth Space

The Sun constantly emits a supersonic stream of electrified and magnetized gas, called the solar wind. When it reaches Earth, most of this wind is deflected by the planet's strong magnetic field, the magnetosphere. The solar wind can enter near-Earth space if the solar magnetic field connects with Earth's magnetic field. Scientists have made key discoveries regarding two entry mechanisms.

Kelvin-Helmholtz waves are formed as the solar wind flows around Earth's magnetosphere, allowing a mixing of solar wind plasma across this surface.

Previously, scientists thought Kelvin-Helmholtz waves only appeared under specialized conditions. To determine when and where Kelvin-Helmholtz waves occur in near-Earth space, scientists used data from two NASA Heliophysics spacecraft: the Advanced Composition Explorer (ACE) and the Time History of Events and Macroscale Interactions during Substorms (THEMIS).

Similarly, solar wind can be captured near the "nose" of the magnetosphere when the solar magnetic field is simultaneously connected to Earth's magnetic field in two places. Researchers used data from the joint European Space Agency–NASA Cluster spacecraft to demonstrate that such double reconnection events occur regularly when the solar magnetic field has a certain orientation.

These two independent discoveries show that the solar wind regularly crosses the magnetosphere boundary and enters near-Earth space.

New Insight into the Dynamics of Earth's Atmosphere

Gravity waves, waves in the atmosphere similar to ocean tides, play an important part in the dynamics of Earth's atmosphere, transferring energy and momentum over large distances, and driving winds in the upper mesosphere. For the first time, a new whole-atmosphere circulation model resolves gravity waves down to the tens of kilometers level. The new simulation revealed the planetary-scale extent of a group of gravity waves about 60 miles above the Earth's surface that was directly attributed to a tropical cyclone. The model shows the increasing dominance of gravity waves at higher altitudes.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Demonstrate planned progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.	10HE01 Green	HE 11 1 Green	HE 12 1 Green	HE 13 1 Green	HE 14 1 Green	HE 15 1 Green
Planned Future Performance						
For FY 2016: HE-16-1: Demonstrate planned progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.						
For FY 2017: HE-17-1: Demonstrate planned progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system.						
Contributing Theme: Heliophysics	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: HE-17-4: Achieve Magnetospheric Multiscale (MMS) mission success criteria.	
Contributing Theme: Heliophysics	**Contributing Program:** Solar Terrestrial Probes

Performance Goal 1.4.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.	2.2.2.1 Green	2.2.2.1 Green	2.2.2.1 Green	1.4.2 Green	1.4.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Heliophysics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Heliophysics Subcommittee of the NASA Advisory Council Science Committee determined in September 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

Competing Effects on Earth's Upper Atmosphere

Auroras occur when the solar wind, a supersonic stream of electrified and magnetized gas emitted by the Sun, interacts with Earth's ionosphere. Their impacts on Earth's meteorological processes and on the atmosphere are not fully understood. Measurements taken by suborbital sounding rockets carrying university-developed experiments showed that solar wind-driven electric currents heat the thin air near the aurora. This results in an expanded atmosphere and a tenfold increase in drag on satellites orbiting up to around 600 miles altitude, lasting for a few days.

Space weather-events are not the only source of drag on satellites in the upper atmosphere. The longer-term cooling effects of upward flows of carbon dioxide from the lower atmosphere have more dramatic effects at higher altitudes. Observations made by NASA's Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED) satellite covering the last 13 years confirm that long-term carbon dioxide concentrations at satellite altitudes are increasing at more than twice the average rate at Earth's surface. In addition, the Aeronomy of Ice in the Mesosphere (AIM) satellite has recorded the largest extremes in upper atmospheric wave activity since 1978 due to changes in the underlying stratospheric winds. These findings highlight the importance of lower-to-upper atmosphere coupling in the study of solar-terrestrial connections.

New Insights into Solar Wind Interactions with Planetary Bodies

Mercury's internal dynamo and teardrop-shaped magnetic bubble, the magnetosphere, point to the existence of an electrical current system powered by the solar wind as it flows past the planet. However, scientists have wondered how this electrical current system connects with the planet's interior, since Mercury lacks an ionosphere, which typically serves as a conductive medium at other planets. The MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) spacecraft, from an orbit closer than 65 miles from the planet's surface, revealed that this space current flows through the highly resistive surface of the planet itself.

Mars, on the other hand, does have an atmosphere and ionosphere. In this case, it is the ionosphere that bends the solar wind magnetic field and streamlines, creating an "induced magnetosphere." Recent Mars Atmosphere and Volatile EvolutioN (MAVEN) mission data revealed that some of the

fully ionized solar wind gets neutralized by the ionosphere and penetrates deep into the upper atmosphere of Mars, where it is re-ionized. Additional solar wind-powered acceleration there allows ions to escape from the poles into interplanetary space.

Combining these NASA planetary mission observations with similar observations made by NASA's Heliophysics System Observatory of Earth's near-space environment provides significant new insights regarding solar wind interactions with planetary ionospheres, atmospheres, and interiors.

IBEX and Cassini Illuminate the Heliosphere's Structure and Its Interstellar Interactions

Scientists combined simulations with Interplanetary Boundary Explorer (IBEX) and Cassini spacecraft observations of energetic neutral atoms, and found that the shape of the heliosphere—the bubble created by the solar wind that extends beyond the solar system—does not actually look like a comet. Instead, the heliosphere looks a lot more like a crescent moon, with two giant jets of material shooting backwards over the north and south poles of the Sun. Furthermore, the two jets resemble other jets seen in space, and could provide insight into jets throughout the universe.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in advancing understanding of the connections that link the Sun, Earth and planetary space environments, and the outer reaches of the solar system.	10HE06 Green	HE 11 4 Green	HE 12 4 Green	HE 13 4 Green	HE 14 4 Green	HE 15 2 Green
Planned Future Performance						
For FY 2016: HE-16-2: Demonstrate planned progress in advancing understanding of the connections that link the Sun, Earth, and planetary space environments, and the outer reaches of the solar system.						
For FY 2017: HE-17-2: Demonstrate planned progress in advancing understanding of the connections that link the Sun, Earth, and planetary space environments, and the outer reaches of the solar system.						
Contributing Theme: Heliophysics	**Contributing Program:** Multiple Programs					

Performance Goal 1.4.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.	2.2.3.1 Green	2.2.3.1 Green	2.2.3.1 Green	1.4.3 Green	1.4.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Heliophysics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Heliophysics Subcommittee of the NASA Advisory Council Science Committee determined in September 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

Coronal Dimming Predicts Coronal Mass Ejection Strength

Coronal mass ejections are violent explosions in which mass and magnetic field are ejected from the Sun into interplanetary space. They can contain up to a billion tons of material, travel at up to a million miles per hour, and play a major role in space weather events. Researchers recently found that the amount of extreme ultraviolet (EUV) light from the Sun's atmosphere, or corona, can decrease when a coronal mass ejection is emitted from the Sun.

As emitting material leaves the corona, there is a brief void, or dimming, that can be observed and measured. Data from NASA's Solar Dynamics Observatory's (SDO's) EUV Variability Experiment (EVE) show that the dimming of the EUV spectra correlates with both the speed and amount of material within the coronal mass ejection. Scientists use EVE data, combined with other SDO data, to monitor changes in the spectra to provide new, near-real-time data products. These new insights will improve predictions of solar explosive events that can potentially impact Earth and the space environment.

The Inner Radiation Zone Contains No High-Energy Electrons

The Van Allen Belts are two donut-shaped regions encircling Earth, where charged particles from the Sun and space are trapped by Earth's magnetic field. The population of charged particles can wax and wane in response to incoming energy from the Sun, sometimes swelling enough to expose satellites in low Earth orbit to damaging radiation. Researchers used data from NASA's twin Van Allen Probes to discover a sharp inner edge in the outer belt that acts as a barrier, preventing high-energy electrons from coming closer to Earth, resulting in only lower-energy electrons in the inner belt.

This barrier for the highest-energy electrons is controlled by the existence of a cool, dense population of electrically charged gas. This gas allows certain radio waves to scatter the energetic electrons. Then the radiation belt particles "rain" into Earth's upper atmosphere, harmlessly losing their energy. Observations from the Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL) mission confirmed that high-energy electrons are rapidly lost from the radiation belt due to their interaction with radio waves in the presence of the dense, cool gas. This work enables better understanding of the potential dangers to astronauts and technological assets in low Earth orbit.

New Predictive Capability for Equatorial Ionospheric Space Weather

The equatorial ionosphere contains the densest plasma near Earth and is often the location of severe disturbances in satellite communications, short-wave radio reception, and Global Positioning System (GPS) navigation location accuracy. Disturbances are greatest when the smooth ionospheric layer breaks apart and splits just after sunset. This is because the irregular environment reflects and directs radio waves in unpredictable directions. The velocity of the plasma, called plasma drift, has been found to be a key indicator for predicting these plasma irregularities. The Communications/Navigation Outage Forecasting System (C/NOFS) satellite, carrying the NASA Coupled Ion-Neutral Dynamics Investigation (CINDI) payload, has measured both the plasma drift and plasma irregularities at the top of the ionosphere for 10 years. CINDI found a remarkably strong statistical relationship between the plasma drift around sunset and the occurrence of strong plasma irregularities. When the upward drift was less than 10 meters per second, strong

irregularities never occurred. If the upward drift was greater than 60 meters per second, irregularities always occurred. This finding will help scientists reliably predict disruptive space weather in the equatorial ionosphere.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.	10HE08 Green	HE 11 5 Green	HE 12 5 Green	HE 13 5 Green	HE 14 7 Green	HE 15 3 Green
Planned Future Performance						
For FY 2016: HE-16-3: Demonstrate planned progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.						
For FY 2017: HE-17-3: Demonstrate planned progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.						
Contributing Theme: Heliophysics	**Contributing Program:** Multiple Programs					

Performance Goal 1.4.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
By December 2017, launch two missions in support of Strategic Objective 1.4.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.4.4 Green	1.4.4 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Heliophysics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA remained on track to achieve this performance goal by launching the Magnetospheric Multiscale (MMS) mission on March 12, 2015, and making progress on the Ionospheric Connection Explorer (ICON).

MMS is studying magnetic reconnection, the process where the Sun and Earth's magnetic fields connect and disconnect, explosively releasing energy. MMS consists of four spacecraft that work together to provide a three-dimensional view of magnetic reconnection.

The ICON project completed its Critical Design Review (CDR) in April 2015, allowing the project to begin final design and fabrication of the spacecraft. ICON is a single spacecraft mission dedicated to exploring the boundary region between Earth and space, called the thermosphere, where ionized plasma and

neutral gas collide and interact, causing dramatic variability. The mission will resolve both long-standing and newly emerging questions about the mechanisms that control the daily development of plasma in Earth's space environment.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Launch the Magnetospheric Multiscale (MMS) mission.	10HE02 Green	HE 11 2 Green	HE 12 2 Green	HE 13 3 Green	HE 14 3 Green	HE 15 4 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Heliophysics	**Contributing Program:** Solar Terrestrial Probes					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Initiate Solar Orbiter Collaboration launch integration activities at Kennedy Space Center.	No API this fiscal year	No API this fiscal year	No API this fiscal year	HE 13 6 Green	HE 14 5 Green	HE 15 5 Green
Planned Future Performance						
For FY 2016: HE-16-8: Complete Solar Orbiter Collaboration (SOC) Solar Orbiter Heliospheric Imager (SoloHI) and Heavy Ion Sensor (HIS) instrument Pre-Ship Reviews (PSRs).						
For FY 2017: No API this fiscal year						
Contributing Theme: Heliophysics	**Contributing Program:** Living with a Star					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete Solar Probe Plus (SPP) Critical Design Review (CDR).	10HE04 Green	No API this fiscal year	No API this fiscal year	No API this fiscal year	HE 14 6 Green	HE 15 6 Green
Planned Future Performance						
For FY 2016: HE-16-5: Complete Solar Probe Plus System Integration Review (SIR).						
For FY 2017: HE-17-5: Complete Solar Probe Plus (SPP) Solar Wind Electrons Alphas and Protons (SWEAP), FIELDS, Integrated Science Investigation of the Sun (ISIS) and the Wide-Field Imager for SPP (WISPR) Pre-Ship Reviews (PSRs).						
Contributing Theme: Heliophysics	**Contributing Program:** Living with a Star					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Ionospheric Connection (ICON) Critical Design Review (CDR).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	HE 15 7 Green
Planned Future Performance						
For FY 2016: HE-16-6: Complete the Ionospheric Connection (ICON) Explorer System Integration Review (SIR).						
For FY 2017: HE-17-6: Complete the Ionospheric Connection (ICON) Explorer Pre-Ship Review (PSR).						
Contributing Theme: Heliophysics	**Contributing Program:** Heliophysics Explorer Program					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: HE-16-7: Release the next Heliophysics Explorer Announcement of Opportunity (AO).
For FY 2017: HE-17-7: Complete the Explorer Step One selection.
Contributing Theme: Heliophysics / **Contributing Program:** Heliophysics Explorer Program

Strategic Objective 1.5

Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.

Lead Office

Planetary Science Division, Science Mission Directorate (SMD)

Goal Leader

Dr. James Green, Director, Planetary Science Division

Contributing Programs

Planetary Science Research, Discovery, New Frontiers, Mars Exploration, Outer Planets, Technology

Budget for Strategic Objective 1.5

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$1,447	—	$1,519	$1,440	$1,520	$1,575	$1,626

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has determined that performance toward this strategic objective is making noteworthy progress.

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. NASA's Strategic Objective 1.5 is pursued by the Science Mission Directorate (SMD) Planetary Science Division, which continues to expand the Agency's knowledge of the solar system. For example, in FY 2015, the New Horizons mission accomplished the historic first-ever flyby of Pluto, and the Dawn spacecraft arrived at Ceres, the largest object in the main asteroid belt between Mars and Jupiter. The Planetary Science Division launched their last three missions below each mission's development cost estimates, and particularly noteworthy scientific

discoveries were announced in the last year. The critical next steps include continuing the development of the next Planetary Science missions, such as Mars 2020 and the Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) asteroid mission. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA plans that the Agency's current efforts under Strategic Objective 1.5 will lead to further understanding of the content, origin, and evolution of the solar system, as well as the potential for life elsewhere. A recurrent threat in this area is the requirements creep that missions may face, which, if left unchecked, likely would lead to cost growth and schedule slip. Many of the key challenges for the Planetary Science Division are common across all of the SMD divisions (access to space; technology development; project technical, cost, and schedule challenges; partnerships; and mission support services and infrastructure) and are articulated in the *2014 Science Plan*. With the current and anticipated budget, it is difficult to maintain a balanced program between competed and strategic missions, across planetary destinations, and among research and technology investments. However, Planetary Science is sustaining extensive intra- and extra-Agency partnerships, and is pursuing efficiencies and informed investments tied to long-term strategic needs.

For more information, please see http://solarsystem.nasa.gov/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*. Additional information on strategies, challenges, implementation, and program-specific detail is available in the NASA *2014 Science Plan*.

FY 2015 Performance Measures

Strategic Objective 1.5: Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.					
Performance Goal 1.5.1: Demonstrate progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.	Performance Goal 1.5.2: Demonstrate progress in exploring and observing the objects in the solar system to understand how they formed and evolve.	Performance Goal 1.5.3: Demonstrate progress in exploring and finding locations where life could have existed or could exist today.	Performance Goal 1.5.4: Demonstrate progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.	Performance Goal 1.5.5: Demonstrate progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.	Performance Goal 1.5.6: By December 2017, launch at least two missions in support of Strategic Objective 1.5.
Annual Performance Indicators					
• PS-15-1: Demonstrate planned progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact, and evolve.	• PS-15-2: Demonstrate planned progress in exploring and observing the objects in the solar system to understand how they formed and evolve.	• PS-15-3: Demonstrate planned progress in exploring and finding locations where life could have existed or could exist today.	• PS-15-4: Demonstrate planned progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.	• PS-15-5: Conduct research into mitigation strategies utilizing observed characteristics and properties of those small bodies that pose a threat to terrestrial life. • PS-15-9: Demonstrate planned progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.	• PS-15-6: Complete the Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) Systems Integration Review (SIR). • PS-15-7: Complete the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) Systems Integration Review (SIR). • PS-15-8: Complete the Mars 2020 Preliminary Design Review (PDR).

Summary of Performance for Strategic Objective 1.5

Performance Goal Ratings for Strategic Objective 1.5, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	6	6	--		--
2014	6	6	--		--
2013	5	5	--		--
2012	5	5	--		--

Annual Performance Indicator Ratings for Strategic Objective 1.5, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	9	8	1		--
2014	8	8	--		--
2013	6	6	--		--
2012	6	5	1		--
2011	5	5	--		--
2010	4	4	--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 1.5.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact and evolve.	2.3.1.1 Green	2.3.1.1 Green	2.3.1.1 Green	1.5.1 Green	1.5.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Planetary Science Subcommittee of the NASA Advisory Council Science Committee determined in October 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

Venus's Mysterious Auroras

The effects of solar activity on the planets, often referred to as space weather effects, are of special interest at Venus, where there is no substantial planetary magnetic field. Data from the Venus Express Radio Science experiment show increased ionospheric electrons low in the ionosphere of the planet. Although Venus has no magnetic field and is not expected to possess auroras, atmospheric emissions have been detected sporadically in the Venusian atmosphere. The greatest emission is observed after large injections of solar charged particles from coronal mass ejections. Planetary scientists consider this to be an auroral-type emission occurring low in the ionosphere—the first of its kind to be detected on a nonmagnetic planet.

New Craters on the Moon

On March 17, 2013, NASA's Marshall Lunar Impact Monitoring Program observed a bright flash on the lunar surface, the largest impact they had observed. High-resolution images from the Lunar Reconnaissance Orbiter (LRO) Camera found the source of the flash: A new 18-meter diameter crater, with ejecta identified as far as 30 kilometers away from the primary crater. In addition, reimaging of the lunar surface by LRO has led to the identification of more than 50 new craters. These observations show that the secondary ejecta are a more widespread hazard than the primary impactor. The study of hypervelocity impacts through observations of new craters and ejecta patterns will inform strategies for planetary defense, including suggestions for breaking up large asteroids before terrestrial impact.

LADEE Determines the Composition of the Lunar Atmosphere

The Lunar Atmosphere and Dust Environment Explorer's (LADEE's) Neutral Mass Spectrometer systematically measured the contents of the thin lunar atmosphere, leading the science team to determine that the atmosphere is overwhelmingly dominated by helium, neon, and argon. For the first time, three simultaneously operating NASA lunar missions made complementary exospheric observations: LADEE, the Acceleration, Reconnection, Turbulence and Electrodynamics of the Moon's Interaction with the Sun (ARTEMIS), and LRO's Lyman Alpha Mapping Project (LAMP). ARTEMIS observed the solar

wind input, while LADEE and LAMP sensed the exospheric response near the equator and poles, respectively. Finally, new exospheric species have been identified, including carbon and nitrogen.

Methane—An Unexplained Mystery in the Martian Atmosphere

Reports of plumes or patches of methane in the Martian atmosphere that vary over monthly time scales have defied explanation to date. For most of its mission, the Curiosity rover has observed a constant background level of atmospheric methane at Gale Crater of about 0.69 parts per billion by volume (ppbv), likely from methane released from the degradation of interplanetary dust and meteorites. However, in four sequential measurements spanning two months, the rover measured a ten-fold increase (around 7.2 ppbv), suggesting that methane was actively added to the atmosphere from an additional, unknown source.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact, and evolve.	No API this fiscal year	PS 11 1 Green	PS 12 1 Green	PS 13 1 Green	PS 14 1 Green	PS 15 1 Green
Planned Future Performance						
For FY 2016: PS-16-1: Demonstrate planned progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact, and evolve.						
For FY 2017: PS-17-1: Demonstrate planned progress in advancing the understanding of how the chemical and physical processes in the solar system operate, interact, and evolve.						
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs					

Performance Goal 1.5.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in exploring and observing the objects in the solar system to understand how they formed and evolve.	2.3.2.1 Green	2.3.2.1 Green	2.3.2.1 Green	1.5.2 Green	1.5.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Planetary Science Subcommittee of the NASA Advisory Council Science Committee determined in October 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

LRO is Rewriting the Textbooks on Lunar Volcanism

Prior to the Lunar Reconnaissance Orbiter (LRO), lunar volcanism was thought to have ended approximately one billion years ago. New data from LRO suggests volcanism occurred as recently as 100 million years ago, and perhaps as recently as 20 million years ago. High-resolution images from the LRO Camera reveal 70 unusual volcanic features, or irregular mare patches, on the lunar nearside, including the well-known Ina (or Ina D). Crater counts have shown these irregular mare patches to be at least 900 million years younger than the previously identified youngest lunar lava flow. This finding drastically alters researchers' view of the duration of lunar volcanism. The ages of these features are inferred from the sparse cratering on the smooth units within them.

MESSENGER Reveals Ancient Magnetic Field on Mercury

Mercury is the only inner planet besides Earth with a magnetic field generated by a dynamo in a fluid outer core. Low-altitude measurements made with the NASA MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) spacecraft's magnetometer identified signals indicating the presence of magnetized crustal rocks on Mercury. Since these rocks solidified 3.7 to 3.9 billion years ago, the planet's magnetic field has been in place for much of the planet's history, and may have been stronger in the distant past.

New Evidence that Venus May Still be Volcanically Active

Venus is known to have been resurfaced by volcanic activity in the last one billion years. New observations from the Venus Express Venus Monitoring Camera have seen transient bright spots that are consistent with the extrusion of lava flows. The bright spots cause significantly elevated surface temperatures. They are found along the extremely young Ganiki Chasma. Their similarity to locations of rift-associated volcanism on Earth provide strong evidence for their volcanic origin and suggest that Venus is currently geodynamically active.

NASA's New Horizons Spacecraft Explores the Diverse Pluto System

NASA's New Horizons spacecraft explored the Pluto system in 2015, making its closest approach on July 14, 2015. Pluto's surface displays evidence for diverse landforms, terrain ages, albedos, colors, and composition gradients. Pluto displays evidence of a water-ice crust, surface areas that are geologically young, surface ice convection, wind streaks, volatile transport, and glacial flow. Pluto's atmosphere is highly extended, with trace hydrocarbons, and a global haze layer, which is a source of weather. The atmosphere also is thinner than previously thought, with a surface pressure less than 10 microbars. Pluto's diverse surface geology and long-term activity raise fundamental questions about how small planets remain active many billions of years after formation. Pluto's large moon, Charon, displays tectonics and evidence for a heterogeneous crustal composition, and its North Pole displays puzzling dark terrain.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in exploring and observing the objects in the solar system to understand how they formed and evolve.	10PS01 Green	PS 11 4 Green	PS 12 4 Green	PS 13 3 Green	PS 14 4 Green	PS 15 2 Green
Planned Future Performance						
For FY 2016: PS-16-2: Demonstrate planned progress in exploring and observing the objects in the solar system to understand how they formed and evolve.						
For FY 2017: PS-17-2: Demonstrate planned progress in exploring and observing the objects in the solar system to understand how they formed and evolve.						
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: PS-16-14: Complete Juno Jupiter orbit insertion.
For FY 2017: No API this fiscal year
Contributing Theme: Planetary Science — **Contributing Program:** Multiple Programs

Performance Goal 1.5.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in exploring and finding locations where life could have existed or could exist today.	2.3.3.1 Green	2.3.3.1 Green	2.3.3.1 Green	1.5.3 Green	1.5.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Planetary Science Subcommittee of the NASA Advisory Council Science Committee determined in October 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

Evidence That Liquid Water Flows on Today's Mars

Recurring slope lineae are long surface albedo features that darken on sunny slopes in local summer, extend downslope, fade in autumn, and then reappear in the next Mars year. Researchers think these features form when the Martian surface is moistened by a surface or sub-surface flow of water

during the warm season. The Mars Reconnaissance Orbiter found that during the season when these features grow, they contain hydrated perchlorate salts, which provide a powerful freezing point depressant. This would keep briny water liquid for a greater portion of the day and for more days in the warm seasons. Perchlorate salts reduce the freezing point of water to as low as -78°C. The observed hydration of the salts is consistent with the probable presence of liquid water flowing on today's Mars.

Mars Has Lost an Ocean's Worth of Water

A primitive ocean on Mars held more water than Earth's Arctic Ocean, according to NASA scientists, who used ground-based observatories to measure water signatures in Mars's atmosphere. They studied the remaining water molecules in the Martian atmosphere. The results showed that a very large amount of heavy water (having deuterium) remains on Mars today, meaning that Mars lost a significant amount of normal water (having just hydrogen) over time. Today, Mars has only 13 percent of the water it once had, losing 87 percent of the original inventory. NASA's Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft is now looking into the processes to determine how Mars lost its water.

Mars Has the Right Ingredients to Have Supported Microbial Life

The Curiosity rover detected nitrogen-bearing compounds in scooped sand and drilled sedimentary rock within Gale Crater, supporting the equivalent of 110–300 parts per million (ppm) of nitrate in the sand samples, and 70–1,100 ppm of nitrate in the mudstone deposits. Discovery of indigenous Martian nitrogen in surface materials has important implications for habitability and, specifically, for the potential evolution of a nitrogen cycle at some point in Martian history. Fixed nitrogen (such as nitrates) could have facilitated the development of a primitive nitrogen cycle on the surface of ancient Mars, potentially providing a biochemically accessible source of nitrogen.

The Acidity of Enceladus's Ocean

Using data from the Cassini spacecraft, researchers have determined that the water in the geyser-like plumes of Enceladus is very acidic. Using mass spectrometry data, the researchers estimated the ocean has a very high pH (roughly 11-12, in a range that goes from 0 to 14) and is salty, containing both sodium chloride and sodium carbonate, similar to the Earth's soda lakes. The high acidity may be a result of "serpentinization," an interaction between water and rock, which leads to the generation of hydrogen, and serves as a potential source of energy for microbial life on Earth.

Prebiotic Glycerol in Interstellar Ices

Glycerol is a key building block of cell membranes, but scientists have not been able to explain its existence on early Earth. A study shows that glycerol might form when ionizing radiation interacts with interstellar ices. Following this radiation-induced formation of glycerol, interstellar grains can then be incorporated into the building material of solar systems. This suggests that comets and meteorites could serve to deliver the glycerol to habitable planets like the early Earth.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in exploring and finding locations where life could have existed or could exist today.	10PS09 Green	PS 11 8 Green	PS 12 7 Green	PS 13 6 Green	PS 14 5 Green	PS 15 3 Green
Planned Future Performance						
For FY 2016: PS-16-3: Demonstrate planned progress in exploring and finding locations where life could have existed or could exist today.						
For FY 2017: PS-17-3: Demonstrate planned progress in exploring and finding locations where life could have existed or could exist today.						
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: PS-16-10: Achieve the Mars Atmosphere and Volatile EvolutioN (MAVEN) mission success criteria.	
For FY 2017: No API this fiscal year	
Contributing Theme: Planetary Science	**Contributing Program:** Mars Exploration

Performance Goal 1.5.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.	2.3.4.1 Green	2.3.4.1 Green	2.3.4.1 Green	1.5.4 Green	1.5.4 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Planetary Science Subcommittee of the NASA Advisory Council Science Committee determined in October 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

Astrobiologists Show that Programmable DNA, Used to Assemble Complex Nanometer-Scale Structures, Can Do So in a Mixture of Solvents that Contains No Water

Astrobiologists are re-examining whether liquid water is necessary for life to develop through all of its stages. Assembly of DNA nanostructures happens slowly, and although heating causes the process to speed up, it also damages the DNA. The new solvent, glycholine, is a mixture of glycerol and choline chloride that is more viscous than water and allows these processes to happen at lower temperatures. Researchers found that they can assemble DNA

nanostructures in glycholine, and that adding a small amount of water to glycholine increases the assembly rate and provides a new means for controlling the process. A mixture of 10 percent water in glycholine adjusts the viscosity of the solvent and can allow for even faster assembly: a two-dimensional DNA structure that assembled at the cool temperature of 20°C (68°F) in just six days in pure glycholine assembled in three hours when wet. Even though DNA is well suited to a wet environment, other molecules thought to be important for the origin of life would develop much more easily without water being present, and this research demonstrates this prebiotic chemistry could have taken place in a water-free solution.

Reproducing the Building Blocks of Life in the Laboratory

NASA scientists studying the origin of life have reproduced uracil, cytosine, and thymine, three key components of human hereditary material, in the laboratory. They discovered that an ice sample containing pyrimidine exposed to ultraviolet radiation under space-like conditions produces these essential ingredients of life.

Ancient Organisms That Have Not Evolved

In the muddy sediments beneath the deep sea, NASA-funded astrobiologists found ancient communities of microbes that have remained virtually unchanged for 2.3 billion years. The three distinct communities of deep-sea microbes were separated from each other in time by hundreds of millions of years. The first is a fossilized community found in 2.3 billion-year-old rock in Western Australia. The second fossilized community was discovered in 1.8 billion-year-old rock, also in Western Australia. The third is a living community discovered in sediments off the west coast of South America. The researchers found that, despite their vast age differences, the three communities look exactly the same, each exhibiting a telltale irregular web-like fabric and a two-tier structure. These organisms are examples of a static community in extreme evolutionary stasis, in which they are all well adapted to their environment and lack competition, perhaps representing the greatest lack of evolution ever seen. This lack of evolution may also, ironically, provide evidence in support of Darwin's theory of evolution by demonstrating that, in the absence of competition, evolution ceases.

Can the Moon Act as a Recorder of Organic Evolution in the Early Solar System?

As the organic record of early Earth has effectively been erased, it is difficult to understand the delivery of organic materials from formation to roughly 3.8 billion years ago. While analysis of meteorites and direct measurements of asteroids and comets provide some insight, an effective chronicle of organic evolution on all solar system objects, including that on planetary surfaces, is more difficult to find. Researchers using lunar regolith simulants discovered that the Moon may preserve organic matter. Investigation of paleoregoliths and ices in permanently shadowed regions potentially hold the key to understanding the organic flux to the Earth–Moon system more than 3.8 billion years ago.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.	10PS07 Green	PS 11 11 Green	PS 12 11 Green	PS 13 8 Green	PS 14 8 Green	PS 15 4 Green
Planned Future Performance						
For FY 2016: PS-16-4: Demonstrate planned progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.						
For FY 2017: PS-17-4: Demonstrate planned progress in improving understanding of the origin and evolution of life on Earth to guide the search for life elsewhere.						
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs					

Performance Goal 1.5.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.	2.3.5.1 Green	2.3.5.1 Green	2.3.5.1 Green	1.5.5 Green	1.5.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Planetary Science Subcommittee of the NASA Advisory Council Science Committee determined in October 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

Near-Earth Object Survey

NASA and its partners maintain a watch for near-Earth objects (NEOs), asteroids, and comets that pass close to Earth's orbit as part of an ongoing effort to discover, catalog, and characterize these bodies. NEOs range in size from a few meters to roughly 34 kilometers in diameter, with smaller objects being about two orders of magnitude more numerous than larger objects.

In FY 2015, asteroid search teams funded primarily by NASA's Near-Earth Object Observations (NEOO) Program found another 15 asteroids larger than one kilometer in diameter with orbits that come close to Earth's vicinity. Asteroid search teams also found 1,481 smaller asteroids less than one kilometer in diameter. Of these, 508 were larger than 140 meters in size, along with 4 additional near-Earth comets. This brought the total known population of NEOs to 13,141 as of September 30, 2015. The high-precision orbit predictions computed by NASA's Jet Propulsion Laboratory show that none of these objects are likely to strike Earth in the next century. However, 1,622 of these objects (of which 153 are larger than one kilometer in diameter, and with 103 more found this year) are in orbits that could become a hazard in the distant future and warrant continued monitoring.

Near-Earth Object Human Space Flight Accessible Targets Study

NASA has created a database, the Near-Earth Object Human Space Flight Accessible Targets Study (NHATS), of the most accessible NEOs in an effort to better understand the options that are available for future human and robotic missions. NHATS is instantaneously updated as new objects are discovered and knowledge of their orbits improved. In addition, NASA is developing a list for NEO targets of strategic knowledge gaps that highlight the various unknowns and data gaps identified by the science and engineering communities as key areas to address prior to committing crews to explore the solar system.

NEOWISE Characterizes Over 9,000 Asteroids in Its First Year of Restart Mission

The NEO Wide-field Infrared Survey Explorer (NEOWISE) restart mission observed preliminary diameters and albedos (surface reflectivity) for 9,309 asteroids in its first year. Of these, 203 are near-Earth asteroids and 9,106 are Main Belt or Mars-crossing asteroids. Diameters can typically be derived to an accuracy of approximately 20 percent, with the 3.4 and 4.6 micron data available from the NEOWISE mission. When visible light observations are available, albedos can be computed with roughly 40-50 percent accuracy. Because NEOWISE observes in the infrared, it can find and characterize optically dark NEOs that are difficult for ground-based visible surveys to discover. All NEOWISE Year 1 observations have been delivered to NASA's Infrared Science Archive (IRSA), the designated repository for infrared observations. NEOWISE continues to operate with nearly identical performance in its 3.4 and 4.6 micron channels to that demonstrated during the WISE prime mission, the original mission for the spacecraft. NEOWISE data have been used in more than 200 refereed publications.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Conduct research into mitigation strategies utilizing observed characteristics and properties of those small bodies that pose a threat to terrestrial life.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	PS 14 10 Green	PS 15 5 Green
Planned Future Performance						
For FY 2016: PS-16-5: Conduct research, involving both U.S. interagency and international cooperation and partnerships, into mitigation techniques and technologies to address the anticipated threat of small body impacts to life on Earth.						
For FY 2017: PS-17-5: Conduct research, involving both U.S. interagency and international cooperation and partnerships, into mitigation techniques and technologies to address the anticipated threat of small body impacts to life on Earth.						
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	PS 14 12 Green	PS 15 9 Green
Planned Future Performance						
For FY 2016: PS-16-9: Demonstrate planned progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.						
For FY 2017: PS-17-9: Demonstrate planned progress in identifying and characterizing objects in the solar system that pose threats to Earth or offer resources for human exploration.						
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs					

Performance Goal 1.5.6

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
By December 2017, launch at least two missions in support of Strategic Objective 1.5.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.5.6 Green	1.5.6 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Planetary Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA remains on track to achieve this performance goal by launching two Planetary Science missions. NASA launched the first mission supporting this performance goal, the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft, in November 2013. MAVEN is exploring Mars's upper atmosphere, ionosphere, and interactions with the Sun and solar wind. Scientists are using the data to determine the role that loss of volatiles (substances that evaporate quickly) from the Mars atmosphere to space has played through time, giving insight into the history of Mars's atmosphere and climate, liquid water, and planetary habitability.

The Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) is scheduled for launch in September 2016. OSIRIS-REx will travel to Bennu, a near-Earth asteroid, and bring a small sample back to Earth for study. As planned, the spacecraft will reach its asteroid target in 2018 and return the sample to Earth in 2023. The sample will provide insight into the composition of the very early solar system, the source of organic materials and water that made life possible on Earth, and to better predict the orbits of asteroids that represent collision threats to Earth. In February 2015, OSIRIS-REx completed its Systems Integration Review, marking the end of the final design phase and the transition to the system assembly, integration, and test phase.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) Systems Integration Review (SIR).	10PS04 Green	PS 11 3 Green	PS-12-2 Yellow	PS 13 5 Green	PS 14 2 Green	PS 15 6 Green
Planned Future Performance						
For FY 2016: PS-16-6: Complete the Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx) Pre-Ship Review (PSR).						
For FY 2017: PS-17-6: Launch the Origins, Spectral Interpretation, Resource Identification, and Security–Regolith Explorer (OSIRIS-REx).						
Contributing Theme: Planetary Science	**Contributing Program:** New Frontiers					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) Systems Integration Review (SIR).	No API this fiscal year	No API this fiscal year	PS 12 3 Green	PS 13 2 Green	PS 14 3 Green	PS 15 7 Green
Planned Future Performance						
For FY 2016: PS-16-7: Launch the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) mission.						
For FY 2017: No API this fiscal year						
Contributing Theme: Planetary Science	**Contributing Program:** Discovery					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Mars 2020 Preliminary Design Review (PDR).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	PS-15-8 Yellow
Planned Future Performance						
For FY 2016: PS-16-8: Complete Mars 2020 Mission Confirmation Review.						
For FY 2017: PS-17-8: Complete Mars 2020 Critical Design Review (CDR).						
Contributing Theme: Planetary Science	**Contributing Program:** Mars Exploration					

Explanation of Rating

The Mars 2020 project has matured to the point that it will be able to conform to a single-step lifecycle review process. A single, integrated Preliminary Design Review (PDR) will now be held in February 2016. As is typical for flight systems of this complexity, multiple element reviews will be held leading up to the mission review so that the vast scope of information involved can be adequately assessed by the Standing Review Board (SRB). A Heritage Flight System Review with the SRB was completed in September 2015.

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: PS-17-12: Complete Europa Instrument Preliminary Design Reviews (PDRs).	
Contributing Theme: Planetary Science	**Contributing Program:** Outer Planets

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: PS-16-15: Complete Discovery 13 selections.	
For FY 2017: PS-17-11: Complete down-select for Discovery 13 mission.	
Contributing Theme: Planetary Science	**Contributing Program:** Discovery

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: PS-17-10: Release New Frontiers 4 Announcement of Opportunity (AO).	
Contributing Theme: Planetary Science	**Contributing Program:** New Frontiers

Strategic Objective 1.6

Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars.

Lead Office

Astrophysics Division, Science Mission Directorate (SMD)

Goal Leader

Dr. Paul Hertz, Director, Astrophysics Division

Contributing Programs

James Webb Space Telescope, Astrophysics Research, Cosmic Origins, Physics of the Cosmos, Exoplanet Exploration, Astrophysics Explorer

Budget for Strategic Objective 1.6

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$1,376	—	$1,351	$1,295	$1,297	$1,316	$1,342

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. NASA's Strategic Objective 1.6 is pursued by the Science Mission Directorate (SMD) Astrophysics Division, which seeks to understand how does the universe work, how did we get here, and are we alone. The Astrophysics Division is demonstrating satisfactory overall cost and schedule performance for missions in development, and a number of significant scientific discoveries were announced in the last year. The Astrophysics Division's critical next steps include continuing the development of the next Astrophysics missions, including the James Webb Space Telescope and the Transiting Exoplanet Survey Satellite (TESS). Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA plans that the Agency's current efforts under Strategic Objective 1.6 will lead to further understanding of the universe and how it works, its history, as well as the continued search for life beyond the solar system. Many of the key challenges for the Astrophysics Division are common across all of the SMD divisions (access to space; technology development; project technical, cost, and schedule challenges; partnerships; and mission support services and infrastructure) and are articulated in the *2014 Science Plan*. Additionally, the James Webb Space Telescope (Webb) is on track, but challenges will remain until launch for Webb to maintain cost and schedule. Launching Webb in 2018 is one of NASA's agency priority goals.

For more information, please see http://science.nasa.gov/astrophysics/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*. Additional information on strategies, challenges, implementation, and program-specific detail is available in the NASA *2014 Science Plan*, as well as the 2013 Astrophysics Roadmap.

FY 2015 Performance Measures

Strategic Objective 1.6: Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars.				
Performance Goal 1.6.1: Launch the James Webb Space Telescope. (Agency Priority Goal)	Performance Goal 1.6.2: Demonstrate progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.	Performance Goal 1.6.3: Demonstrate progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.	Performance Goal 1.6.4: Demonstrate progress in discovering and studying planets around other stars and exploring whether they could harbor life.	Performance Goal 1.6.5: By December 2018, launch at least one mission in support of Strategic Objective 1.6.
Annual Performance Indicators				
• JWST-15-1: Deliver James Webb Space Telescope (Webb) flight backplane to Goddard Space Flight Center.	• AS-15-1: Demonstrate planned progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.	• AS-15-2: Demonstrate planned progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe. • AS-15-3: Complete commissioning flights for the Stratospheric Observatory for Infrared Astronomy (SOFIA) Echelon-Cross-Echelle Spectrograph (EXES) science instrument.	• AS-15-5: Demonstrate planned progress in discovering and studying planets around other stars and exploring whether they could harbor life.	• AS-15-4: Complete the Transiting Exoplanet Survey Satellite (TESS) Mission Confirmation Review.

Summary of Performance for Strategic Objective 1.6

Performance Goal Ratings for Strategic Objective 1.6, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	5	5	--		--
2014	5	5	--		--
2013	4	4	--		--
2012	4	4	--		--

Annual Performance Indicator Ratings for Strategic Objective 1.6, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	6	6	--		--
2014	6	5	1		--
2013	5	5	--		--
2012	5	4	--		1
2011	5	5	--		--
2010	5	4	1		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 1.6.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Launch the James Webb Space Telescope. (Agency Priority Goal)	2.4.2.2 Yellow	2.4.2.2 Green	2.4.2.2 Green	1.6.1 Green	1.6.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: James Webb Space Telescope	**Contributing Program:** James Webb Space Telescope				

FY 2015 Performance Results

NASA is on track to launch the James Webb Space Telescope (Webb) in October 2018. NASA achieved its agency priority goal with the on-schedule delivery of the flight backplane to the Goddard Space Flight Center (GSFC) on August 24, 2015, via a U.S. Air Force C-5C Galaxy airlift.

During FY 2015, the Webb program completed the Pathfinder Telescope (or "Pathfinder"), a non-flight replica of the Webb telescope's backplane, comprising a telescope center section, two mirror segments, and a secondary mirror. The Webb program subsequently completed two successful cryovacuum tests of Pathfinder at the Johnson Space Center. The tests provided important lessons for when the Webb program tests the actual flight telescope and science instruments.

The science instruments have undergone a second cryovacuum test at GSFC. The Webb program found that several hardware elements, including the heat straps and sensor chips for one of the instruments, were not operating optimally, and replaced them after the test. Uncovering issues is precisely the point of hardware testing. The science instruments with updated hardware are now undergoing their third and final cryovacuum test before being mated to the telescope.

The cryocooler for the Mid-Infrared Instrument (MIRI), which experienced difficulties during its development, was delivered to the Jet Propulsion Laboratory during summer 2015 for environmental testing. The flight system is now undergoing acceptance testing and is performing well.

More detailed information on this agency priority goal is included in Part 2.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Deliver James Webb Space Telescope (Webb) flight backplane to Goddard Space Flight Center.	10AS06 Green	JWST 11 1 Green	JWST-12-1 White	JWST 13 1 Green	JWST 14 1 Green	JWST 15 1 Green
Planned Future Performance						
For FY 2016: JWST-16-1: Deliver James Webb Space Telescope (Webb) integrated optical telescope and science instrument module to Goddard Space Flight Center for testing.						
For FY 2017: JWST-17-1: Complete the testing of the James Webb Space Telescope Optical Telescope Element (OTE) plus Integrated Science Instrument Module (ISIM), known as OTIS.						
Contributing Theme: James Webb Space Telescope	**Contributing Program:** James Webb Space Telescope					

Performance Goal 1.6.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.	2.4.1.1 Green	2.4.1.1 Green	2.4.1.1 Green	1.6.2 Green	1.6.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Astrophysics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Astrophysics Subcommittee of the NASA Advisory Council Science Committee determined in July 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015.

Planck Mission Explores the History of the Universe

New data released by Planck, a European Space Agency (ESA) mission in which NASA played a key role, are refining what is known about the universe from precise measurements of the cosmic microwave background radiation. The data enable more precise measurements of matter, including dark matter, and how it is clumped together. A preliminary analysis suggests that the period known as the Dark Ages, which took place before the first stars and other objects ignited, lasted more than 100 million years longer than thought. The Planck data also support the idea that the mysterious force known as dark energy is acting against gravity to push the universe apart at ever-increasing speed. The new Planck catalog contains over 1,500 images of clusters of galaxies, the largest catalog of this type ever made. The Planck team calculated the masses of these clusters by observing how the clusters bend background microwave light. The results refine mass estimates of galaxy clusters, which in turn improve the understanding of dark matter and dark energy.

Hubble and Chandra Find Clues about Dark Matter

Dark matter, which makes up most of the mass of the universe, can be traced indirectly through its gravitational influence on ordinary matter. Clusters of galaxies contain vast quantities of dark matter. Astronomers can measure how it warps space through gravitational lensing, during which the light from a distant source is magnified and distorted by its gravity. In one study, researchers collected data taken with NASA's Hubble Space Telescope and Chandra X-ray Observatory of 72 colliding galaxy clusters. Hubble was used to map the distribution of stars and dark matter after a collision, which was traced through its gravitational lensing effect on background light. Chandra was used to detect the X-ray emission from colliding gas clouds. The study found that dark matter continued straight through the violent collisions without slowing down much, indicating that it interacted much less with other dark matter than previously thought. These results have narrowed down the properties of dark matter. In another study, astronomers using Hubble spotted for the first time a distant supernova split into four images. The multiple images of the exploding star are caused by the powerful gravity of a foreground elliptical galaxy embedded in a massive cluster of galaxies. This unique observation will help astronomers refine their estimates of the mass of dark matter in the elliptical galaxy and cluster of galaxies.

NASA's Telescopes Shed Light on Black Holes

Working together with the ESA's X-ray Multi-Mirror Mission (XMM-Newton) telescope, NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) mission has shown that fierce winds from a supermassive black hole blow outward in all directions, a phenomenon that had been suspected, but difficult to prove until now. This discovery has given astronomers their first opportunity to measure the strength of these ultra-fast winds and prove they are powerful enough to inhibit the host galaxy's ability to make new stars. In the new study, astronomers determined that PDS 456, an extremely bright black hole known as a quasar more than two billion light-years away, sustains winds that carry more energy every second than is emitted by more than a trillion suns. This latest discovery demonstrates a supermassive black hole and its high-speed winds greatly affect the host galaxy. As the black hole bulks up in size, its winds push vast amounts of matter outward through the galaxy, which ultimately stops new stars from forming.

The most luminous known galaxy, reported by the Wide-field Infrared Survey Explorer (WISE) satellite this year to be shining with the light of 300 trillion suns, appears to be lit up from a supermassive black hole gorging itself on gas falling in from the host galaxy. The fact that the light from this galaxy is 12.5 billion years old—about 90 percent of the age of the universe—testifies that supermassive black holes play an integral role in how galaxies form and evolve throughout cosmic history.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.	10AS01 Green	AS 11 1 Green	AS 12 1 Green	AS 13 1 Green	AS 14 1 Green	AS 15 1 Green
Planned Future Performance						
For FY 2016: AS-16-1: Demonstrate planned progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.						
For FY 2017: AS-17-1: Demonstrate planned progress in probing the origin and destiny of the universe, including the nature of black holes, dark energy, dark matter, and gravity.						
Contributing Theme: Astrophysics	**Contributing Program:** Multiple Programs					

Performance Goal 1.6.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.	2.4.2.1 Green	2.4.2.1 Green	2.4.2.1 Green	1.6.3 Green	1.6.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Astrophysics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Astrophysics Subcommittee of the NASA Advisory Council Science Committee determined in July 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015.

Probing the Formation and Evolution of the Earliest Galaxies

NASA's Hubble Space Telescope and Spitzer Space Telescope were used with observations from the W. M. Keck Observatory to set a new galaxy distance record, to a time when the universe was only five percent of its present age of 13.8 billion years, allowing astronomers to view this galaxy as it was when it was only about 100 million years old. Using the magnifying effect of a mammoth cluster of galaxies, astronomers discovered one of the smallest and faintest distant galaxies ever seen, when the universe was only 500 million years old, allowing progress in understanding how and why young spiral galaxies stop making stars, and transition into "red and dead" galaxies composed only of aging stars. Researchers using Hubble and the Chandra X-ray Observatory uncovered young, massive, compact galaxies whose star-making phase is ending early, indicating that galaxy mergers may be able to drive gas to such high densities that intense star formation results. The firestorm of star birth has consumed much of the gaseous fuel needed to make future generations of stars, and the powerful stellar winds of the newly born stars have blown away any remaining fuel.

New Insights on the Origin and Evolution of Planets and Stars

With new capabilities on the Stratospheric Observatory for Infrared Astronomy (SOFIA), astronomers were able to peer into the galactic center and characterize the remnant of a dying star. While it was known that the outward-moving shock wave from supernova can produce significant amounts of dust, SOFIA showed that dust survives the rebound shock wave from interaction with surrounding interstellar gas. As a result, dust is now flowing into the interstellar medium, where it serves as seed material for new stars and planets.

Astronomers used Hubble's sensitivity, resolution, and ultraviolet coverage to obtain an unprecedented image of the center of a massive globular cluster, 47 Tuc. The new image reveals that the remnants of stellar evolution—white dwarfs—are among the brightest stars in the cluster at ultraviolet wavelengths. By mapping the cooling sequence of these remnants, astronomers showed that newly formed stars are still moving in the cluster like their heavier progenitors, whereas cooler stars have gravitationally relaxed to a different spatial distribution, providing the first direct measurement of the diffusion constant due to dynamical evolution.

NASA Rocket Experiment Finds the Universe Brighter than Thought

A NASA Sounding Rocket experiment detected a surprising surplus of infrared light in the dark space between galaxies, a diffuse cosmic glow as bright as all known galaxies combined. The glow is thought to be from orphaned stars flung out of galaxies. The findings redefine what scientists think of as galaxies. Galaxies may not have a set boundary of stars, but instead stretch out to great distances, forming a vast, interconnected sea of stars. The Cosmic Infrared Background ExpeRIment (CIBER) is helping to understand whether the cosmic infrared background light comes from these streams of stripped stars, or from the first galaxies to form in the universe. Bright fluctuations in the infrared background light showed splotches much bigger than individual galaxies, allowing measurements of the total amount of background light. Surprisingly, the maps revealed excesses of light beyond what comes from galaxies. This infrared background light has a blue spectrum, providing evidence that the light comes from previously undetected star populations between galaxies. Light from the first galaxies would give a spectrum of colors that is redder than what was seen.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Demonstrate planned progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.	10AS09 Green	AS 11 3 Green	AS 12 3 Green	AS 13 3 Green	AS 14 3 Green	AS 15 2 Green
Planned Future Performance						
For FY 2016: AS-16-2: Demonstrate planned progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.						
For FY 2017: AS-17-2: Demonstrate planned progress in exploring the origin and evolution of the galaxies, stars, and planets that make up the universe.						
Contributing Theme: Astrophysics	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete commissioning flights for the Stratospheric Observatory for Infrared Astronomy (SOFIA) Echelon-Cross-Echelle Spectrograph (EXES) science instrument.	10AS07 Yellow	AS 11 4 Green	AS 12 4 Green	AS 13 4 Green	AS-14-5 Yellow	AS 15 3 Green
Planned Future Performance						
For FY 2016: AS-16-3: Complete commissioning flights for Stratospheric Observatory for Infrared Astronomy (SOFIA) second-generation instrument suite.						
For FY 2017: AS-17-3: Complete Stratospheric Observatory for Infrared Astronomy (SOFIA) third-generation instrument Critical Design Review (CDR).						
Contributing Theme: Astrophysics	**Contributing Program:** Cosmic Origins					

Performance Goal 1.6.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in discovering and studying planets around other stars and exploring whether they could harbor life.	2.4.3.1 Green	2.4.3.1 Green	2.4.3.1 Green	1.6.4 Green	1.6.4 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Astrophysics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Astrophysics Subcommittee of the NASA Advisory Council Science Committee determined in July 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015.

Data from NASA's missions continue to expand knowledge of the ubiquity and diversity of planetary systems. The Kepler mission is at the forefront of this effort, recently announcing over 500 new planet candidates, bringing the total planet haul to more than 4,000. Over 1,000 of these planet candidates have been confirmed to date by direct dynamical measurements or statistical validation. Beyond simply increasing the number of known planets, Kepler continues to push the boundaries of known exoplanet properties. Transit timing variation measurements have yielded the first mass measurement of a planet smaller than the Earth: Kepler-138b, with a mass of roughly a tenth the mass of Earth. NASA's missions also continue to expand our planet search area. A unique application of the Spitzer Space Telescope has allowed astronomers to pinpoint the location of an exoplanet well outside the local neighborhood of the Sun, thus paving the way for the measurement of the distribution of exoplanets throughout the Milky Way Galaxy.

NASA's missions also continue to revolutionize the understanding of the detailed properties of individual planets. By monitoring the Jupiter-sized transiting planet WASP-43b throughout its 19-hour orbit using the Hubble Space Telescope, astronomers have been able to make a map of the longitudinal variation of the temperature and water vapor abundance of this extreme world. Hubble measurements of the nearby planetary system

GJ 436 have detected an enormous cloud of hydrogen escaping from the warm, Neptune-sized planetary companion, providing direct evidence for evaporation of this planet by the extreme radiation from the parent star.

These discoveries are providing the context needed to prepare for the search for life on other worlds. Kepler's latest catalog includes the first terrestrial-size planets orbiting in the habitable zones of G-type stars, as reported in the November 2015 *Astrophysical Journal*. The revised estimates of the frequency of potentially habitable planets orbiting red dwarfs result in the astonishing conclusion that the closest potentially habitable planet is likely to be within only about 16 light years of the Sun.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Demonstrate planned progress in discovering and studying planets around other stars and exploring whether they could harbor life.	10AS10 Green	AS 11 5 Green	AS 12 5 Green	AS 13 5 Green	AS 14 6 Green	AS 15 5 Green
Planned Future Performance						
For FY 2016: AS-16-5: Demonstrate planned progress in discovering and studying planets around other stars and exploring whether they could harbor life.						
For FY 2017: AS-17-5: Demonstrate planned progress in discovering and studying planets around other stars and exploring whether they could harbor life.						
Contributing Theme: Astrophysics	**Contributing Program:** Multiple Programs					

Performance Goal 1.6.5

	FY 2011	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
By December 2018, launch at least one mission in support of Strategic Objective 1.6.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.6.5 Green	1.6.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Astrophysics	**Contributing Program:** Multiple Programs				

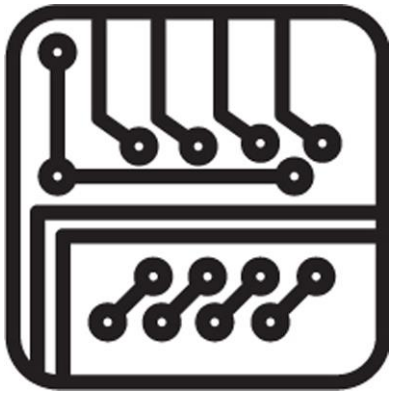
FY 2015 Performance Results

In support Strategic Objective 1.6, NASA has continued work on the Transiting Exoplanet Survey Satellite (TESS), which will use an array of telescopes to perform the first-ever spaceborne all-sky transit survey. TESS will look for exoplanets ranging from Earth-sized to gas giants in orbit around the nearest and brightest stars in the sky. The project's goal is to identify terrestrial planets in the habitable zones of nearby stars. TESS will monitor the brightness of half a million stars, looking for momentary changes in brightness caused when a planet passes, or transits, in front of the star as viewed from Earth. In October 2014, NASA completed the TESS Mission Confirmation Review. Successful completion of the Mission Confirmation Review allows a project to

proceed to its final design phase, which culminates with the Critical Design Review. NASA also completed the TESS Critical Design Review in 2015, allowing the mission to begin final design and fabrication. TESS is on track for launch by 2018.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Complete the Transiting Exoplanet Survey Satellite (TESS) Mission Confirmation Review.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AS 14 7 Green	AS 15 4 Green
Planned Future Performance						
For FY 2016: AS-16-4: Complete the Transiting Exoplanet Survey Satellite (TESS) instrument integration and test (I&T).						
For FY 2017: AS-17-4: Complete the Transiting Exoplanet Survey Satellite (TESS) observatory integration and test (I&T).						
Contributing Theme: Astrophysics	**Contributing Program:** Exoplanet Exploration					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2017.
Planned Future Performance
For FY 2016: AS-16-6: Begin Wide-Field Infrared Survey Telescope (WFIRST) mission formulation.
For FY 2017: AS-17-6: Complete environmental testing of a sample Sensor Chip Assembly to support Wide-Field Infrared Survey Telescope (WFIRST) Wide-Field Instrument technology development.
Contributing Theme: Astrophysics / **Contributing Program:** Exoplanet Exploration



Strategic Objective 1.7

Transform NASA missions and advance the Nation's capabilities by maturing crosscutting and innovative space technologies.

Lead Office

Space Technology Mission Directorate (STMD)

Goal Leader

Prasun Desai, Director for Strategic Integration and Analysis, STMD

Contributing Programs

FY 2015: Crosscutting Space Technology Development, Exploration Technology Development, SBIR and STTR
FY 2016 and FY 2017: SBIR and STTR, Space Technology Research and Development

Budget for Strategic Objective 1.7

Budget Authority (in $ millions)	Actual FY 2015	Enacted FY 2016	Requested FY 2017	Notional FY 2018	Notional FY 2019	Notional FY 2020	Notional FY 2021
Total Budget	$569	—	$792	$669	$683	$697	$710

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Under Strategic Objective 1.7, NASA's Space Technology Mission Directorate (STMD) works to mature crosscutting and innovative space technologies. STMD is making great strides by delivering new technologies and capabilities (for example, completing the first two major demonstration of the Low Density Supersonic Decelerator, advancing the state of the art in high power solar arrays to enable future electric propulsion systems, completing mission infusion review of compression pad technology for Orion Exploration Mission (EM) 1, delivering Robonaut 2 legs and 3D printer hardware to the ISS, and flying PhoneSat missions).

Over the next several years, NASA's critical next steps are to continue exploring early stage concepts, advancing promising new technologies, and maturing transformative solutions for flight demonstration. This approach will include continued emphasis on portfolio balance and lean, rapid technology development. STMD will also continue to emphasize partnerships within and outside the Agency. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA plans that the Agency's current efforts under Strategic Objective 1.7 will lead to advancing technology solutions that address NASA mission challenges and other national needs, as well as the market challenges of providing state-of-the-art commercial space products and services that significantly benefit the commercial space sector. However, STMD foresees several challenges and is pursing risk mitigation strategies for these issues.

- This strategic objective has faced historical funding uncertainty, which creates programmatic planning challenges. STMD strives to remain flexible in an uncertain budget environment.
- STMD pursues high-risk technology development. As is expected in such endeavors, STMD experiences challenges and setbacks. STMD continues to respond to budget constraints; cost, schedule, and performance issues; and other factors with both preventative and corrective actions.
- STMD recognizes the opportunity to further improve the integration of activities and technology transition. To increase the probability of transition, STMD conducts activities such as early stage innovation workshops, is increasing emphasis on SBIR post-Phase II activities, and is investing in tipping point technologies that are particularly promising opportunities for the U.S. commercial space sector.
- Access to space is also a challenge. To demonstrate new technology capabilities in space, STMD relies on rideshare launch capabilities (i.e., as secondary payloads or hosted payloads). Increasing launch costs and limited availability are challenges.

For more information, please see http://www.nasa.gov/directorates/spacetech/home/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 1.7: Transform NASA missions and advance the Nation's capabilities by maturing crosscutting and innovative space technologies.		
Performance Goal 1.7.1: Explore and advance promising early stage solutions to space technology challenges through investment across the U.S. innovation community.	Performance Goal 1.7.2: Advance technologies that offer significant improvement to existing solutions or enable new space science and exploration capabilities.	Performance Goal 1.7.3: Mature new crosscutting space technology capabilities for demonstration.
Annual Performance Indicators		
• ST-15-1: Research, study, or develop concepts for technologies, as documented in 175 technology reports or plans. • ST-15-2: Conduct at least two Centennial Challenges competitions.	• ST-15-3: Complete at least eight feasibility studies, ground demonstrations, or laboratory experiments proving the technical feasibility of new space technologies.	• ST-15-4: Complete four Key Decision Points for small spacecraft projects to demonstrate game changing or crosscutting technologies in space. • ST-15-5: Complete four Key Decision Points for Technology Demonstration Mission (TDM) technology development projects. • ST-15-6: Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least five different commercial reusable suborbital or parabolic platform providers.

Summary of Performance for Strategic Objective 1.7

Performance Goal Ratings for Strategic Objective 1.7, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	3	3	--		--
2014	3	3	--		--
2013	2	2	--		--
2012	2	2	--		--

Annual Performance Indicator Ratings for Strategic Objective 1.7, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	6	5	1		--
2014	5	5	--		--
2013	5	5	--		--
2012	6	6	--		--
2011	5	5	--		--
2010	--		--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 1.7.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Explore and advance promising early stage solutions to space technology challenges through investment across the U.S. innovation community.	3.1.1.1 Green	3.1.1.1 Green	3.1.1.1 Green	1.7.1 Green	1.7.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development				

FY 2015 Performance Results

NASA is on track to meet this multiyear performance goal as the Agency continues to advance early stage innovation. The Space Technology Mission Directorate (STMD) develops the crosscutting new technologies and capabilities needed by the Agency to achieve its current and future missions. NASA made significant progress in the following areas:

Accelerating Development Through Research Grants

NASA STMD accelerates the development of low technology readiness level space technologies to support future space science and exploration needs. Implementation of this approach includes selection of research grants through competitive solicitations for proposals from accredited U.S. universities. Through NASA Space Technology Research Fellowships (NSTRF), Early Career Faculty (ECF) awards, and Early Stage Innovations (ESI) awards, STMD engages a broad spectrum of academic researchers, from graduate researchers to senior faculty members. In FY 2015, NASA:

- Selected the 2015 class of NSTRF fellows;
- Selected eight ECF Space Technology Research Grants;
- Selected 11 ESI Research Grants; and
- Produced 209 NSTRF research training plans and six ECF technology reports.

More information is available on the Space Technology Research Grants website.

Investing in Innovative and Advanced Concepts

NASA invests in concepts with the potential to transform future aerospace missions, enable new capabilities, or significantly alter and improve current approaches. In FY 2015, NASA:

- Made excellent progress on innovative concept studies selected in prior fiscal years;
- Selected 22 new innovative concept studies comprising 15 Phase I projects and 7 Phase II projects; and
- Produced 11 Phase I final reports.

More information is available on the NASA Innovative Advanced Concepts website.

Encouraging Innovation Within NASA's Centers

NASA encourages creativity and innovation within the NASA Centers by supporting low technology readiness level initiatives that leverage Center talent and capability. During FY 2015, NASA:

- Conducted Center Innovation Fund (CIF) projects across all 10 NASA Centers; and
- Produced 10 FY 2014 Center reports, detailing the accomplishments of innovative studies that span NASA's 15 Technology Roadmaps.

More information is available on the CIF website.

Incentivizing Innovation Through Cash Prizes

NASA provides cash prize incentives to non-traditional sources for innovations of interest and value to the Agency and the Nation. As part of Centennial Challenges, NASA:

- Conducted four challenge competitions in FY 2015; and
- Awarded prizes to teams who successfully met competition performance milestones. NASA awarded prizes in each of the four competitions held in FY 2015.

More information is available on the Centennial Challenges website.

Fostering Innovation at Small Businesses

NASA provides opportunities for small, highly innovative companies and research institutions to participate in government-sponsored research and development (R&D) efforts in key technology areas of interest to the NASA mission directorates. The Agency accomplishes this through its Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs. In FY 2015, NASA:

- Selected 332 SBIR Phase I projects, 129 SBIR Phase II projects, 50 STTR Phase I projects, and 21 STTR Phase II projects; and
- Executed 27 Phase II-Enhancement contract options to extend SBIR/STTR R&D in partnership with non-SBIR/STTR funding partners, and selected 17 commercial readiness projects to create direct infusion potential for SBIR/STTR developed technology. The SBIR/STTR Programs continue to promote advancement to and beyond Phase II, working closely with internal and external programs to identify and pursue potential collaborations. SBIR/STTR post-Phase II advancement greatly exceeded expectations in FY 2015, especially given the inherent complexities in aligning willing external partners, appropriate technologies, and the right timing.

More information is available on the SBIR/STTR website.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Research, study, or develop concepts for technologies, as documented in 175 technology reports or plans.	No API this fiscal year	ST 11 1 Green	ST 12 1 Green	ST 13 1 Green	ST 14 1 Green	ST 15 1 Green
Planned Future Performance						
For FY 2016: ST-16-1: Initiate at least 165 activities to research, study, or develop concepts for new technologies.						
For FY 2017: ST-17-1: Initiate at least 165 activities to research, study, or develop concepts for new technologies.						
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Conduct at least two Centennial Challenges competitions.	No API this fiscal year	ST 11 2 Green	ST 12 2 Green	No API this fiscal year	No API this fiscal year	ST 15 2 Green
Planned Future Performance						
For FY 2016: ST-16-2: Conduct at least three Centennial Challenges competitions.						
For FY 2017: ST-17-2: Conduct at least three Centennial Challenges competitions.						
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: ST-16-3: Create seven opportunities for advancement beyond Phase II SBIR/STTR.	
For FY 2017: ST-17-3: Create 10 opportunities for advancement beyond Phase II SBIR/STTR.	
Contributing Theme: Space Technology	**Contributing Program:** SBIR and STTR

Performance Goal 1.7.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Advance technologies that offer significant improvement to existing solutions or enable new space science and exploration capabilities.	3.2.1.1 Green	3.2.1.1 Green	3.2.1.1 Green	1.7.2 Green	1.7.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development				

FY 2015 Performance Results

NASA is on track to meet this multiyear performance goal as the Space Technology Mission Directorate (STMD) continues to deliver improvements to existing capabilities, while also advancing promising new technology solutions.

Improving Existing Capabilities and Advancing Promising New Technology Solutions

In FY 2015, STMD Game Changing Development continued advancement of many promising technology solutions, including completion of feasibility studies, ground demonstrations, and laboratory experiments. These included the following accomplishments:

- Advanced Caution and Warning System (ACAWS) software execution in shadow mode on Orion Exploration Flight Test (EFT)-1;
- Coronagraph focal plane phase mask fabrication and performance characterization tests;
- Development of six full-scale, 3-Dimensional Multifunctional Ablative Thermal Protection System (3DMAT) billets and completion of Orion mission (i.e., Exploration Mission [EM]-1) infusion review;
- Variable Oxygen Regulator (VOR) 3.0 development and delivery to the Advanced Exploration Systems (AES) program for Portable Life Support System (PLSS) integration;
- Radiation commissioning beam experiments;
- Robotic camera inspection system demonstration for the Minimalistic Advanced Soft-Goods Hatch (MASH);
- Arcjet test campaign for Heatshield for Extreme Entry Environment Technology (HEEET); and
- Demonstration of the integration and operation of the Deep Space Optical Communications (DSOC) Flight Laser Transceiver (FLT) in the upgraded test bed.

More information is available on the Game Changing Development website.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete at least eight feasibility studies, ground demonstrations, or laboratory experiments proving the technical feasibility of new space technologies.	No API this fiscal year	ST 11 7 Green	ST 12 7 Green	ST 13 2 Green	ST 14 2 Green	ST 15 3 Green
Planned Future Performance						
For FY 2016: ST-16-4: Complete at least 75 percent of Game Changing Development program milestones, as established at the beginning of the fiscal year.						
For FY 2017: ST-17-4: Complete at least 75 percent of Game Changing Development program milestones, as established at the beginning of the fiscal year.						
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development					

Performance Goal 1.7.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Mature new crosscutting space technology capabilities for demonstration.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	1.7.3 Green	1.7.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development				

FY 2015 Performance Results

NASA is on track to meet this multiyear performance goal as the Agency continues to mature new crosscutting space technology capabilities for demonstration.

Employing the Unique Features of Small Spacecraft

NASA develops and demonstrates new capabilities employing the unique features of small spacecraft for science, exploration, and space operations. As part of this effort, the Space Technology Mission Directorate (STMD) made significant progress on small spacecraft demonstration projects, including completion of major project lifecycle milestones for the Network & Operation Demonstration Satellite (NODES), the Edison Demonstration of Smallsat Networks (EDSN), the Integrated Solar Array and Reflectarray Antenna (ISARA), the Optical Communications and Sensor Demonstration (OCSD), and the Iodine Satellite (iSAT). STMD currently anticipates as many as six small satellite orbital flight demonstrations during FY 2016.

More information is available on the Small Spacecraft Technology website.

Maturing Crosscutting Technologies to Flight-Ready Status

Charged with proving revolutionary, crosscutting technologies—ones that could radically advance NASA's Mission in space and reap untold benefits for science and industry here on Earth—STMD seeks to mature laboratory-proven technologies to flight-ready status. In this area, STMD made significant progress on several Technology Demonstration Mission (TDM) projects in FY 2015:

- Completed the second major demonstration of the Low-Density Supersonic Decelerator (LDSD) in June 2015.
- Completed major project lifecycle milestones for Solar Electric Propulsion (SEP), Composites for Exploration Upper Stage (CEUS), Evolvable Cryogenics (eCryo), and Green Propellant Infusion Mission (GPIM).

More information is available on the Technology Demonstration Missions website.

Providing Flight Opportunities

NASA develops and provides flight opportunities for space technologies to be demonstrated and validated in relevant environments. During FY 2015, STMD flew technology payloads using flight services from four providers: UP Aerospace, Masten Space Systems (Masten), World View, and Near Space.

More information is available on the Flight Opportunities website.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Complete four Key Decision Points for small spacecraft projects to demonstrate game changing or crosscutting technologies in space.	No API this fiscal year	No API this fiscal year	ST 12 9 Green	ST 13 3 Green	ST 14 3 Green	ST 15 4 Green
Planned Future Performance						
For FY 2016: ST-16-5: Complete three major milestones for small spacecraft projects to demonstrate game changing or crosscutting technologies in space.						
For FY 2017: ST-17-5: Complete three major milestones for small spacecraft projects to demonstrate game changing or crosscutting technologies in space.						
Contributing Theme: Space Technology		**Contributing Program:** Crosscutting Space Technology Development				

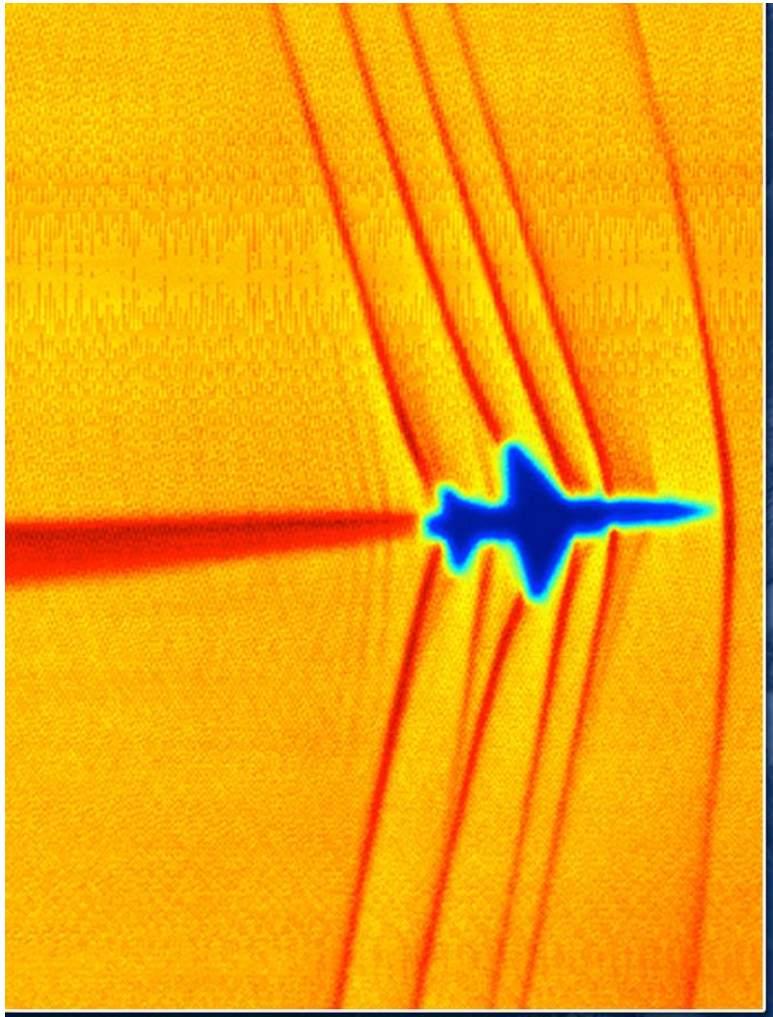
Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete four Key Decision Points for Technology Demonstration Mission (TDM) technology development projects.	No API this fiscal year	ST 11 10 Green	ST 12 10 Green	ST 13 4 Green	ST 14 4 Green	ST 15 5 Green
Planned Future Performance						
For FY 2016: ST-16-6: Complete three major milestones for Technology Demonstration Mission (TDM) technology development projects.						
For FY 2017: ST-17-6: Complete three major milestones for Technology Demonstration Mission (TDM) technology development projects.						
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least five different commercial reusable suborbital or parabolic platform providers.	No API this fiscal year	ST 11 11 Green	ST 12 11 Green	ST 13 5 Green	ST 14 5 Green	ST-15-6 Yellow
Planned Future Performance						
For FY 2016: ST-16-7: Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least five different commercial reusable suborbital or parabolic platform providers.						
For FY 2017: ST-17-7: Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least five different commercial reusable suborbital or parabolic platform providers.						
Contributing Theme: Space Technology	**Contributing Program:** Crosscutting Space Technology Development					

Explanation of Rating

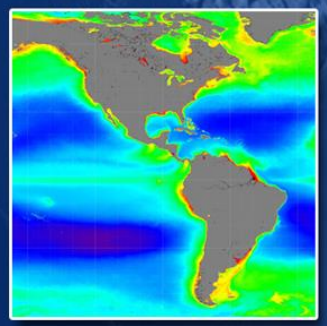
In FY 2015, NASA flew payloads using flight services from four commercial providers (i.e., UP Aerospace, Masten, World View, and Near Space). Two originally planned potential providers on which the Flight Opportunities (FO) program did not fly payloads in FY 2015 were Zero-G and Virgin Galactic. In both cases, the commercial platforms were not available to fly FO payloads in FY 2015.

In April 2015, the FO program selected multiple payloads for future commercial parabolic flights. The FO program anticipates flights in FY 2016, pending Federal Aviation Administration certification of one or more commercial parabolic flight providers (e.g., Zero-G). The FO program currently also anticipates flying technology payloads on Virgin Galactic SpaceShip2 as early as FY 2016. In FY 2016, the FO program will conduct a call to on-ramp new flight providers onto the existing contract. In addition, the FO program released an Announcement of Collaborative Opportunity (ACO) during FY 2015 to further encourage and assist development of commercial platforms. NASA anticipates that these efforts will result in the long-term addition of providers.



Strategic Goal 2

Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.



Strategic Goal 2: Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.			
Strategic Objective 2.1: Enable a revolutionary transformation for safe and sustainable U.S. and global aviation by advancing aeronautics research.	Strategic Objective 2.2: Advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet.	Strategic Objective 2.3: Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit.	Strategic Objective 2.4: Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets.
FY 2015 Performance Goals			
• 2.1.1: Develop solutions that will advance decision-making ability for improving air traffic management to accommodate future growth in air travel, and for increasing aviation safety under hazardous conditions. • 2.1.2: Demonstrate the ability to reduce sonic booms, enabling future industry innovation in commercial supersonic aircraft. • 2.1.3: Advance airframe and engine technologies to enable the development of future generations of ultra efficient aircraft that minimize environmental impact. • 2.1.4: Facilitate significant environmental and efficiency improvements through research on alternative jet fuel use and on hybrid gas-electric propulsion system concepts. • 2.1.5: Significantly increase the ability to anticipate and resolve potential safety issues and to predict the health and robustness of aviation systems. • 2.1.6: Support transformation of civil aircraft operations and air traffic management through the development, application, and validation of advanced autonomy and automation technologies, including addressing critical barriers to future routine access of Unmanned Aircraft Systems (UAS) in the National Airspace System, through the development and maturation of technologies and validation of data.	• 2.2.1: Demonstrate progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition. • 2.2.2: Demonstrate progress in improving the capability to predict weather and extreme weather events. • 2.2.3: Demonstrate progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle. • 2.2.4: Demonstrate progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change. • 2.2.5: Demonstrate progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system. • 2.2.6: Demonstrate progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events. • 2.2.7: Further the use of Earth system science research to inform decisions and provide benefits to society. • 2.2.8: By December 2017, launch at least five missions in support of Strategic Objective 2.2.	• 2.3.1: Implement the five-year Strategic Plan to improve the ability to transfer NASA-developed technologies. • 2.3.2: Implement a process that enables the Agency to define and lead the Agency Grand Challenge.	• 2.4.1: Assure that students participating in NASA higher education projects are representative of the diversity of the Nation. • 2.4.2: Continue to support STEM educators through the delivery of NASA education content and engagement in educator professional development opportunities. • 2.4.4: Continue to provide opportunities for learners to engage in STEM education through NASA-unique content provided to informal education institutions designed to inspire and educate the public. • 2.4.5: Continue to provide opportunities for learners to engage in STEM education engagement activities that capitalize on NASA-unique assets and content.

Summary of Performance for Strategic Goal 2

Summary of Ratings of All Performance Measures for FY 2015 and 2014

Summary of Ratings for Performance Goals and Annual Performance Indicators by Strategic Objective, FY 2015

Lead	Strategic Objective	Performance Goals					Annual Performance Indicators				
		Total	Green	Yellow	Red	White	Total	Green	Yellow	Red	White
ARMD	2.1	6	6	0	0	0	7	6	1	0	0
SMD	2.2	8	8	0	0	0	14	14	0	0	0
OCT	2.3	2	2	0	0	0	2	2	0	0	0
Education	2.4	4	4	0	0	0	4	4	0	0	0
Total		20	20	0	0	0	27	26	1	0	0
Summary			100%	0%	0%	0%		96%	4%	0%	0%

Strategic Objective 2.1

Enable a revolutionary transformation for safe and sustainable U.S. and global aviation by advancing aeronautics research.

Lead Office

Aeronautics Research Mission Directorate (ARMD)

Goal Leader

Mr. Robert A. Pearce, Deputy Associate Administrator for Strategy, ARMD

Contributing Programs

FY 2015: Advanced Air Vehicles, Aeronautics Construction of Facilities (CoF), Airspace Operations and Safety, Integrated Aviation Systems, Transformative Aeronautics Concepts
FY 2016 and FY 2017: Advanced Air Vehicles, Airspace Operations and Safety, Integrated Aviation Systems, Transformative Aeronautics Concepts

Budget for Strategic Objective 2.1

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$651	—	$790	$846	$1,060	$1,173	$1,287

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Under Strategic Objective 2.1, NASA's Aeronautics Research Mission Directorate (ARMD) advances aeronautics research along six Strategic Thrusts, which are research areas guiding ARMD's response to global trends affecting aviation:

- Strategic Thrust 1: Safe, Efficient Growth in Global Operations
- Strategic Thrust 2: Innovation in Commercial Supersonic Aircraft

- Strategic Thrust 3: Ultra-Efficient Commercial Vehicles
- Strategic Thrust 4: Transition to Low-Carbon Propulsion
- Strategic Thrust 5: Real-Time System-Wide Safety Assurance
- Strategic Thrust 6: Assured Autonomy for Aviation Transformation

This strategic direction is relatively new (ARMD released their *Strategic Implementation Plan* in 2015), and the 2015 NASA Strategic Review found that ARMD's progress towards the strategic portfolio and direction is on track during the limited implementation period. External reports have been positive regarding the portfolio of programs and new strategic direction. In addition, ARMD began implementing a series of new and improved processes and structures. Over the next several years, NASA's critical next steps are to continue contributing to the six new Strategic Thrusts through the completion of the Technical Challenges in partnership with the aviation community.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. There are no known significant events or issues that would prevent ARMD from achieving the strategic objective. For more information, please see http://www.aeronautics.nasa.gov/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 2.1: Enable a revolutionary transformation for safe and sustainable U.S. and global aviation by advancing aeronautics research.					
Performance Goal 2.1.1: Develop solutions that will advance decision-making ability for improving air traffic management to accommodate future growth in air travel, and for increasing aviation safety under hazardous conditions.	Performance Goal 2.1.2: Demonstrate the ability to reduce sonic booms, enabling future industry innovation in commercial supersonic aircraft.	Performance Goal 2.1.3: Advance airframe and engine technologies to enable the development of future generations of ultra efficient aircraft that minimize environmental impact.	Performance Goal 2.1.4: Facilitate significant environmental and efficiency improvements through research on alternative jet fuel use and on hybrid gas-electric propulsion system concepts.	Performance Goal 2.1.5: Significantly increase the ability to anticipate and resolve potential safety issues and to predict the health and robustness of aviation systems.	Performance Goal 2.1.6: Support transformation of civil aircraft operations and air traffic management through the development, application, and validation of advanced autonomy and automation technologies, including addressing critical barriers to future routine access of Unmanned Aircraft Systems (UAS) in the National Airspace System, through the development and maturation of technologies and validation of data.
Annual Performance Indicators					
• AR-15-1: Demonstrate the Concept of Operations for an integrated set of aircraft arrival technologies (ATD-1) that will provide for efficient performance during congested operations at busy airports.	• AR-15-2: Develop full-vehicle analysis and optimization tools for multi-point low-boom supersonic aircraft design.	• AR-15-3: Develop and analyze vehicle concepts with the appropriate technology suite to simultaneously meet fuel burn, community noise, and Landing and Take-off Nitrogen Oxides subsonic transport goals by the 2020-2025 timeframe.	• AR-15-4: Characterize gaseous and particulate cruise emissions of biofuel-blended jet fuels and effects of fuel sulfur during flight at cruise conditions.	• AR-15-5: Demonstrate that aircraft engine diagnostic systems that rely on advanced sensors can detect faults and hazards between maintenance inspections.	• AR-15-6: Implement Automatic Dependent Surveillance-Broadcast Out (ADS-B Out) capability on select flight test support aircraft to enable the testing of operational design solutions that enable safe, efficient growth in global operations. • AR-15-7: Deliver data, analysis, and recommendations based on integrated simulations and flight tests to the RTCA Special Committee on Minimum Operational Performance Standards (MOPS) for Unmanned Aircraft Systems to support preliminary MOPS development.

Summary of Performance for Strategic Objective 2.1

Performance Goal Ratings for Strategic Objective 2.1, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	6	6	--		--
2014	6	6	--		--
2013	4	4	--		--
2012	4	4	--		--

Annual Performance Indicator Ratings for Strategic Objective 2.1, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	7	6	1		--
2014	6	6	--		--
2013	4	4	--		--
2012	5	5	--		--
2011	3	3	--		--
2010	3	2	1		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 2.1.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Develop solutions that will advance decision-making ability for improving air traffic management to accommodate future growth in air travel, and for increasing aviation safety under hazardous conditions.	4.1.2.1 Green	4.1.2.1 Green	4.1.2.1 Green	2.1.1 Green	2.1.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Aeronautics	**Contributing Program:** Airspace Operations and Safety				

FY 2015 Performance Results
During FY 2015, NASA contributed specific research and technology to enable the continued development of the Next Generation Air Transportation System (NextGen) and beyond, and addressed current and future safety risks.

Two NASA-developed software tools moved from concept to reality during FY 2015. One of these tools, Terminal Sequencing and Spacing (previously called TSS, now TSAS), will help air traffic controllers manage airspace within a doughnut-shaped region of sky that begins five miles from a major airport and extends outward about 35 miles. This new technology will allow pilots to better use flight deck automation to fly fuel-efficient, optimized profile descents, which streamlines glide paths toward the runway, reducing fuel use and approach noise to an airport. TSAS safely permits more flights to merge together at a point where they can be cleared for final approach and landing. The Federal Aviation Administration (FAA) and NASA completed an operational integration assessment of the tool in May 2015 at the FAA's William J. Hughes Technical Center. The FAA received a final investment decision for the program, meaning the agency intends to deploy the capability in the National Airspace System beginning with nine major airports between 2018 and 2022.

The other tool, Airborne Spacing for Terminal Arrival Routes (ASTAR), is designed to give pilots specific speed information and guidance so that planes can be more precisely spaced, enabling pilots to fly a "follow the leader" approach to their destination airport. This type of approach would minimize flight path deviations, allow more efficient use of existing airspace, and possibly reduce noise over communities surrounding airports—all of which could lead to reductions in commercial flight delays. The software was tested on the Boeing ecoDemonstrator 787 test airplane as part of the Boeing Company's ecoDemonstrator program. During the flight tests, a NASA engineer operated ASTAR on a laptop in the rear of the aircraft. As a second aircraft flew in front of the ecoDemonstrator 787, ASTAR computed and displayed the speed required to follow safely behind. The engineer then communicated those speed commands to the ecoDemonstrator 787 pilots. This demonstration is part of the lead up to flight trial for the Air Traffic Management Technology Demonstration #1 (ATD-1), expected in 2017.

Also during FY 2015, NASA continued its research in the phenomena of ice crystal icing conditions at high altitude. Current weather radar can detect rain or hail, but is limited in its ability to discern which types and smaller sizes of ice crystals are in the atmosphere, which can lead to pilots encountering some challenging flying conditions. That's because when ice crystals hit warm aircraft engines, they start to melt and evaporate, cooling the engine core surfaces to temperatures below freezing. The cooling engine causes the melted ice crystal water to refreeze, and ice accumulates inside the engine core. Ice in this location may cause temporary power loss or engine blade damage. During the month of August, NASA's DC-8 completed flights in Florida aimed

at collecting data on high-altitude crystals for the High Ice Water Content (HIWC) mission. The campaign collected almost 72 hours of in-flight meteorological and radar data associated with adverse weather and thunderstorms. The goal for this NASA-led research campaign was to record both instrumented weather and standard radar data as the plane flew in known HIWC conditions, and then see if, by comparing the data, a potential HIWC radar signature could be identified. Researchers will use the data to develop technology that can be used onboard commercial aircraft to avoid high ice water content conditions and provide a safer flight for passengers.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate the Concept of Operations for an integrated set of aircraft arrival technologies (ATD-1) that will provide for efficient performance during congested operations at busy airports.	10AT06 Green	AR 11 4 Green	AR 12 6 Green	No API this fiscal year	AR 14 4 Green	AR 15 1 Green
Planned Future Performance						
For FY 2016: AR-16-1: Develop an integrated Concept of Operations (ConOps) to reduce take-off time variability, thereby decreasing delays, aircraft wait time, and fuel usage, and conduct a simulation to demonstrate technologies that support the integrated ConOps.						
For FY 2017: AR-17-1: Conduct Shadow Mode assessment of departure metering prototypes in the field.						
Contributing Theme: Aeronautics	**Contributing Program:** Airspace Operations and Safety					

Performance Goal 2.1.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate the ability to reduce sonic booms, enabling future industry innovation in commercial supersonic aircraft.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	2.1.2 Green	2.1.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Aeronautics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA's Commercial Supersonic Technology Project, part of the Advanced Air Vehicles Program, completed in FY 2015 a set of performance milestones that represent the culmination of more than six years of work by a multi-Center NASA team, which was supported by U.S. partners in industry and academia. The work delivered new computational tools and design approaches that have created a breakthrough capability to design supersonic aircraft adept at flying overland without creating annoying sonic boom noise.

These tools can fully simulate the supersonic flow around an aircraft, including details of the flow and the sonic boom shock wave that are affected by the engine inlet and nozzle. The analysis tools were validated through wind tunnel testing in a variety of facilities. The design approaches that were developed

are capable of producing robust designs with low sonic boom noise, not only directly below the aircraft but over the full "carpet" of area exposed off to the sides of the aircraft flight track. The design tools also can take into account changing atmospheric conditions, such as winds, temperatures, and humidity, in creating robust designs that achieve sonic boom loudness at perceived decibel levels (PldB) at or below the goal level of 80 PldB—which is 25 PldB or more below current military aircraft, or what was generated by the now-retired Concorde supersonic airliner. The tools and design approaches have been transferred to NASA's U.S. industry partners and have been applied in the successful conceptual design of small supersonic civil airliners and a subscale low boom X-plane that could be used to demonstrate the acceptability of low boom supersonic flight over land.

In support of this ongoing development of commercial supersonic technology, NASA continued its efforts related to another challenging environmental problem for commercial supersonic vehicles—propulsion noise generated while the vehicle is at the airport. In FY 2015, NASA developed models of the types of advanced nozzles that will be needed for a small, low boom aircraft. These models will be used to predict the noise generated by the propulsion system. Future testing will validate the accuracy of these models. Additionally, these efforts are complemented by the selection of industry and university research studies to further address sonic boom propagation, nozzle noise, and high-altitude emissions from supersonic jets.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Develop full-vehicle analysis and optimization tools for multi-point low-boom supersonic aircraft design.	10AT09 Green	AR 11 8 Green	AR 12 10 Green	AR 13 5 Green	AR 14 12 Green	AR 15 2 Green
Planned Future Performance						
For FY 2016: AR-16-2: Complete Low Boom Flight Demonstration (LBFD) Concept Refinement Studies.						
For FY 2017: AR-17-2: Complete Low-Boom Flight Demonstrator (LBFD) Preliminary Design Review (PDR).						
Contributing Theme: Aeronautics	**Contributing Program:** Advanced Air Vehicles					

Performance Goal 2.1.3

	FY 2011	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Advance airframe and engine technologies to enable the development of future generations of ultra efficient aircraft that minimize environmental impact.	4.1.3.1 Green	4.1.3.1 Green	4.1.3.1 Green	2.1.3 Green	2.1.3 Green
Planned Future Performance					
For FY 2016 and 2017: 2.1.3: Advance airframe and engine technologies to enable the development of future generations of ultra efficient air vehicles that minimize environmental impact.					
Contributing Theme: Aeronautics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA's long research heritage in advancing airframe and engine technologies was marked in FY 2015 as the Agency celebrated the 100th anniversary of the establishment of the National Advisory Committee for Aeronautics, the organization from which NASA was created in 1958. Many of the technological advances realized during the past fiscal year can trace their origins to the original lessons learned about aviation during the past century.

The most visible achievements by NASA's aeronautical innovators were evident during FY 2015 in the Environmentally Responsible Aviation project, which concluded its final year having successfully completed eight Integrated Technology Demonstrations that support a NASA goal to enable industry to build advanced, ultra-efficient commercial vehicles. For airplanes flying in the 2020-2025 timeframe, NASA research is aimed at cutting fuel use in half, reducing emissions up to 75 percent during take-off and landing, and quieting aircraft noise 42 decibels below current standards.

Two of these demonstrations took place this year aboard Boeing's ecoDemonstrator 757 flying laboratory. The first studied how small jets embedded in an aircraft's vertical tail and blowing air over its surfaces could provide enough force to safely allow smaller tails on future aircraft designs. Doing so would save weight, reduce drag, and drop fuel usage up to 0.5 percent—a small number that quickly adds up to big savings. The active flow control technology was tested during six flights in a variety of configurations and flight conditions, including simulated engine failures, and appeared to work as expected, duplicating the results of wind tunnel tests conducted in 2013.

The second demonstration studied how well special coatings worked to prevent sticky bug residue from building up on the leading edge of an airplane wing and increasing drag. Fewer remains would smooth airflow and help reduce fuel consumption. NASA and Boeing engineers made 15 flights into bug-filled skies near Shreveport Regional Airport testing non-stick wing coatings. Although more testing needs to be done, one of the five coatings tested showed promising results, reducing bug counts and residue by about 40 percent.

In FY 2015, NASA completed testing of an advanced, hybrid wing body aircraft configuration that has significant potential to be more efficient in flight—dramatically reducing needed fuel. The configuration also included mounted engines located on top of the vehicle, rather than below the wing, as done presently. This testing was completed in the National Transonic Wind Tunnel at NASA Langley Research Center in Virginia and was done in partnership with the both another government agency and an airframe manufacturer.

Working toward ultra-efficient vehicles also requires the advancement of technologies to address other environmental factors, such as noise. In the area of vertical lift (rotorcraft) vehicles, in FY 2015, NASA conducted flight tests using a pair of helicopters to validate a computer-based model known as the FRAME, which predicts when and where rotorcraft noise might become a problem as the vehicle flies in different conditions and altitudes. FRAME is short for Fundamental Rotorcraft Acoustic Modeling for Experiments, and works by bringing together researchers' basic understanding of the physics of rotorcraft noise and existing noise data from flight tests and wind tunnel measurements. Results of the flight testing have enabled the validation of this prediction tool, which in turn will enable on-board tools and techniques to allow helicopter pilots to "fly neighborly" in real time—meaning that pilots will be able to adjust their flight profiles based on readily-available information on how the noise signature is hitting the ground.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Develop and analyze vehicle concepts with the appropriate technology suite to simultaneously meet fuel burn, community noise, and Landing and Take-off Nitrogen Oxides subsonic transport goals by the 2020-2025 timeframe.	10AT12 Yellow	AR 11 10 Green	AR 12 12 Green	AR 13 6 Green	AR 14 7 Green	AR 15 3 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Aeronautics	**Contributing Program:** Integrated Aviation Systems					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Does not trend until FY 2016.	10AT07 Green	AR 11 6 Green	AR 12 8 Green	AR 13 4 Green	AR 14 5 Green	None
Planned Future Performance						
For FY 2016: AR-16-3: Quantify the drag reduction benefit of boundary layer ingestion for a representative aircraft configuration.						
For FY 2017: AR-17-3: Design, fabricate, and test an engine inlet-fan configuration that withstands the flow distortions arising from boundary layer ingestion and demonstrates vehicle-level fuel-burn benefit through minimal impact on fan performance and stability.						
Contributing Theme: Aeronautics	**Contributing Program:** Advanced Air Vehicles					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Does not trend until FY 2016.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AR-14-9 Yellow	None
Planned Future Performance						
For FY 2016: AR-16-4: Complete Phase I activities and create a plan for Phase II to enable the project to reduce the timeline for development and certification of advanced composite structures.						
For FY 2017: AR-17-4: Successfully complete Phase-2 Authority to Proceed (ATP) Review (i.e., Key Decision Point-D [KDP-D]), mature the down-selected tools and methodologies according to Phase-2 KDP success criteria, and fabricate key element or component-level validation test articles.						
Contributing Theme: Aeronautics	**Contributing Program:** Advanced Air Vehicles					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: AR-17-6: Complete Preliminary Design Review (PDR) of an efficient, hybrid laminar flow, ultra-high bypass engine nacelle.	
Contributing Theme: Aeronautics	**Contributing Program:** Integrated Aviation Systems

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: AR-17-7: Demonstrate advanced high-temperature engine materials for high-pressure turbine components, enabling reduced cooling and thereby lower engine fuel burn.	
Contributing Theme: Aeronautics	**Contributing Program:** Transformative Aeronautics Concepts

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: AR-17-8: Demonstrate a two-speed drive system that achieves a reduction in helicopter rotor revolutions per minute (RPM).	
Contributing Theme: Aeronautics	**Contributing Program:** Advanced Air Vehicles

Performance Goal 2.1.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Facilitate significant environmental and efficiency improvements through research on alternative jet fuel use and on hybrid gas-electric propulsion system concepts.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	2.1.4 Green	2.1.4 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Aeronautics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

During FY 2015, NASA continued its investigations into the use of alternative fuels for commercial jet airliners, as well as the reduction of petroleum-based fuels by turning to hybrid gas-electric powered engines.

The Agency kicked off the calendar year at a public forum in Florida in which NASA shared results from the previous spring's second round of Alternative Fuel Effects on Contrails and Cruise Emissions (ACCESS II) research flights. Forum attendees included many of the 24 member nations that make up the International Forum for Aviation Research, or IFAR. Several IFAR members partnered with NASA for the ACCESS II research. It was the first time NASA was able to brief IFAR members since project researchers announced initial results the previous September. The ACCESS II campaign used NASA's DC-8, burning biofuel and Jet-A, and aircraft from partner nations, Germany and Canada, to fly sampling missions. Ground sampling of emissions from an idling DC-8 also was done. Data from this ACCESS II test, as well as from predecessor tests, are now publicly available at https://aero-fp.larc.nasa.gov.

At the end of the fiscal year NASA collaborated with the German Aerospace Center (DLR), by supplying several key measurement instruments for the DLR's Emissions and Climate Impacts of Alternative Fuels (ECLIF) experiments. NASA's role in the highly successful field campaign was to design and install an exhaust sampling system and provide detailed particle emission characterization measurements for the ground tests, the results of which will be used to help interpret the airborne observations and validate a model to predict cruise emission from engine certification measurements. Under this activity, NASA instruments were placed about 100 feet (30 meters) behind a parked DLR Airbus 320. These instruments then measured the exhaust from the jet as it burned eight different types of standard and alternative fuels that contained varying amounts of aromatic compounds and sulfur impurities. Emissions covering a total of about nine hours of ground-based jet engine operations were sampled, and data were recorded and analyzed as part of NASA's contribution to the German-led effort. Data analysis is just getting underway, but preliminary results are consistent with those from ACCESS II and indicate that fuels with reduced aromatic and sulfur content produce lower particle emissions. ECLIF data will help confirm and supplement information gathered during NASA's own research with the Alternative Aviation Fuel Experiment (AAFEX) activities in 2009 and 2011, and then during the ACCESS flight research campaigns in 2013 and 2014.

During FY 2015, NASA conducted research in hybrid gas-electric propulsion system concepts that could enable very-low or nearly no carbon emission propulsion. Detailed design began for the first fully superconducting machine (both rotor and stator are superconducting) at power levels of interest to aircraft. This 0.75 megawatt machine is based on a heritage Air Force rotor and NASA-designed stator. Additionally, feasibility was established for achieving substantially high efficiencies and power densities in non-superconducting motors. These machines, while not superconducting, hold potential for hybrid gas-electric aircraft without the need for cryogenics.

NASA completed laying the foundation for two new testbed capabilities. The first, located at the Armstrong Flight Research Center, is designed to investigate the power and control design and integration challenges associated with a one megawatt hybrid electric vehicle. The second, located at the Glenn Research Center, is designed to provide capability to test mega-watt class electric drive systems.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Characterize gaseous and particulate cruise emissions of biofuel-blended jet fuels and effects of fuel sulfur during flight at cruise conditions.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AR 14 13 Green	AR 15 4 Green
Planned Future Performance						
For FY 2016: AR-16-5: Develop a detailed conceptual design of a hybrid gas-electric propulsion system for a B737-class aircraft and assess its overall vehicle-level benefits in terms of noise, emissions, and energy consumption.						
For FY 2017: AR-17-5: Design and fabricate a megawatt-class fully superconducting electric machine with advanced stator design and demonstrate its capability for at least 750 kilowatt rated power.						
Contributing Theme: Aeronautics	**Contributing Program:** Advanced Air Vehicles					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: AR-16-6: Establish a process for originating, proposing, and selecting feasibility assessment research activities for the Convergent Aeronautics Solutions (CAS) Project.
For FY 2017: No API this fiscal year
Contributing Theme: Aeronautics — **Contributing Program:** Transformative Aeronautics Concepts

Performance Goal 2.1.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Significantly increase the ability to anticipate and resolve potential safety issues and to predict the health and robustness of aviation systems.	4.1.1.1 Green	4.1.1.1 Green	4.1.1.1 Green	2.1.5 Green	2.1.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Aeronautics — **Contributing Program:** Multiple Programs					

FY 2015 Performance Results

Safety is the highest priority in aviation, so the quest for reducing risk in the air is never ending. Today's technology and tomorrow's innovations demand constant attention to ensuring safety with every flight, no matter what conditions present themselves in the sky.

An example of NASA's devotion to anticipating and resolving potential safety issues dealt with the presence of volcanic ash in the atmosphere and its effects on engine health. Conducted during FY 2015, the final of a three-phase Vehicle Integrated Propulsion Research (VIPR) project chose to use volcanic ash for its studies of an engine health monitoring system. Atmospheric particulates have become of interest to military and civil aviation authorities that have to assess the airworthiness of engines that have encountered the ash. Eruptions in Iceland during the past five years, especially in 2010, disrupted air traffic worldwide and cost airline companies more than $1 billion due to cancelled or rerouted flights. The new health monitoring sensors are designed to detect the degradation caused by the volcanic ash, quantify the significance of the event, and aid in identifying which engine components might require maintenance. To reduce risk, testing was conducted on the ground under controlled conditions. The VIPR project began in 2011 with a baseline test to lay the groundwork for more complex experiments. The engine detected simulated faults, including an oil leak. A second test in early 2013 verified that sensors could detect actuator faults over a range of operating conditions.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate that aircraft engine diagnostic systems that rely on advanced sensors can detect faults and hazards between maintenance inspections.	No API this fiscal year	No API this fiscal year	AR 12 1 Green	No API this fiscal year	AR 14 1 Green	AR 15 5 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Aeronautics	**Contributing Program:** Transformative Aeronautics Concepts					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: AR-16-7: Mature the safety risk assessment tools to validate and demonstrate safety metrics for real-time system-wide safety assurance.	
For FY 2017: No API this fiscal year	
Contributing Theme: Aeronautics	**Contributing Program:** Airspace Operations and Safety

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: AR-17-10: Develop technologies and training processes that mitigate the problems and contributing factors that lead to flight crew loss of airplane state awareness.	
Contributing Theme: Aeronautics	**Contributing Program:** Airspace Operations and Safety

Performance Goal 2.1.6

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Support transformation of civil aircraft operations and air traffic management through the development, application, and validation of advanced autonomy and automation technologies, including addressing critical barriers to future routine access of Unmanned Aircraft Systems (UAS) in the National Airspace System, through the development and maturation of technologies and validation of data.	4.2.1.1 Green	4.2.1.1 Green	4.2.1.1 Green	2.1.6 Green	2.1.6 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Aeronautics	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

Ever-increasing levels of automation and autonomy are transforming aviation. Safe integration of Unmanned Aircraft Systems (UAS)—colloquially known as drones—into the National Airspace System (NAS) requires research in multiple areas, including communications, human-machine interfaces, sense-and-avoid, and separation assurance. NASA's aeronautical innovators addressed each of these areas during FY 2015.

Public attention to UAS and their growing presence in the NAS stimulated widespread interest in a conference co-hosted by NASA and held during July in California. The three-day UAS Traffic Management (UTM) convention brought together a domestic and international audience of representatives from government and academia, as well as the aviation, agriculture, film, and other industries. Through discussions held at this conference, and with others, NASA is working to develop a well-coordinated plan for incorporating UTM operations into the NAS that will inform regulatory actions taken in the future by the Federal Aviation Administration. In late August 2015, NASA's UTM project successfully completed its Build 1 Demonstration flight test. Objectives included demonstration of UTM capabilities and procedures, navigation performance, and aircraft tracking. Data were collected on noise signatures and observations for weather models. Analysis of the results will help design future UTM flight tests.

During May 2015, the Radio Technical Commission for Aeronautics—Special Committee 228 (RTCA-SC228) held working group meetings in Washington, DC, at which NASA's UAS Integration in the NAS project representatives participated. The special committee is responsible for developing Minimum Operational Performance Standards (MOPS) for flying UAS in the NAS. NASA researchers provided input, including data, analysis, and recommendations based on integrated flight tests involving both simulated and live vehicles traversing airspace and interacting with other aircraft. Section areas briefed for the committee's report included guidance, alerting, human-machine interface, aircraft performance, terminology, system-specific performance requirements, and equipment test procedures. This information was incorporated into the preliminary MOPS, which were approved by the RTCA Program Management Council in FY 2015.

UAS activity for FY 2015 wrapped up with the successful demonstration of a prototype Detect-and-Avoid (DAA) system using NASA's remotely piloted Ikhana aircraft. Ikhana made 11 flights over the California high desert, involving more than 200 scripted encounters with approaching aircraft. Depending on the specific scenario, either Ikhana detected one or more approaching aircraft and sent an alert to its remote pilot to take action, or Ikhana itself took action on its own by flying a programmed maneuver to avoid a collision—an aviation first. The DAA research was designated FT3, the third in a series of

flight test campaigns for NASA's UAS Integration in the NAS project. The DAA system tested relied on three sensors that included a prototype radar, an Automatic Dependent Surveillance-Broadcast (ADS-B), and a second generation Traffic alert and Collision Avoidance System (TCAS). ADS-B is a satellite-based navigation tool in which an aircraft determines its position and then broadcasts that information, enabling other nearby airplanes equipped with the same tool to know where everyone is at in the sky. And as its name implies, TCAS keeps an electronic eye on the sky immediately surrounding an airplane. Should another airplane with a similar device fly too close, an alert will prompt the pilot to take action. Knowledge gleaned from the data recorded during this third phase of UAS-NAS flight tests not only will help researchers plan the next phase of flight tests targeted for FY 2016, but also will help inform organizations developing UAS-related operating standards, including the RTCA-SC228.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Implement Automatic Dependent Surveillance-Broadcast Out (ADS-B Out) capability on select flight test support aircraft to enable the testing of operational design solutions that enable safe, efficient growth in global operations.	No API this fiscal year	No API this fiscal year	No API this fiscal year	AR 13 9 Green	No API this fiscal year	AR-15-6 Yellow
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Aeronautics	**Contributing Program:** Integrated Aviation Systems					

Explanation of Rating

To meet its annual performance indicator, by the end of FY 2015, NASA needed to install Automatic Dependent Surveillance-Broadcast Out (ADS-B Out) capability in four aircraft at the Armstrong Flight Research Center (AFRC), including two Beechcraft B200 Super King Air aircraft, or B200s; one Raytheon Aircraft Company's T-34C training plane, or T-34; and one civil-transport class aircraft (i.e., a Grumman Gulfstream II [G-II] or its replacement). The ADS-B Out units also needed to be operational to meet the project flight test schedule, and capable of meeting airspace requirements to fly in the National Airspace System.

NASA completed the installation of ADS-B Out units on the T-34 and both B-200 aircraft at AFRC. NASA also installed an ADS-B Out unit on a B200 at the Langley Research Center. All units are operational. However, procurement of the G-II replacement aircraft took longer than anticipated. AFRC took possession of the aircraft in October 2015. To minimize the potential for further delay, funding was allocated to the on-site aircraft maintenance contractor to install an operational ADS-B Out capability. The aircraft is projected to be fully activated with ADS-B Out by March 31, 2016. This will meet current operational requirements, as the first need for the aircraft with ADS-B Out is scheduled for April 2016.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Deliver data, analysis, and recommendations based on integrated simulations and flight tests to the RTCA Special Committee on Minimum Operational Performance Standards (MOPS) for Unmanned Aircraft Systems to support preliminary MOPS development.	No API this fiscal year	No API this fiscal year	AR 12 13 Green	AR 13 7 Green	AR 14 8 Green	AR 15 7 Green
Planned Future Performance						
For FY 2016: AR-16-8: Deliver data, analysis, and recommendations based on integrated simulation and flight test series with simulated traffic or live vehicles to the RTCA Special Committee on Minimum Operational Performance Standards (MOPS) for Unmanned Aircraft Systems to support development of the final MOPS.						
For FY 2017: No API this fiscal year						
Contributing Theme: Aeronautics	**Contributing Program:** Integrated Aviation Systems					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: AR-16-9: Complete Unmanned Aircraft Systems Traffic Management initial prototype to enable safe and efficient low altitude airspace operations and conduct initial tests.	
For FY 2017: AR-17-9: Deliver the second build of an Unmanned Aerial System Traffic Management (UTM) prototype, enabling increased density and contingency management.	
Contributing Theme: Aeronautics	**Contributing Program:** Airspace Operations and Safety

Strategic Objective 2.2

Advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet.

Lead Office

Earth Science Division, Science Mission Directorate (SMD)

Goal Leader

Dr. Michael Freilich, Director, Earth Science Division

Contributing Programs

Earth Science Research, Earth Systematic Missions, Earth System Science Pathfinder, Earth Science Multi-Mission Operations, Earth Science Technology, Applied Sciences

Budget for Strategic Objective 2.2

Budget Authority (in $ millions)	Actual FY 2015	Enacted FY 2016	Requested FY 2017	Notional FY 2018	Notional FY 2019	Notional FY 2020	Notional FY 2021
Total Budget	$1,784	—	$2,032	$1,990	$2,001	$2,021	$2,048

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has determined that performance toward this strategic objective is making noteworthy progress.

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. NASA's Strategic Objective 2.2 is pursued by the Science Mission Directorate (SMD) Earth Science Division, which seeks to develop a scientific understanding of Earth's system and its response to natural or human-induced changes, and to improve prediction of climate, weather, and natural hazards. NASA's 2015 Strategic Review found that the Earth Science flight program is making great progress

towards Strategic Objective 2.2. For example, NASA recently achieved a significant accomplishment by launching five Earth observing missions in one calendar year, including two that use the International Space Station as a platform. In addition, significant scientific contributions were noted by the 2014 external expert review. NASA's critical next steps include continuing the development of several missions, such as the Stratospheric Aerosol and Gas Experiment (SAGE) III (which will utilize the International Space Station as a platform), Ice, Cloud, and land Elevation Satellite (ICESat)-2, Gravity Recovery and Climate Experiment Follow-On (GRACE-FO), and the Cyclone Global Navigation Satellite System (CYGNSS). Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA plans that the Agency's current efforts under Strategic Objective 2.2 will lead to further understanding of Earth as a system to meet the challenges of environmental change, as well as continued improvement of life on Earth. Many of the key challenges for the Earth Science Division are common across all of the SMD divisions—access to space; technology development; project technical, cost, and schedule challenges; partnerships; and mission support services and infrastructure—and are articulated in the *2014 Science Plan*. NASA is also facing the challenge of continuing to advance Earth system science (including research endeavors, observational capabilities, and data systems) while simultaneously addressing increasing demands to provide sustained climate observations—all within a constrained budget. The Earth Science Division is pursuing several opportunities to mitigate or address challenges, such as international partnerships, developing new and innovative ways of making Earth observations via the Earth Venture solicitations, utilizing the International Space Station as a platform for observations, and continuing to make technology investments through the Earth Science Technology Program.

For more information, please see http://science.nasa.gov/earth-science/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*. Additional information on strategies, challenges, implementation, and program-specific detail is available in the NASA *2014 Science Plan*.

FY 2015 Performance Measures

Strategic Objective 2.2: Advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet.							
Performance Goal 2.2.1: Demonstrate progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.	Performance Goal 2.2.2: Demonstrate progress in improving the capability to predict weather and extreme weather events.	Performance Goal 2.2.3: Demonstrate progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle.	Performance Goal 2.2.4: Demonstrate progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.	Performance Goal 2.2.5: Demonstrate progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.	Performance Goal 2.2.6: Demonstrate progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.	Performance Goal 2.2.7: Further the use of Earth system science research to inform decisions and provide benefits to society.	Performance Goal 2.2.8: By December 2017, launch at least five missions in support of Strategic Objective 2.2.
Annual Performance Indicators							
• ES-15-1: Demonstrate planned progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.	• ES-15-2: Demonstrate planned progress in improving the capability to predict weather and extreme weather events.	• ES-15-3: Demonstrate planned progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle.	• ES-15-4: Demonstrate planned progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change. • ES-15-5: Complete Aquarius mission success criteria.	• ES-15-7: Demonstrate planned progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.	• ES-15-8: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.	• ES-15-10: Maintain a high level of customer satisfaction, as measured by exceeding the most recently available Federal government average rating of the American Customer Satisfaction Index. • ES-15-9: Advance at least 25 percent of decision-support projects one Applications Readiness Level.	• ES-15-11: Complete the Cyclone Global Navigation Satellite System (CYGNSS) Critical Design Review (CDR). • ES-15-12: Launch the Soil Moisture Active Passive (SMAP) mission. • ES-15-13: Complete the Ice, Cloud, and Land Elevation Satellite (ICESat)-2 Spacecraft Readiness for Integration Review. • ES-15-14: Complete the Surface Water and Ocean Topography (SWOT) mission Ka-band Radar Interferometer (KaRIn) antenna Preliminary Design Review (PDR). • ES-15-15: Complete the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) mission Critical Design Review (CDR).

Summary of Performance for Strategic Objective 2.2

Performance Goal Ratings for Strategic Objective 2.2, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	8	8	--		--
2014	8	8	--		--
2013	7	7	--		--
2012	7	7	--		--

Annual Performance Indicator Ratings for Strategic Objective 2.2, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	14	14	--		--
2014	12	11	1		--
2013	11	10	1		--
2012	10	9	1		--
2011	10	8	2		--
2010	10	9	1		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 2.2.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.	2.1.1.1 Green	2.1.1.1 Green	2.1.1.1 Green	2.2.1 Green	2.2.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Earth Science Subcommittee of the NASA Advisory Council Science Committee determined in August 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015. These and other advances are documented in publications posted to the Earth Science Division Publications (ESDPubs) website.

Researchers made significant advances in understanding how emissions affect Earth's atmosphere, including the following:

- A Chemistry-Climate-Model study found that the inter-hemispheric gradient and the global trend provide useful information for quantitatively constraining carbon tetrachloride emissions and lifetime estimates. Carbon tetrachloride, an ozone-depleting substance, was once used in a number of commercial products before it was regulated in 1987 under the Montreal Protocol.
- A study reported that emissions of hydrofluorocarbons from developed countries are consistent with atmospheric measurements, and almost half of global emissions now originate from non-reporting countries.
- Researchers found that satellite data analysis challenges previous views of stratospheric water vapor trends and calls into question previous estimates of surface radiative forcing based on presumed global long-term increases in water vapor concentrations in the lower stratosphere. With the use of Micro-Pulse Lidar Network (MPLNET) observations, researchers were able to reinterpret previous studies focused on the stratospheric impact of the Nabro and Sarychev volcanic aerosol plume transports, as determined from Optical Spectrograph and Infrared Imaging System (OSIRIS) data.

Recently published scientific results highlighted how the use of satellite-derived data, when combined with ground-based and in-situ observations, improves model estimates of ozone and its precursors in the United States and abroad. Domestically, scientific results from the Earth Venture Suborbital program investigation DISCOVER-AQ (Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality) have found that, for the Baltimore-Washington metropolitan area, emissions of nitric oxide and nitrogen dioxide from mobile sources are overestimated by at least 50 percent in the National Emissions Inventory. Internationally, Indian and southeast Asian emissions of ozone pollution exported to the northwestern Pacific were found to be comparable to Chinese emissions in winter, to approximately 50 percent of Chinese emissions in spring and fall, and to 20 percent of Chinese emissions in summer.

A recent study made use of combined ground-based, in-situ and satellite observations to find that, from 1990 to 2007, there has been an increase in tropospheric ozone over southern Africa. Another study reported a decrease in the spatial distribution of tropospheric carbon monoxide, using observations from the Measurements Of Pollution In The Troposphere (MOPITT) instrument and in-situ measurements from 2002 to 2011.

A 2015 study used observations during the 2008 Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) campaign to account for negative biases in Goddard Earth Observing System (GEOS)-Chem simulations. The researchers went on to assimilate Aura Tropospheric Emission Spectrometer (TES) observations into their study and improved the predictive skill of the models as validated against ARCTAS observations. Provocative findings regarding the role of biomass burning emissions and severe weather in the U.S. were put forth by scientists who posited that biomass burning emissions transported from Central America provided an environment to enhance the development of tornados in the U.S. Additionally, findings from two studies this year better constrained the transport and deposition of Saharan dust to the Amazon Basin, using satellite Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) data.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.	10ES01 Green	ES 11 1 Green	ES 12 1 Green	ES 13 1 Green	ES 14 1 Green	ES 15 1 Green
Planned Future Performance						
For FY 2016: ES-16-1: Demonstrate planned progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.						
For FY 2017: ES-17-1: Demonstrate planned progress in advancing the understanding of changes in Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition.						
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs					

Performance Goal 2.2.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in improving the capability to predict weather and extreme weather events.	2.1.2.1 Green	2.1.2.1 Green	2.1.2.1 Green	2.2.2 Green	2.2.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Earth Science Subcommittee of the NASA Advisory Council Science Committee determined in August 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. During FY 2015, NASA continued its investment in weather and extreme events research, using data obtained from a variety of satellite platforms, including the Geostationary Operational Environmental Satellites (GOES), Tropical Rainfall Measuring Mission (TRMM), Global Precipitation Measurement (GPM), Aqua, Terra, Suomi National Polar-orbiting Partnership (NPP), CloudSat, and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO). It also completed a hurricane field experiment and a field experiment focusing on three-dimensional wind measurement technologies. Below are examples of the scientific progress reported in FY 2015.

NASA's Short-term Prediction Research and Transition (SPoRT) program continued to make significant progress in transitioning weather research products to the operational community. SPoRT collaborated with National Oceanic and Atmospheric Administration (NOAA) to assess a snowfall rate product that includes data from the Suomi-NPP Advanced Technology Microwave Sounder instrument. The product uses information in microwave channels to estimate liquid-equivalent snowfall rates, which can then be used by forecasters to identify the areas of the heaviest snowfall during winter weather events, like the historic January 2015 Northeast blizzard.

In an effort to give special emphasis to developing countries that may have limited access to traditional supercomputing facilities, Amazon Elastic Compute Cloud (EC2) resources were used in an Infrastructure as a Service capacity (where processing, storage, networks, and other services are provided to the customer over the Internet) to provide regional weather simulations. Weather Research and Forecasting (WRF) model simulations provided a reasonable depiction of sensible weather elements and precipitation when compared against typical validation data available over Central America and the Caribbean.

A recent study developed a prototype online extreme-precipitation monitoring system, using data from the TRMM Multi-satellite Precipitation Analysis (TMPA) near-real-time precipitation product. The system provides additional rarity information for ongoing precipitation events based on local climatology, which can be used by the general public and decision makers for various hazard-management applications.

Researchers also used TMPA data in the re-forecasting of the July 2012 extreme rainfall event in Beijing, China. Using rain gauge networks as a benchmark, the researchers investigated the detectability and predictability of the extreme rainfall event in Beijing via the Global Hydrological Prediction System forced by the NASA near-real-time TMPA data, and the deterministic and ensemble precipitation forecast products from the NOAA Global Forecast System. TMPA was also used to characterize the distribution and frequency of landslide events worldwide.

Researchers have already used the first year of GPM mission data to classify the global behavior of precipitation features. The study asserted that while extreme precipitation systems are rare, they contribute significantly to the global precipitation and their impacts should be included in global climate models to correctly describe the global water cycle.

Additionally, NASA conducted two Polar Winds Airborne Campaigns to test the NASA-developed wind lidar instruments and to support the European Space Agency's Atmospheric Dynamics Mission Aeolus (ADM-Aeolus) satellite. Scheduled to launch in March 2016, ADM-Aeolus will be the first Earth-orbiting wind-profiling lidar. The global wind measurements are likely to greatly improve Numerical Weather Prediction and severe weather warnings.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Demonstrate planned progress in improving the capability to predict weather and extreme weather events.	10ES04 Green	ES 11 5 Green	ES 12 4 Green	ES 13 3 Green	ES 14 3 Green	ES 15 2 Green
Planned Future Performance						
For FY 2016: ES-16-2: Demonstrate planned progress in improving the capability to predict weather and extreme weather events.						
For FY 2017: ES-17-2: Demonstrate planned progress in improving the capability to predict weather and extreme weather events.						
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: ES-17-6: Achieve the Cyclone Global Navigation Satellite System (CYGNSS) mission success criteria.	
Contributing Theme: Earth Science	**Contributing Program:** Earth System Science Pathfinder

Performance Goal 2.2.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle.	2.1.3.1 Green	2.1.3.1 Green	2.1.3.1 Green	2.2.3 Green	2.2.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Earth Science Subcommittee of the NASA Advisory Council Science Committee determined in August 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015.

NASA continued its investment in the science of the Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE). As permafrost melts, organic material trapped inside thaws and decays, releasing methane (a greenhouse gas) into the atmosphere. Researchers reported that Alaska emitted less than two percent of the total global methane flux during the 2012 growing season, despite widespread permafrost thaw and other evidence of climate change in the region.

Data from the Impacts of Climate on the Ecosystems and Chemistry of the Arctic Pacific Environment (ICESCAPE) field campaign have confirmed that sea ice morphology in the Chukchi Sea has undergone a regime shift over a decadal time scale, transitioning from a multiyear thick sea ice pack to thinner, first year-dominated seasonal sea ice pack. The first comprehensive analysis of the subsurface chlorophyll maximum (which is a key ecological response to environmental changes) in the area revealed a shallower subsurface chlorophyll maximum than the surrounding Canada Basin.

Ground and aircraft measurements showed that the seasonal magnitude of carbon dioxide concentrations increased by as much as 50 percent over the past 50 years. Scientists reported that up to one-quarter of these observed changes are due to a 240 percent increase in Northern Hemisphere extra-tropical crop production between 1961 and 2008.

Using satellite-remote sensing products, researchers found that vegetation cover was more important than weather in controlling the severity of fires in central Idaho and western Montana forests. Additionally, a study showed that between 1991 and 2010, 13 percent of the forests in western Oregon were disturbed by harvests, fires, pests, and pathogens. Scientists also found that, because of differences in forest type and plant community structure, boreal forests in North America were more vulnerable to high intensity crown fires than those in Eurasia.

Investigators analyzed the relationship between the progress of accumulated springtime temperatures and satellite observations of landscape greenness across the U.S. Great Plains during 2002-2012. Results revealed that urban intensity, as measured by the proportion of impervious surface area, influences the seasonal progression of landscape greenness differently depending on regional climate. Also in the area of urban growth, the Po Plain Experiment (POPLEX) is a research project on mega-urban changes and associated impacts on the local environment. Innovative data processing and use of Quick Scatterometer (QuikSCAT) satellite data allowed scientists to successfully develop a spatially and temporally consistent dataset delineating urban extension.

In the past year, the Carbon Monitoring System (CMS) science team meeting was preceded by a day-long symposium of studies in which end users and researchers developed research agendas, providing decision makers with insight into state and regional terrestrial biomass estimates, as well as Indonesian, Mexican, and African carbon dynamics. Accomplishments include globally gridded land use and land cover projections to 2100 using remote sensing alongside land use allocations from a socio-economic model. A high-resolution methane and carbon dioxide flux inventory was completed for the northeast U.S. corridor.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Demonstrate planned progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle.	10ES07 Green	ES 11 7 Green	ES 12 6 Green	ES 13 5 Green	ES 14 6 Green	ES 15 3 Green
Planned Future Performance						
For FY 2016: ES-16-3: Demonstrate planned progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle.						
For FY 2017: ES-17-3: Demonstrate planned progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle.						
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: ES-17-12: Achieve the Orbiting Carbon Observatory (OCO)-2 mission success criteria.	
Contributing Theme: Earth Science	**Contributing Program:** Earth System Science Pathfinder

Performance Goal 2.2.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.	2.1.4.1 Green	2.1.4.1 Green	2.1.4.1 Green	2.2.4 Green	2.2.4 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Earth Science Subcommittee of the NASA Advisory Council Science Committee determined in August 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015.

This year, the first two global assessments ever fully informed by observations were published. The first quantifies water cycle fluxes and storages using observations from several NASA satellites and a framework that incorporates uncertainties, generally resulting in less than 10 percent observed residuals for the annual water budget. The second study similarly balances the energy budget, yielding an implied residual heat flux into the oceans consistent with recent observations. The Goddard Modeling and Assimilation Office is using the resulting budget information to validate their seven kilometer Goddard Earth Observing System Model, Version 5 (GEOS-5) nature run and Modern-Era Retrospective analysis for Research and Applications (MERRA)-2. Other researchers have used the data to investigate energy transport across the equator and its role in the climate system.

NASA's Land Data Assimilation System (LDAS) and Land Information System (LIS) tools continue to improve; LIS has been upgraded to assimilate remotely-sensed soil moisture from the Soil Moisture Active Passive (SMAP) mission and terrestrial water storage from the Gravity Recovery and Climate Experiment (GRACE). Upgrades also enabled improved model forcing with increased spatial resolution, the expansion of the LDAS domain to all of North America, and the reduction of data lag to near zero. Tutorials on the software were held to transition the software into National Centers for Environmental Prediction operations. A National Climate Assessment version of LDAS has also been created as an end-to-end enabling tool for sustained evaluation and dissemination of terrestrial hydrologic variables.

A study examined the creation of a North American river width database containing over 240,000 kilometers of rivers wider than 30 meters. NASA investigators argue that North American river surface area is underestimated by 20 percent, which could greatly affect estimates of river discharge and carbon fluxes from rivers to the atmosphere. The team is working on a similar global river width database that will be used by the Surface Water Ocean Topography (SWOT) algorithm developers. Another study detailed a method to estimate water depth in flooded forests and applied it to the Congo Basin. This new approach offers a method to calibrate and validate multiple aspects of two-dimensional hydrodynamic modeling. It can be applied to other regions and should serve as a useful pre-launch virtual mission study for SWOT.

The Airborne Snow Observatory (ASO) has continued operations and added new watersheds to its observed areas. Preliminary results demonstrate a capability to assess snow water content and inform melt rate modeling sufficient to provide strong correlations between predicted runoff and

observations. Recently, ASO was added to the suite of instruments for the Global Precipitation Measurement (GPM) mission's upcoming Olympic Mountain Experiment (Olympex) validation campaign.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Demonstrate planned progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.	10ES09 Green	ES 11 9 Green	ES 12 8 Green	ES 13 7 Green	ES 14 7 Green	ES 15 4 Green
Planned Future Performance						
For FY 2016: ES-16-4: Demonstrate planned progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.						
For FY 2017: ES-17-4: Demonstrate planned progress in enabling better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change.						
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete Aquarius mission success criteria.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ES 15 5 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Earth Science	**Contributing Program:** Earth System Science Pathfinder					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: ES-16-6: Achieve Soil Moisture Active Passive (SMAP) mission success criteria.
For FY 2017: No API this fiscal year
Contributing Theme: Earth Science / **Contributing Program:** Earth Systematic Missions

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: ES-17-17: Achieve the Global Precipitation Measurement (GPM) mission success criteria.	
Contributing Theme: Earth Science	**Contributing Program:** Earth Systematic Missions

Performance Goal 2.2.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.	2.1.5.1 Green	2.1.5.1 Green	2.1.5.1 Green	2.2.5 Green	2.2.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Earth Science Subcommittee of the NASA Advisory Council Science Committee determined in August 2015 that NASA remained on track in its annual performance towards the achievement of this performance goal. NASA is researching the physical oceanography, cryospheric sciences, and global modeling aspects of climate variability. Examples of scientific progress during FY 2015 cited by the Earth Science Subcommittee include new results arising from ongoing satellite observations and integrative Earth system modeling. Below are further examples of the scientific progress reported in FY 2015.

A study of sea level rise using Jason-2 altimetry, the Gravity Recovery and Climate Experiment (GRACE), and the Argo array of more than 3,000 free-drifting floats concluded that the deep ocean has not warmed enough to account for the hiatus in air temperature over the past decade, and thus the added heat is stored in the upper layers of the ocean. Another study found that the partitioning of northern and southern hemispheric simulated sea surface height changes from climate models are consistent with precise altimeter observations, but inconsistent with in-situ estimates of ocean heat content between 1970 and 2004.

Satellite data during the past year reinforced the long-term downward trend in the extent of Arctic sea ice. The September 2014 seasonal minimum extent was the sixth lowest on record, but more significantly, the seasonal maximum extent was achieved 15 days earlier than the long-term average, and was the lowest in the satellite record. Around Antarctica, sea ice reached a record high extent in September 2014, exceeding 20 million square kilometers for the first time in the satellite record.

The picture of the Greenland Ice Sheet continued to develop, with more information than ever about its surface and the bedrock beneath it. Researchers compiled aircraft and satellite laser altimetry measurements from 1993-2012 to reconstruct records of ice thickness change at 100,000 sites in Greenland. They also constructed a comprehensive deep radiostratigraphy of the Greenland Ice Sheet from airborne ice-penetrating radar data collected between 1993 and 2013.

To further NASA's ability to evaluate the design and impact of new observations in models, a very high-resolution "nature run" was completed and will become a central component of Observing System Simulation Experiments. The nature run used real data on atmospheric conditions, greenhouse gas emissions, and simulations of winds, clouds, water vapor, and airborne particles, as well as other factors, to model the natural behavior of the Earth's atmosphere. In addition, development of the Goddard Institute for Space Studies (GISS) ModelE Earth System Model/General Circulation Model continued this year, with implementation of gravity waves associated with model convection and increased vertical resolution, which resulted for the first time in the generation of a realistic stratospheric quasi-biennial oscillation by the model. Additionally, the convective parameterization was found to substantially improve the model representation of the Madden-Julian oscillation, which is the largest element of short-term variability in the tropical atmosphere.

A study of climate forcing demonstrated that irrigation constitutes a small but significant source of anthropogenic climate forcing, which tends to have a cooling effect. In addition, a Modeling, Analysis, and Prediction (MAP)-funded study showed that snow darkening causes substantial regional climate forcing, suggesting that higher-resolution climate models will need to include such effects to correctly represent regional variations in climate.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Demonstrate planned progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.	10ES11 Green	ES 11 11 Green	ES 12 10 Green	ES 13 9 Green	ES 14 9 Green	ES 15 7 Green
Planned Future Performance						
For FY 2016: ES-16-7: Demonstrate planned progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.						
For FY 2017: ES-17-7: Demonstrate planned progress in improving the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land, and ice in the climate system.						
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: ES-17-5: Produce three consistent indicators of critical Earth system parameters based on data from NASA research satellites (either on their own or in conjunction with non-NASA satellites) to help document long-term Earth system evolution. Indicators will cover time scales appropriate for climate variability and change studies.	
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs

Performance Goal 2.2.6

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Demonstrate progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.	2.1.6.1 Green	2.1.6.1 Green	2.1.6.1 Green	2.2.6 Green	2.2.6 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

The Earth Science Subcommittee of the NASA Advisory Council Science Committee determined in August 2015 that NASA remained on track in its annual performance toward the achievement of this performance goal. Below are examples of the scientific progress reported in FY 2015:

The Advanced Rapid Imaging and Analysis (ARIA) Center for Natural Hazards and the Real-time Earthquake Analysis for Disaster (READI) Mitigation Network Working Group led research responses to significant solid-Earth events in the past year. Following the August 2014 magnitude 6.0 South Napa Earthquake, NASA-derived Synthetic Aperture Radar data products were widely used to identify and measure fault slip and assess if the mainshock (i.e., the strongest earthquake in the sequence) damaged nearby levees and infrastructure. NASA also helped coordinate the research response to the April 2015 magnitude 7.8 Gorkha Earthquake in Nepal, particularly in the retrieval of Global Positioning System (GPS) data in the region. These data are instrumental for determining the extent and time evolution of the rupture, as well as for monitoring aftershocks and postseismic deformation.

Using a simulation of moment magnitude 7.0 earthquake in California, and real data from the moment magnitude 9.0 Tohoku-oki earthquake, NASA researchers demonstrated that earthquake early warning could be achieved through crowdsourcing with common consumer devices, such as smartphones.

Research provided a number of results in volcanic processes. Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) and satellite Interferometric Synthetic Aperture Radar (InSAR) imagery from the Laguna del Maule caldera in Chile shows that the broader volcanic complex inflated by

15-20 centimeters per year between 2013 and 2014. Two volcanoes erupted during the final set of 2015 UAVSAR flights to Central and South America. Analysis and computer modeling is underway with UAVSAR, satellite InSAR, and available GPS data at a number of actively deforming Latin American volcanoes. This research will enable improved understanding of volcanic processes and mechanisms of the associated hazards.

Two studies in California combined SAR, GPS, seismic, and other data to help researchers better understand interactions between hydraulic systems and solid-Earth deformation. The first analyzed satellite InSAR data for the Santa Clara Valley, characterizing the surface deformation caused by ground water storage variations between 1992 and 2011. The study shows that after a period of calibration, InSAR can be used to characterize basin-wide water level changes without well measurements with an accuracy of 70 percent, providing useful data for groundwater management. The second study found a region within the Central Valley subsiding at a rate of roughly 10 centimeters per year due to excessive groundwater pumping during drought conditions. Snow and surface water are of primary importance in the hydrologic cycle of California, and these new techniques are today being applied to their mapping and monitoring.

NASA investigators used data from the Gravity Recovery and Climate Experiment (GRACE) satellite mission to measure and model the large coseismic and postseismic gravity changes after the 2012 Indian Ocean earthquake sequence, showing that GRACE data are suitable for analyzing strike-slip earthquakes as small as moment magnitude 8.2 given the noise characteristics of this region. Researchers also used numerical simulations of earthquake fault systems and the Virtual California model to estimate gravity changes. Computed gravity changes are near the detection threshold for GRACE.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.	10ES13 Green	ES 11 15 Green	ES 12 14 Green	ES 13 11 Green	ES 14 11 Green	ES 15 8 Green
Planned Future Performance						
For FY 2016: ES-16-8: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.						
For FY 2017: ES-17-8: Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events.						
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs					

Performance Goal 2.2.7

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Further the use of Earth system science research to inform decisions and provide benefits to society.	2.1.7.1 Green	2.1.7.1 Green	2.1.7.1 Green	2.2.7 Green	2.2.7 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA's Applied Sciences Program enables innovative and practical uses of Earth observations by businesses, governments, and nonprofits to inform their decisions and actions. The enhanced decision-making made possible by the program's projects improves quality of life and strengthens the economy. Following are some examples from FY 2015:

- The California Department of Water Resources and other state and federal agencies applied Landsat, Terra, and Aqua satellite observations to create monthly maps of fallowed, or idle, areas in the Central Valley. This allowed them to gauge changes in idle agricultural land and provide analysis needed to support state allocation of drought emergency funds.
- The Texas Commission for Environmental Quality applied Visible Infrared Imaging Radiometer Suite (VIIRS) and Moderate Resolution Imaging Spectroradiometer (MODIS) data with air quality models to develop an exceptional event (e.g., wildfire, dust storm) case for the U.S. Environmental Protection Agency.
- The Nature Conservancy applied NASA MODIS and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data to identify wetlands for a reverse auction to increase habitat along the Pacific flyway for migrating wild birds.
- The U.S. Forest Service integrated Suomi National Polar-orbiting Partnership (NPP) satellite data for enhanced fire detection and progression predictions, improving abilities to determine fire boundaries and advance ecosystem restoration.

In addition, NASA used the vantage point of space to support the response to numerous national and international disasters. Some examples:

- NASA supported the response to May flooding in Texas and surrounding areas, including information from the Global Precipitation Measurement (GPM) satellite and flood models to characterize the extent of the event and to aid decisions on closures of navigational rivers in Oklahoma and Arkansas.
- NASA data from Earth Observing (EO)-1, MODIS, the Aura Ozone Monitoring Instrument (OMI), and the Atmospheric Infrared Sounder (AIRS) guided the air traffic control response to the eruption of Alaska's Mount Pavlof, which is along major airplane routes.
- NASA supported the international response to the Gorkha earthquake in Nepal, providing information products on damage proxy maps, landslides, deformation models, and vulnerability maps derived from satellite data.

NASA's Applied Sciences Program continues to extend the benefits of Earth science observations to inform decision-making. Of its 69 current decision-support projects, the Applied Sciences Program advanced 45 projects, or 65 percent, at least one application readiness level, or ARL—an index used to track the maturity level of projects, from basic research through development, transition, and operational deployment. The higher ARLs achieved by the

project teams indicate that they are advancing the transfer and adoption of use of the observations into the decision-making processes of the user organizations.

The Applied Sciences Program also engaged the applications community to expand knowledge about NASA's Earth Science missions and in planning for upcoming satellites: the NASA–Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR), Surface Water Ocean Topography (SWOT), and Cyclone Global Navigation Satellite System (CYGNSS) missions held their first applications workshops; the Pre-Aerosol, Clouds, and ocean Ecosystem (PACE) mission held an applications town hall forum; the GPM mission held its first applications workshop since its launch; the Gravity Recovery and Climate Experiment (GRACE) mission delivered an applications plan; and the Soil Moisture Active Passive (SMAP) and Ice, Cloud, and Land Elevation Satellite (ICESat)-2 missions expanded their numbers of Early Adopters to apply the data and information.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Maintain a high level of customer satisfaction, as measured by exceeding the most recently available Federal government average rating of the American Customer Satisfaction Index.	10ES16 Green	ES 11 18 Green	ES 12 17 Green	ES 13 14 Green	ES 14 14 Green	ES 15 10 Green
Planned Future Performance						
For FY 2016: ES-16-10: Maintain a high level of customer satisfaction, as measured by exceeding the most recently available Federal government average rating of the American Customer Satisfaction Index.						
For FY 2017: ES-17-10: Maintain high level of customer satisfaction, as measured by exceeding the most recently available Federal government average rating of the American Customer Satisfaction Index.						
Contributing Theme: Earth Science	**Contributing Program:** Earth Science Multi-Mission Operations					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Advance at least 25 percent of decision-support projects one Applications Readiness Level.	10ES14 Green	ES 11 16 Green	ES 12 15 Green	ES 13 12 Green	ES 14 12 Green	ES 15 9 Green
Planned Future Performance						
For FY 2016: ES-16-9: Advance at least 40 percent of Earth science applications projects one Applications Readiness Level.						
For FY 2017: ES-17-9: Advance at least 40 percent of Earth science applications projects one Applications Readiness Level.						
Contributing Theme: Earth Science	**Contributing Program:** Applied Sciences					

Performance Goal 2.2.8

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
By December 2017, launch at least five missions in support of Strategic Objective 2.2.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	2.2.8 Green	2.2.8 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Earth Science	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

In FY 2015, NASA remained on target to achieve this performance goal by launching a mission that supports Strategic Objective 2.2.

NASA launched the Soil Moisture Active Passive (SMAP) mission in January 2015. The launch of the SMAP mission adds to the two missions launched in FY 2014 in support of this strategic objective: the NASA–Japanese Aerospace Exploration Agency (JAXA) Global Precipitation Measurement (GPM) mission and the Orbiting Carbon Observatory (OCO)-2.

In addition, NASA is on schedule with its plans to launch two more missions that will support this performance goal:

- The Cyclone Global Navigation Satellite System (CYGNSS) mission, scheduled for launch in FY 2016, will make frequent and accurate measurements of ocean surface winds throughout the life cycle of tropical storms and hurricanes, with the goal of improving hurricane forecasting. In January 2015, NASA completed the Critical Design Review (CDR) for CYGNSS, allowing the mission to begin final design and fabrication.
- The Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) mission, scheduled for launch in FY 2017, is a partnership between NASA and the German Research Centre for Geosciences. It will measure variations in gravity over Earth's surface, producing a new map of the gravity field every 30 days. In February 2015, NASA completed the CDR for the GRACE-FO mission.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Cyclone Global Navigation Satellite System (CYGNSS) Critical Design Review (CDR).	No API this fiscal year	No API this fiscal year	No API this fiscal year	ES 13 2 Green	ES 14 5 Green	ES 15 11 Green
Planned Future Performance						
For FY 2016: ES-16-11: Complete Cyclone Global Navigation Satellite System (CYGNSS/EV-2) Unit 1 thermal vacuum test.						
For FY 2017: ES-17-11: Launch Cyclone Global Navigation Satellite System (CYGNSS).						
Contributing Theme: Earth Science	**Contributing Program:** Earth System Science Pathfinder					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Launch the Soil Moisture Active Passive (SMAP) mission.	10ES10 Yellow	ES-11-10 Yellow	ES 12 9 Green	ES 13 8 Green	ES 14 8 Green	ES 15 12 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Earth Science	**Contributing Program:** Earth Systematic Missions					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Ice, Cloud, and Land Elevation Satellite (ICESat)-2 Spacecraft Readiness for Integration Review.	10ES12 Green	ES-11-14 Yellow	ES-12-13 Yellow	ES-13-10 Yellow	ES-14-10 Yellow	ES 15 13 Green
Planned Future Performance						
For FY 2016: ES-16-13: Complete Ice, Cloud, and Land Elevation Satellite (ICESat)-2 Mission Operations Center (MOC) final release.						
For FY 2017: ES-17-13: Complete Ice, Cloud, and Land Elevation Satellite (ICESat)-2 Pre-Ship Review (PSR).						
Contributing Theme: Earth Science	**Contributing Program:** Earth Systematic Missions					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Surface Water and Ocean Topography (SWOT) mission Ka-band Radar Interferometer (KaRIn) antenna Preliminary Design Review (PDR).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ES 15 14 Green
Planned Future Performance						
For FY 2016: ES-16-14: Complete the Surface Water and Ocean Topography (SWOT) mission Preliminary Design Review (PDR).						
For FY 2017: ES-17-14: Complete the Surface Water and Ocean Topography (SWOT) mission Critical Design Review (CDR).						
Contributing Theme: Earth Science	**Contributing Program:** Earth Systematic Missions					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) mission Critical Design Review (CDR).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ES 14 18 Green	ES 15 15 Green
Planned Future Performance						
For FY 2016: ES-16-15: Complete the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) mission instrument deliveries to integration and test (I&T).						
For FY 2017: ES-17-15: Complete the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) mission Pre-Ship Review (PSR).						
Contributing Theme: Earth Science	**Contributing Program:** Earth Systematic Missions					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: ES-16-16: Complete NASA-Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR) High Capacity Data Storage Subsystem Preliminary Design Review (PDR).
For FY 2017: ES-17-16: Complete NASA-Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR) L-Band SAR Instrument Critical Design Review (CDR).
Contributing Theme: Earth Science | **Contributing Program:** Earth Systematic Missions

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: ES-16-18: Complete Earth Venture Instrument (EVI)-3 selections.
For FY 2017: ES-17-18: Release Earth Venture Instrument (EVI)-4 Announcement of Opportunity.
Contributing Theme: Earth Science | **Contributing Program:** Earth System Science Pathfinder

Annual Performance Indicator
For FY 2015: Does not trend until FY 2017.
Planned Future Performance
For FY 2016: ES-16-19: Complete the Landsat 9 Mission Definition Review (MDR).
For FY 2017: ES-17-19: Complete the Landsat 9 Thermal Infrared Sensor (TIRS)-2 instrument Critical Design Review.
Contributing Theme: Earth Science | **Contributing Program:** Earth Systematic Missions

Strategic Objective 2.3

Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit.

Lead Office

Office of the Chief Technologist (OCT)

Goal Leader

Jim Adams, Deputy Chief Technologist, OCT

Contributing Programs

FY 2015: Partnership Development and Strategic Integration
FY 2016 and FY 2017: Agency Technology and Innovation

Budget for Strategic Objective 2.3

Budget Authority (in $ millions)	Actual FY 2015	Enacted FY 2016	Requested FY 2017	Notional FY 2018	Notional FY 2019	Notional FY 2020	Notional FY 2021
Total Budget	$31	—	$34	$35	$36	$36	$37

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Under Strategic Objective 2.3, NASA's Office of the Chief Technologist (OCT) provides the strategy and leadership that guide NASA's technology development and open innovation activities. OCT accomplished a number of Federal Government "firsts" this year, including the public release of TechPort and the release of an updated version of NASA's software catalog. Additionally, OCT launched NASASolve and the Asteroid Data Hunter Challenge greatly exceeded expectations.

Over the next several years, NASA's critical next steps are to complete an independent review of the *2015 NASA Technology Roadmaps*, finalize the updated NASA Strategic Technology Investment Plan (STIP), and develop and implement a new initiative to track infusion of NASA-developed technology into NASA missions and ground activities. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. In 10 years, NASA plans that the Agency's current efforts under Strategic Objective 2.3 will lead to the optimization of the Agency's technology portfolio (by aligning technology investments across organizations and minimizing duplication), Open Innovation will thrive within NASA, and the transfer of technologies to U.S. companies will be maximized. NASA is working to improve the transfer of technology to external users, which requires the resources and workforce to implement.

For more information, please see http://www.nasa.gov/offices/oct/home/index.html. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 2.3: Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit.	
Performance Goal 2.3.1: Implement the five-year Strategic Plan to improve the ability to transfer NASA-developed technologies.	Performance Goal 2.3.2: Implement a process that enables the Agency to define and lead the Agency Grand Challenge.
Annual Performance Indicators	
• ST-15-7: Each Center will engage with at least one university business school for technology marketing assessments and encouragement of technology application.	• ST-15-8: Establish at least two new "open innovation" mechanisms that leverage external support for the Asteroid Grand Challenge.

Summary of Performance for Strategic Objective 2.3

Performance Goal Ratings for Strategic Objective 2.3, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	2	2	--		--
2014	2	2	--		--
2013	--		--		--
2012	1	1	--		--

Annual Performance Indicator Ratings for Strategic Objective 2.3, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	2	2	--		--
2014	2	2	--		--
2013	--		--		--
2012	1	1	--		--
2011	1	1	--		--
2010	--		--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 2.3.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Implement the five-year Strategic Plan to improve the ability to transfer NASA-developed technologies.	3.4.1.2 Green	3.4.1.2 Green	No PG this fiscal year	2.3.1 Green	2.3.1 Green
Planned Future Performance					
For FY 2016: 2.3.1: Implement the five-year Strategic Plan to improve the ability to transfer NASA-developed technologies.					
For FY 2017: 2.3.1: Facilitate and track NASA technology infusion, internal success stories, and technology transfer.					
Contributing Theme: Space Technologies	**Contributing Program:** Partnership Development and Strategic Integration				

FY 2015 Performance Results

NASA is on track to complete this performance goal. NASA is currently tracking 18 different goals related to a broad set of technology transfer activities, ranging from new initiatives to improving existing processes. By the end of FY 2015, NASA had closed out its FY 2015 goals and drafted new goals for implementation in FY 2016.

During FY 2015, NASA continued the development and implementation of innovative methods for technology licensing. This included the following activities:

- Through its Technology Transfer University (T2U), NASA is bringing real-world, proven technologies into the classroom. As of the end of FY 2015, NASA had 15 difference business schools engaged in T2U. Three startup companies formed from student groups engaged in T2U this fiscal year alone.
- NASA released the second edition of the *NASA Software Catalog*, a downloadable collection of software programs providing cutting-edge solutions for a wide selection of industrial, academic, government, and public applications. The catalog includes more than 1,000 software codes organized into 15 categories, available for use at no charge. It enables NASA projects, government agencies, and other users to save money and time by using ready-made coding tools, rather than buying or building their own.

NASA's technology transfer efforts also support the Lab-To-Market cross-agency priority goal.

More information is available at NASA's Office of the Chief Technologist website.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Each Center will engage with at least one university business school for technology marketing assessments and encouragement of technology application.	No API this fiscal year	ST 11 14 Green	ST 12 14 Green	No API this fiscal year	ST 14 8 Green	ST 15 7 Green
Planned Future Performance						
For FY 2016: ST-16-8: Streamline, augment, and automate intellectual property and license portfolio management through a licensee monitoring system.						
For FY 2017: ST-17-8: Develop, launch, and migrate all Agency licensing activities to an online patent licensing portal.						
Contributing Theme: Space Technologies	**Contributing Program:** Partnership Development and Strategic Integration					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: ST-16-9: Develop an initiative to encourage and track infusion of NASA-developed technology into NASA missions, and pilot the initiative at three or more NASA Centers
For FY 2017: ST-17-9: Execute an initiative across seven Centers to encourage and track infusion (use) of NASA-developed technology by NASA missions and other NASA user groups.
Contributing Theme: Space Technologies | **Contributing Program:** Agency Technology and Innovation

Performance Goal 2.3.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Implement a process that enables the Agency to define and lead the Agency Grand Challenge.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	2.3.2 Green	2.3.2 Green
Planned Future Performance					
This performance goal does not continue past FY 2015.					
Contributing Theme: Space Technologies | **Contributing Program:** Partnership Development and Strategic Integration					

FY 2015 Performance Results

A Grand Challenge is an ambitious, but achievable, goal on a national or global scale that captures the imagination and demands advances in innovation and breakthroughs in science and technology. It requires high-impact, multi-disciplinary collaborations and public-private partnerships in areas where the

Federal Government alone cannot achieve the desired outcome. A Grand Challenge consists of both NASA organized and non-NASA organized activities, potentially including a number of challenges, to make progress toward the goal.

During FY 2015, NASA continued the successful operation of the Asteroid Grand Challenge, and can use the lessons learned from this experience for future processes. NASA marked the two-year anniversary of the Asteroid Grand Challenge in June 2015. As part of its planning for the three-year anniversary, NASA added a robust documentation process for this Grand Challenge.

In addition, during FY 2015, NASA continued to establish new "open innovation" mechanisms to leverage external support for the Asteroid Grand Challenge. For example:

- In June 2015, NASA signed a Space Act Agreement with Verizon Wireless for the development of an asteroid hunter application, which will enable citizen scientists to assist NASA in classifying asteroid data.
- NASA completed a Research Opportunities in Space and Earth Sciences (ROSES) solicitation to develop open source tools to support expanded amateur astronomer completion of light curve analysis.
- NASA ran a successful asteroid digital badging pilot with middle school students. The digital learning badges serve as recognition that the students have achieved new skills.
- NASA oversaw the operation of a user-built 3D printed telescope by students in a township in South Africa.
- NASA launched a brand-new volunteer built Web interface for easier access to existing asteroid data.

More information is available at NASA's Office of the Chief Technologist website.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Establish at least two new "open innovation" mechanisms that leverage external support for the Asteroid Grand Challenge.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ST 14 9 Green	ST 15 8 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Space Technologies	**Contributing Program:** Partnership Development and Strategic Integration					

Strategic Objective 2.4

Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets.

Lead Office

Office of Education

Goal Leader

Dr. Roosevelt Johnson, Deputy Associate Administrator for Education

Contributing Programs

Aerospace Research and Career Development Program, STEM Education and Accountability Program

Budget for Strategic Objective 2.4

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$119	—	$100	$102	$104	$106	$108

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has highlighted this strategic objective as a focus area for improvement.

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Strategic Objective 2.4 covers NASA's Office of Education, which performs a critical role in advancing the Nation's science, technology, engineering, and mathematics (STEM) education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets. During the 2015 Strategic Review, NASA found that the Office of Education has made progress against each of the five strategies identified for successfully achieving increased impact on the Nation's STEM education and workforce pipeline.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. Strategic Objective 2.4 is rated as a focus area for improvement, because despite the successes noted above, challenges remain within this portfolio. To address these issues, the Office of Education is taking several steps to improve portfolio management as well as strengthening the capacity of NASA Education to build evidence. A key step for performance improvement is that NASA is introducing a new annual performance indicator in FY 2017 that tracks evaluations conducted on educational activities.

For more information, please see http://www.nasa.gov/offices/education/about/index.html. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 2.4: Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets.			
Performance Goal 2.4.1: Assure that students participating in NASA higher education projects are representative of the diversity of the Nation.	Performance Goal 2.4.2: Continue to support STEM educators through the delivery of NASA education content and engagement in educator professional development opportunities.	Performance Goal 2.4.4: Continue to provide opportunities for learners to engage in STEM education through NASA-unique content provided to informal education institutions designed to inspire and educate the public.	Performance Goal 2.4.5: Continue to provide opportunities for learners to engage in STEM education engagement activities that capitalize on NASA-unique assets and content.
Annual Performance Indicators			
• ED-15-1: Provide significant, direct student awards in higher education to (1) students across all institutional categories and levels (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, and (4) persons with disabilities at percentages that meet or exceed the national percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the four categories.	• ED-15-2: Engage with at least 80,000 educators in NASA-supported professional development, research, and internships that use NASA-unique STEM content.	• ED-15-4: Maintain the NASA Museum Alliance and/or other STEM education strategic partnerships in no fewer than 30 states, U.S. territories, and/or the District of Columbia.	• ED-15-5: Engage with at least 600,000 elementary and secondary students in NASA STEM activities.

Summary of Performance for Strategic Objective 2.4

Performance Goal Ratings for Strategic Objective 2.4, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	4	4	--		--
2014	4	4	--		--
2013	4	2	--		2
2012	4	3	1		--

Annual Performance Indicator Ratings for Strategic Objective 2.4, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	4	4	--		--
2014	4	4	--		--
2013	2	1	--		1
2012	3	2	--	1	--
2011	3	2	1		--
2010	2	1	1		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 2.4.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Assure that students participating in NASA higher education projects are representative of the diversity of the Nation.	5.1.2.1 Green	5.1.2.1 Yellow	5.1.2.1 White	2.4.1 Green	2.4.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Education	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA's performance in diversity is examined across ethnicity, race, gender, and disability status. NASA Education is on target to complete this performance goal, having provided 4,297 significant, direct student awards in higher education to students across all institutional categories and levels in FY 2014.[6] The FY 2014 population of significant awardees also exceeded the national science, technology, engineering, and mathematics (STEM) enrollment percentages for the demographic category of racially and ethnically underrepresented student participants.

NASA student participants receiving significant awards attend institutions that represent all institutional categories (Predominantly White Institutions, Predominantly Black Institutions, Tribal Colleges and Universities, and Hispanic-Serving Institutions) and levels (at least two but less than four years, and four or more years), as defined by the U.S. Department of Education. NASA Education provided 29 percent of its awards to racially and ethnically underrepresented student participants, compared to 8 percent for the national average. However, NASA is below the national enrollment percentage for women and persons with disabilities. NASA provided 36 percent of its awards to women, compared to 39 percent for the national average; and 1.3 percent of its awards to persons with disabilities, compared to 11 percent for the national average.

NASA's offices, mission directorates, and Centers are collaborating in the implementation of an Agency-wide approach to STEM education. As NASA integrates its STEM Education projects and activities into a more focused portfolio, NASA Education is developing new awards to support the consolidation efforts. Due to various awards still completing their award period, NASA is roughly on par with national STEM averages, rather than exceeding national STEM averages in certain diversity areas. Moving forward, NASA Education will fund open competitions focused on its performance goals. NASA Education will also strategically fund activities to support the Committee on Science, Technology, Engineering, and Math Education (CoSTEM) priorities and NASA Education business lines. More detail on these efforts is included in the *NASA Education Implementation Plan: 2015-2017*.

NASA Education's efforts also support the STEM Education cross-agency priority goal.

[6] NASA Education rates this performance goal using data reported on the academic calendar. The FY 2015 rating is based on data from the 2013-2014 academic calendar.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Provide significant, direct student awards in higher education to (1) students across all institutional categories and levels (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, and (4) persons with disabilities at percentages that meet or exceed the national percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the four categories.	10ED03 Yellow	ED-11-1 Yellow	ED 12 1 Red	ED-13-1 White	ED 14 1 Green	ED 15 1 Green
Planned Future Performance						
For FY 2016: ED-16-1: Provide significant, direct student awards in higher education to (1) students across all institutional categories and levels (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, and (4) persons with disabilities at percentages that meet or exceed the national enrolled percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the four categories.						
For FY 2017: ED-17-1: Provide significant, direct student awards in higher education to (1) students across all institutional categories and levels (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, and (4) persons with disabilities at percentages that meet or exceed the national enrolled percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the four categories.						
Contributing Theme: Education	**Contributing Program:** Multiple Programs					

Performance Goal 2.4.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Continue to support STEM educators through the delivery of NASA education content and engagement in educator professional development opportunities.	6.1.1.1 Green	6.1.1.1 Green	6.1.1.1 White	2.4.2 Green	2.4.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Education	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA Education is on target to achieve this performance goal. Through NASA Education, 91,075 educators have participated in NASA-supported activities. This number includes 3,836 pre-service and 76,436 in-service K-12 educators, 8,223 informal educators, and 2,580 higher education faculty.[7]

[7] NASA Education rates this performance goal using data reported on the academic calendar. The FY 2015 rating is based on data from the 2013-2014 academic calendar.

In September 2015, NASA released the *NASA Education Implementation Plan: 2015-2017*, which describes NASA's Educator Professional Development (EPD) activities to provide high-quality science, technology, engineering, and mathematics (STEM) content and hands-on learning experiences to educators. These efforts are organized into four integrated delivery mechanisms:

- Face to Face Institute provides face-to-face interactions at NASA facilities, conducted through a single delivery model and implemented uniformly across all NASA Centers and facilities. It leverages the content specific to each Center or facility, at grade-appropriate levels based on specific audiences, for a minimum of 40 contact hours.
- Partner-Delivered EPD provides a uniform set of standards for partners to adhere to when developing or offering EPD in concert with NASA. The purpose of Partner-Delivered EPD is to increase the number of geographically dispersed participants engaged in NASA Educator EPD offerings.
- Online EPD provides a uniform set of standards for designing, planning, and implementing online learning opportunities for educators. Online EPD includes synchronous and asynchronous virtual learning opportunities that enhance and extend the breadth, depth, and reach of NASA's EPD training, content, and resources, using a variety of electronic delivery tools.
- Community-Requested EPD provides NASA Centers and the Jet Propulsion Laboratory the flexibility to meet and respond to the educator professional development needs of their surrounding communities on a case-by-case basis throughout the year, using a set of uniform guidelines to the greatest extent possible.

NASA Education's efforts also support the STEM Education cross-agency priority goal.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Engage with at least 80,000 educators in NASA-supported professional development, research, and internships that use NASA-unique STEM content.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ED 14 6 Green	ED 15 2 Green
Planned Future Performance						
For FY 2016: ED-16-2: Engage with at least 80,000 educators in NASA-supported professional development, research, and internships that use NASA-unique STEM content.						
For FY 2017: ED-17-2: Engage with at least 100,000 educators in NASA-supported professional development, research, and internships that use NASA-unique STEM content.						
Contributing Theme: Education	**Contributing Program:** Multiple Programs					

Performance Goal 2.4.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Continue to provide opportunities for learners to engage in STEM education through NASA-unique content provided to informal education institutions designed to inspire and educate the public.	6.4.1.1 Green	6.4.1.1 Green	6.4.1.1 Green	2.4.4 Green	2.4.4 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Education	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

NASA is on target to achieve this performance goal by providing NASA-unique content through different education institutions. NASA Education supports a diverse portfolio of programs that enhance education efforts on space exploration, aeronautics, space science, Earth science, and microgravity research. These partnerships, maintained through the NASA Museum Alliance, result in strategic collaboration between science, technology, engineering, and mathematics (STEM) formal and informal education providers, such as science centers, planetariums, museums, aquariums, zoos, nature centers, parks and observatories, federal and non-federal NASA Visitor Centers and affiliates, and Challenger Centers. The Museum Alliance, which has 576 organizations in 52 U.S. states and territories, extended an existing, free-of-charge NASA STEM content facilitation membership service to youth-serving efforts throughout the United States.

NASA Education's efforts also support the STEM Education cross-agency priority goal.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Maintain the NASA Museum Alliance and/or other STEM education strategic partnerships in no fewer than 30 states, U.S. territories, and/or the District of Columbia.	10ED10 Green	ED 11 9 Green	ED 12 9 Green	ED 13 5 Green	ED 14 5 Green	ED 15 4 Green
Planned Future Performance						
For FY 2016: ED-16-4: Maintain the NASA Museum Alliance and/or other STEM education strategic partnerships in no fewer than 30 states, U.S. territories, and/or the District of Columbia.						
For FY 2017: ED-17-4: Support informal education institutions, including youth-serving organizations, to use NASA-unique content in no fewer than 30 states, U.S. Territories and/or the District of Columbia.						
Contributing Theme: Education	**Contributing Program:** Multiple Programs					

Performance Goal 2.4.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Continue to provide opportunities for learners to engage in STEM education engagement activities that capitalize on NASA-unique assets and content.	6.1.2.2 Green	6.1.2.2 Green	6.1.2.2 Green	2.4.5 Green	2.4.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Education	**Contributing Program:** Multiple Programs				

FY 2015 Performance Results

In FY 2014, NASA Education reached 775,906 elementary and secondary students in NASA science, technology, engineering, and mathematics (STEM) engagement activities.[8] These events leveraged NASA-unique resources, personnel, content, and facilities. Interactive events included experiential learning opportunities for youth at NASA Centers or events at NASA Education partner facilities with NASA content; design challenges with live mentoring from NASA scientists and engineers; professional development opportunities for the Nation's K-12 STEM educators; and other opportunities. NASA's plans to accelerate and expand the engagement of students, learners, and educators in STEM activities are described in the *NASA Education Implementation Plan: 2015-2017*.

NASA Education's efforts also support the STEM Education cross-agency priority goal.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Engage with at least 600,000 elementary and secondary students in NASA STEM activities.	No API this fiscal year	ED 11 5 Green	ED 12 5 Green	No API this fiscal year	ED 14 8 Green	ED 15 5 Green
Planned Future Performance						
For FY 2016: ED-16-5: Engage with at least 750,000 elementary and secondary students in NASA STEM activities.						
For FY 2017: ED-17-5: Engage with at least 750,000 elementary, secondary, and higher education students in NASA STEM activities.						
Contributing Theme: Education	**Contributing Program:** Multiple Programs					

[8] NASA Education rates this performance goal using data reported on the academic calendar. The FY 2015 rating is based on data from the 2013-2014 academic calendar.

Performance Goal 2.4.6

Does not trend until FY 2017.
Planned Future Performance
For FY 2016: No performance goal this fiscal year.
For FY 2017: Ensure that grantees and cooperative agreement awardees conduct independent, well-designed evaluations, providing evidence for the effectiveness of NASA STEM education projects.

Contributing Theme: Education	**Contributing Program:** Multiple Programs

Annual Performance Indicator
For FY 2015: Does not trend until FY 2017.
Planned Future Performance
For FY 2016: No API this fiscal year
For FY 2017: ED-17-3: Ensure that at least 30 percent of grantees and cooperative agreement awardees conduct independent, well-designed evaluations, and report to NASA on their evaluation activities.

Contributing Theme: Education	**Contributing Program:** Multiple Programs

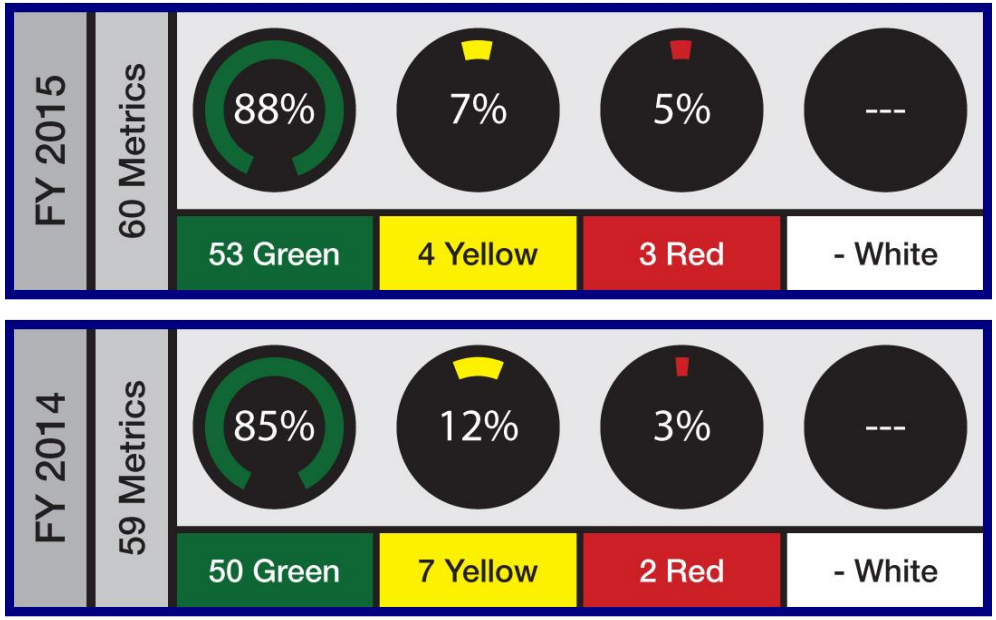
Strategic Goal 3

Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.

Strategic Goal 3: Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.			
Strategic Objective 3.1: Attract and advance a highly skilled, competent, and diverse workforce, cultivate an innovative work environment, and provide the facilities, tools, and services needed to conduct NASA's missions.	Strategic Objective 3.2: Ensure the availability and continued advancement of strategic, technical, and programmatic capabilities to sustain NASA's Mission.	Strategic Objective 3.3: Provide secure, effective, and affordable information technologies and services that enable NASA's Mission.	Strategic Objective 3.4: Ensure effective management of NASA programs and operations to complete the mission safely and successfully.
FY 2015 Performance Goals			
• 3.1.1: Define and build diverse workforce skills and competencies needed for the Agency's mission. • 3.1.2: Advance a workplace environment that affords equal employment opportunities (EEO) to all employees and takes proactive diversity and inclusion (D&I) efforts. • 3.1.3: Promote equal opportunity compliance and encourage best practices among NASA grant recipient institutions. • 3.1.4: Between 2012 and 2016, support the demolition and elimination of obsolete and unneeded facilities. • 3.1.5: Manage coordination of NASA's international and interagency activities in conjunction with the NASA mission directorates. • 3.1.6: Achieve savings for the Agency through acquisition reforms. • 3.1.7: Ensure that NASA continues progress towards implementing statutory or Executive Order targets and goals reflected in its annual Sustainability Plan. • 3.1.8: Enhance reach and effectiveness of programs and projects that engage the public. • 3.1.9: Manage coordination of advisory committees' (NASA Advisory Council and Aerospace Safety Advisory Panel) recommendations to the NASA Administrator.	• 3.2.1: Review the current state of the NASA test capabilities, known test requirements and test requests, and revise the Master Plan as needed. • 3.2.2: Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches. • 3.2.3: Maintain a minimum of 95 percent delivery of the Space Communications network services that support NASA and other customers' mission success. • 3.2.4: Replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC). • 3.2.5: Replace aging Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC). • 3.2.6: Prioritize and complete launch and range complex modernization studies and projects to sustain government and commercial capabilities at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS). • 3.2.7: Ensure the strategic availability and maintenance of facilities that are necessary to meet the long-term needs and requirements of the Agency.	• 3.3.1: Enhance NASA's information security posture through implementation of automated security and privacy tools and technologies. • 3.3.2: Identify viable alternatives to support Federal and Agency mobility goals, supporting Work from Anywhere (WFA). • 3.3.4: By 2015, reduce the number of data centers to 22. • 3.3.5: By 2017, operate as a single NASA enterprise network and effectively utilize the bandwidth of the Communications Services Office (CSO) backbone for both corporate and mission data, enabling more efficient use of available capacity while improving performance with no degradation to mission services. • 3.3.6: Enhance NASA's data management through open data actions, research and development data access, and new data modeling and technologies. • 3.3.7: Increase the adoption of technologies and services such as cloud computing throughout NASA's infrastructure and mission, leveraging savings from solutions such as reduced capital expenditures from not owning hardware, benefits from new technology capabilities, and increased computing flexibility available with "pay as you go" services.	• 3.4.1: Assure the safety and health of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, quality assurance, and health and medical policies and procedures. • 3.4.2: Implement the policies, procedures and oversight to continuously improve the probability of technical and programmatic mission success.

Summary of Performance for Strategic Goal 3

Summary of Ratings of All Performance Measures for FY 2015 and 2014



Summary of Ratings for Performance Goals and Annual Performance Indicators by Strategic Objective, FY 2015

Lead	Strategic Objective	Performance Goals					Annual Performance Indicators				
		Total	Green	Yellow	Red	White	Total	Green	Yellow	Red	White
MSD	3.1	9	7	2	0	0	16	14	2	0	0
HEOMD	3.2	7	7	0	0	0	8	8	0	0	0
MSD	3.3	6	5	0	1	0	7	5	0	2	0
MSD	3.4	2	2	0	0	0	5	5	0	0	0
Total		24	21	2	1	0	36	32	2	2	0
Summary			88%	8%	4%	0%		89%	6%	6%	0%

Strategic Objective 3.1

Attract and advance a highly skilled, competent, and diverse workforce, cultivate an innovative work environment, and provide the facilities, tools, and services needed to conduct NASA's missions.

Lead Office

Mission Support Directorate (MSD)

Goal Leader

Krista C. Paquin, Associate Administrator, Mission Support

Contributing Programs

FY 2015: Agency Management, Center Management and Operations, Institutional Construction of Facilities (CoF), Environmental Compliance and Restoration, Science Construction of Facilities (CoF), Space Shuttle Program
FY 2016 and FY 2017: Agency Management, Center Management and Operations, Institutional Construction of Facilities (CoF), Environmental Compliance and Restoration, Space Shuttle Program

Budget for Strategic Objective 3.1

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$2,745	—	$2,778	$2,833	$2,907	$2,965	$3,025

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has highlighted this strategic objective as a focus area for improvement.

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Strategic Objective 3.1 covers NASA's workforce and institutional capabilities. NASA has had several

recent successes within this portfolio of activities, including success in diversity and equal opportunity, workforce satisfaction and engagement, communications, and sustainability and energy usage. For the fifth consecutive year, NASA was ranked as the top large agency for innovation and, for the third consecutive year, as the Best Place to Work in the Federal Government. Over the next several years, NASA's critical steps under this strategic objective include investing in projects that reduce energy costs, demolishing unneeded infrastructure, renewing and consolidating facilities, continuing to use targeted outreach and recruitment efforts, focusing on activities that impact workforce innovation, and using current and emerging communications technologies, platforms, and methods to reach increasingly broader and more diverse audiences. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. During last year's Strategic Review, Strategic Objective 3.1 was rated as a focus area for improvement, and is rated the same this year. Despite the successes noted above, challenges remain within Strategic Objective 3.1. Continued attention and resources are needed to address risks associated with deferred maintenance, aging infrastructure, and environmental compliance. In 10 years, a part of NASA's vision for success for this strategic objective is for NASA's institutional capabilities to enable the Agency to provide the day-to-day operations required to support and achieve its missions. However, about 83 percent of NASA's infrastructure and facilities are currently beyond their constructed design life. Aging infrastructure from the Apollo era is costly to maintain and, in some cases, poses risk to mission operations. To address challenges associated with aging infrastructure, NASA is aggressively managing its facility portfolio to consolidate and modernize into fewer, more efficient and sustainable facilities. NASA has achieved some success in consolidating facilities, reducing energy costs, and demolishing unneeded infrastructure and will continue to use these strategies to manage its facilities portfolio. Additionally, NASA will continue to prioritize and triage maintenance and repair work to prevent or minimize facility failures and impacts to missions.

For more information, please see http://msd.hq.nasa.gov/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 3.1: Attract and advance a highly skilled, competent, and diverse workforce, cultivate an innovative work environment, and provide the facilities, tools, and services needed to conduct NASA's missions.								
Performance Goal 3.1.1: Define and build diverse workforce skills and competencies needed for the Agency's mission.	Performance Goal 3.1.2: Advance a workplace environment that affords equal employment opportunities (EEO) to all employees and takes proactive diversity and inclusion (D&I) efforts.	Performance Goal 3.1.3: Promote equal opportunity compliance and encourage best practices among NASA grant recipient institutions.	Performance Goal 3.1.4: Between 2012 and 2016, support the demolition and elimination of obsolete and unneeded facilities.	Performance Goal 3.1.5: Manage coordination of NASA's international and interagency activities in conjunction with the NASA mission directorates.	Performance Goal 3.1.6: Achieve savings for the Agency through acquisition reforms.	Performance Goal 3.1.7: Ensure that NASA continues progress towards implementing statutory or Executive Order targets and goals reflected in its annual Sustainability Plan.	Performance Goal 3.1.8: Enhance reach and effectiveness of programs and projects that engage the public.	Performance Goal 3.1.9: Manage coordination of advisory committees' (NASA Advisory Council and Aerospace Safety Advisory Panel) recommendations to the NASA Administrator.
Annual Performance Indicators								
• AMO-15-1: Sustain NASA's Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.	• AMO-15-2: Sustain three programs and processes designed to proactively prevent discrimination, as outlined in the Model EEO Agency Plan. • AMO-15-3: Assess, evaluate, and report the overall progress and effectiveness of the NASA Diversity and Inclusion Strategic Implementation Plan FY 2012 to FY 2015.	• AMO-15-4: Continue to broaden the scope of civil rights technical assistance to NASA grantees through the MissionSTEM Website, focused on grantee civil rights requirements and promising practices for grantee compliance and diversity and inclusion. • AMO-15-5: Provide a civil rights compliance assessment at a minimum of two STEM or STEM-related programs that receive NASA funding.	• COF-15-1: Initiate the demolition or disposal of five facilities or structures during 2015 to reduce the Agency's footprint.	• AMO-15-6: Revise the NASA export control training program plan to update and strengthen the content to reflect changes in regulations and to respond to audit findings. • AMO-15-7: Negotiate and conclude international and interagency agreements with foreign and domestic partners in support of NASA missions.	• AMO-15-8: Achieve savings through effective use of both Federal-level and Agency-level strategic sourcing approaches. • AMO-15-9: Achieve savings through increased contract efficiencies and reduced transaction costs in NASA procurements.	• AMO-15-10: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) by 30 percent from 2003 baseline under 42 U.S.C. 8253. • AMO-15-11: Attain 15 percent sustainable building inventory by 2015. • AMO-15-12: Ensure that at least 10 percent of electricity consumed is generated from renewable energy sources.	• AMO-15-13: Use current and emerging communications technologies, platforms, and methods to reach increasingly broad and diverse audiences. • AMO-15-14: Develop a set of metrics by which to assess the reach and effectiveness of activities in the communications portfolio.	• AMO-15-15: Provide NASA responses to advisory committees' recommendations made formally to the NASA Administrator.

Summary of Performance for Strategic Objective 3.1

Performance Goal Ratings for Strategic Objective 3.1, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	9	7	2		--
2014	9	9	--		--
2013	7	7	--		--
2012	6	6	--		--

Annual Performance Indicator Ratings for Strategic Objective 3.1, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	16	14	2		--
2014	16	14	2		--
2013	8	8	--		--
2012	8	8	--		--
2011	8	6	2		--
2010	4	3	--		1

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 3.1.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Define and build diverse workforce skills and competencies needed for the Agency's mission.	5.1.1.1 Green	5.1.1.1 Green	5.1.1.1 Green	3.1.1 Green	3.1.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

NASA is continuing its efforts to instill a culture of innovation in its workforce by recognizing and rewarding innovative performance; engaging and connecting the workforce to make it easy for employees to collaborate, network, and innovate; and creating an environment in which leaders view developing innovative employees as a productive and vital use of their time.

- Recognizing and rewarding performance: In FY 2014, NASA began the annual NASA Innovation Awards to recognize, encourage, and celebrate a spirit of innovative behavior. There are two categories of awards, the Lean Forward; Fail Smart Award and the Champion of Innovation Award, and the NASA workforce selects the winner in each category. During FY 2015, NASA announced the winners of the 2014 Innovation Awards, and solicited nominations for 2015.
- Engaging and connecting: NASA is working to create a workplace where geography is inconsequential and Agency work can be conducted anywhere and anytime by putting information, data, and tools at the fingertips of those individuals who need it. For example, NASA has made great improvements in effective virtual collaboration. NASA continues to expand the use of its telework program, which allows employees to perform their duties from home or another approved worksite.
- Growing leaders: NASA ensures that first-line supervisors appreciate the importance of developing innovative employees. NASA infuses its leadership values into potential leaders early in their careers through Agency-level and Center-level leadership development programs. These programs have a heavy emphasis on personal effectiveness, relating to others, and self-reflection. According to the annual Federal Employee Viewpoint Survey, which is administered by the Office of Personnel Management, NASA is ranked as one of the top agencies in effective leadership.

NASA demonstrated its commitment to workforce innovation by increasing its Innovation Index score from 78.0 percent in FY 2014 to 79.5 percent in FY 2015, as determined through the Federal Employee Viewpoint Survey. Through the survey, NASA's employees expressed their opinions about their workplace environment and opportunities. The Innovation Index score is derived from the results on three questions measuring the extent to which an individual employee feels encouraged and motivated to improve personal performance and deliver superior results, and six questions centered on the workplace environment, from employee recognition for superior work to opportunities to demonstrate value and creative practices.

Visit http://nasapeople.nasa.gov/ for more information about NASA's human capital program and career opportunities.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Sustain NASA's Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.	10WF06 White	AMO-11-1 Yellow	AMO 12 1 Green	AMO 13 1 Green	AMO 14 1 Green	AMO 15 1 Green
Planned Future Performance						
For FY 2016: AMO-16-1: Sustain NASA's Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.						
For FY 2017: AMO-17-1: Sustain NASA's Innovation Score, as measured by the Innovation-related questions of the Employee Viewpoint Survey (EVS), by taking actions such as refining and updating human capital policies, programs, and systems to support and encourage innovation to meet NASA's missions.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Performance Goal 3.1.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Advance a workplace environment that affords equal employment opportunities (EEO) to all employees and takes proactive diversity and inclusion (D&I) efforts.	5.1.1.5 Green	5.1.1.5 Green	5.1.1.5 Green	3.1.2 Green	3.1.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

NASA continues to proactively prevent discrimination and resolve issues and concerns promptly and efficiently by fully implementing equal employment opportunity (EEO) programs and processes. Examples include alternative dispute resolution (ADR) in the EEO complaints process, reasonable accommodations for individuals with disabilities, and the Anti-Harassment Program. There is a continued downward trend over time in the filing of formal EEO complaints (formal EEO complaints filed remain 30 percent lower since FY 2011), particularly those alleging harassment, which points to the effectiveness of the Anti-Harassment Program in reducing formal EEO complaints alleging harassing conduct as an issue.

Using 2008 as a baseline, NASA achieved positive rates of change in the employment participation rates of underrepresented EEO groups. Specifically, between 2008 and 2015, NASA increased the percentage of individuals with disabilities in its workforce by 12.6 percent. NASA also increased the percentage of women, African-Americans, Asian American and Pacific Islanders, and Hispanics in senior-level General Schedule (GS) positions (i.e., GS-14 and GS-15 positions) and in the Senior Executive Service (SES). NASA increased the percentage of women in senior-level positions by 22 percent, African Americans by 30.5 percent, Asian American and Pacific Islanders by 11 percent, Hispanics by 27 percent, and Native Americans by 55.6 percent.

In addition, NASA developed a new set of reasonable accommodation procedures designed to enhance existing policy for providing qualified individuals with disabilities with effective accommodation when it is needed. NASA also actively engaged in a host of innovative initiatives, including a groundbreaking new framework for model EEO efforts, employee engagement, Special Emphasis Program utilization, and promising practices cross-pollination. ADR utilization rates in EEO cases remain low; however, when ADR is used, processing times and financial resources expended are significantly reduced. For example, when ADR is not used for EEO cases, it takes an average of 464 days to process a complaint; but when ADR is used successfully, it takes an average of only 44 days to process a complaint.

In the diversity and inclusion arena, the Agency continues to make gains on its Agency scores in the Office of Personnel Management's Inclusion Index, specifically designed to measure a federal agency's progress on their efforts to increase diversity and institutionalize inclusive policies and practices.

More information is available at NASA's Office of Diversity and Equal Opportunity website.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Sustain three programs and processes designed to proactively prevent discrimination, as outlined in the Model EEO Agency Plan.	10WF01 Green	AMO-11-7 Yellow	AMO 12 7 Green	AMO 13 2 Green	AMO 14 2 Green	AMO 15 2 Green
Planned Future Performance						
For FY 2016: AMO-16-2: Sustain three programs and processes designed to proactively prevent discrimination, as outlined in the Model EEO Agency Plan.						
For FY 2017: AMO-17-2: Sustain three programs and processes designed to proactively prevent discrimination, as outlined in the Model EEO Agency Plan.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Assess, evaluate, and report the overall progress and effectiveness of the NASA Diversity and Inclusion Strategic Implementation Plan FY 2012 to FY 2015.	10WF02 Green	AMO 11 8 Green	AMO 12 8 Green	AMO 13 3 Green	AMO 14 3 Green	AMO 15 3 Green
Planned Future Performance						
For FY 2016: AMO-16-3: Issue and begin implementation of the NASA Diversity and Inclusion Strategic Implementation Plan FY 2016 to FY 2019.						
For FY 2017: AMO-17-3: Continue implementation of the NASA Diversity and Inclusion Strategic Implementation Plan FY 2016 to FY 2019.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Performance Goal 3.1.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Promote equal opportunity compliance and encourage best practices among NASA grant recipient institutions.	6.1.3.1 Green	6.1.3.1 Green	6.1.3.1 Green	3.1.3 Green	3.1.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

NASA has established a vigorous civil rights compliance review program for its grantee institutions, and a robust technical assistance effort centered on its MissionSTEM website. NASA conducts a proactive onsite compliance review program under all of the grant-related federal civil rights laws for which NASA has implementing regulations. This program, which is unique among grant-awarding federal science agencies, enables the Agency to advance equal opportunity among its grantees regardless of race, color, national origin (including those with limited English proficiency), gender, age, or disability in the formal and informal science, technology, engineering, and mathematics (STEM) fields. NASA complements its compliance review programs with civil rights technical assistance that optimizes online capabilities, while also using more traditional media. MissionSTEM, the centerpiece of NASA's civil rights technical assistance, is designed to highlight both compliance requirements under the civil rights laws, as well as the many promising practices of NASA grant recipients and stakeholder organizations for creating greater diversity and inclusion in STEM. NASA continues to post fresh content, both written and video, to MissionSTEM on a regular basis, and continues to see increases in MissionSTEM usage. Analytics show a high of approximately 73,000 site visits and over 19,000 page views in March 2015, and MissionSTEM is attracting approximately 2,000 new viewers per month.

More information is available at NASA's Office of Diversity and Equal Opportunity website.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Continue to broaden the scope of civil rights technical assistance to NASA grantees through the MissionSTEM Website, focused on grantee civil rights requirements and promising practices for grantee compliance and diversity and inclusion.	10WF11 Green	AMO 11 19 Green	AMO 12 19 Green	AMO 13 11 Green	AMO 14 10 Green	AMO 15 4 Green
Planned Future Performance						
For FY 2016: AMO-16-4: Continue to conduct civil rights compliance assessments at a minimum of two STEM or STEM-related programs that receive NASA funding; and broaden the scope of civil rights technical assistance to NASA grantees through the MissionSTEM website, focused on grantee civil rights requirements and promising practices for grantee compliance and diversity and inclusion.						
For FY 2017: AMO-17-4: Continue to conduct civil rights compliance assessments at a minimum of two STEM or STEM-related programs that receive NASA funding; and broaden the scope of civil rights technical assistance to NASA grantees through the MissionSTEM website, focused on grantee civil rights requirements and promising practices for grantee compliance and diversity and inclusion.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Provide a civil rights compliance assessment at a minimum of two STEM or STEM-related programs that receive NASA funding.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 11 Green	AMO 15 5 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Performance Goal 3.1.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Between 2012 and 2016, support the demolition and elimination of obsolete and unneeded facilities.	5.2.3.1 Green	5.2.3.1 Green	5.2.3.1 Green	3.1.4 Green	3.1.4 Green
Planned Future Performance					
For FY 2016: 3.1.4: Between 2012 and 2016, support the demolition and elimination of obsolete and unneeded facilities.					
For FY 2017: 3.1.4: Between 2012 and 2017, support the demolition and elimination of obsolete and unneeded facilities.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

NASA has a demolition program to eliminate obsolete, unneeded infrastructure to improve efficiency and eliminate safety and environmental risks. The program has been in operation for over a decade, and has been an important part of NASA's plans to reduce its infrastructure and operating costs. In each year from FY 2012 through FY 2015, NASA met its target of demolishing five buildings per year.

In FY 2015, NASA demolished the Shuttle Mate/De-mate Device at the Armstrong Flight Research Center (AFRC). The Shuttle Mate/De-Mate Device at AFRC was a large, gantry-like steel structure that was used to hoist the Shuttle orbiters off the ground during post-landing servicing operations and during mating and de-mating operations with the modified Boeing 747 Shuttle Carrier Aircraft. The structure became obsolete with the end of the Space Shuttle Program, but was considered eligible for the National Register of Historic Places, and thus required mitigation of the demolition in accordance with Section 106 of the National Historic Preservation Act. NASA preserved a few pieces of the structure for local museums.

In addition, NASA demolished an engineering building at the Santa Susana Field Laboratory (SSFL). The engineering building was one of the first buildings to be demolished at SSFL in preparation for the cleanup and excess of the site. NASA conducted an Environmental Impact Statement in the lead up to the cleanup and demolition of the complexes at SSFL. Demolition will continue in FY 2016 in the different test areas of SSFL.

Other buildings demolished in FY 2015 included the Heat Plant Building and the Data Engineering Support Building at the Stennis Space Center, and the Aircraft Landing Dynamics Facility (ALDF) Complex at the Langley Research Center.

NASA identifies facilities for demolition through special studies, which determine if the facility is required for current or future missions. Facilities that no longer are needed are included in a five-year demolition plan that sets project schedules based on last need (both mission and date), annual costs avoided if the facility is demolished, potential liability, and project execution factors. Facilities included in the five-year plan occasionally are adjusted due to consultation with states on historic properties, changes in operational schedules, environmental remediation, funding profiles, local market forces, and the value of recycled materials.

More information is available at NASA's Office of Strategic Infrastructure website.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Initiate the demolition or disposal of five facilities or structures during 2015 to reduce the Agency's footprint.	No API this fiscal year	COF 11 1 Green	COF 12 1 Green	COF 13 1 Green	COF 14 1 Green	COF 15 1 Green
Planned Future Performance						
For FY 2016: COF-16-1: Initiate the demolition or disposal of five facilities or structures during 2016 to reduce the Agency's footprint.						
For FY 2017: COF-17-1: Initiate the demolition or disposal of five facilities or structures during 2017 to reduce the Agency's footprint.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Performance Goal 3.1.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Manage coordination of NASA's international and interagency activities in conjunction with the NASA mission directorates.	5.5.2.1 Green	5.5.2.1 Green	5.5.2.1 Green	3.1.5 Green	3.1.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

The Office of International and Interagency Relations (OIIR) provides executive leadership and coordination for all of NASA's international activities and partnerships, and for policy interactions between NASA and other U.S. Executive Branch offices and agencies. OIIR serves as the principal Agency liaison with the National Security Council, the Office of Science and Technology Policy, the Department of State (State), and the Department of Defense (DoD). OIIR also directs NASA's international relations; negotiates cooperative and reimbursable agreements with foreign space partners; provides management oversight and staff support of NASA's advisory committees, commissions, and panels; and manages the NASA Export Control Program and foreign travel

by NASA employees. During FY 2015, OIIR concluded 139 new agreements, amendments, and extensions with other countries and international organizations.

OIIR's Export Control and Interagency Liaison Division supports the NASA mission directorates through the administration of the Export Control Program, the International Exchange Visitor Program, and the oversight of certain foreign travel. As part of its implementation of the President's Export Control Reform Initiative, during FY 2015, OIIR updated the training materials for its Export Control Program, including the instructor-led training, operations manual, and training modules. OIIR also continued a series of training sessions for Center Export Administrators Agency-wide on the new regulations. The trainings included presentations by State, DoD, and the Department of Commerce.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Revise the NASA export control training program plan to update and strengthen the content to reflect changes in regulations and to respond to audit findings.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 26 Green	AMO 15 6 Green
Planned Future Performance						
For FY 2016: AMO-16-6: Implement the Agency-wide export control training program plan.						
For FY 2017: AMO-17-6: Implement the Agency-wide export control training program.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Negotiate and conclude international and interagency agreements with foreign and domestic partners in support of NASA missions.	No API this fiscal year	AMO 11 18 Green	AMO 12 18 Green	AMO 13 10 Green	AMO 14 9 Green	AMO 15 7 Green
Planned Future Performance						
For FY 2016: AMO-16-7: Negotiate and conclude international and interagency agreements with foreign and domestic partners in support of NASA missions.						
For FY 2017: AMO-17-7: Negotiate and conclude international and interagency agreements with foreign and domestic partners in support of NASA missions.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Performance Goal 3.1.6

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Achieve savings for the Agency through acquisition reforms.	No PG this fiscal year	No PG this fiscal year	5.2.4.1 Green	3.1.6 Green	3.1.6 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

NASA's Office of Procurement is on track to achieve this performance goal due to the successes achieved through strategic sourcing and the plans that are in place to expand both strategic sourcing and reduce transaction costs. The Office of Procurement has made significant progress to achieve the majority of its planned initiatives. No significant threats have been identified that will impact or jeopardize the success of these initiatives.

NASA's procurement efforts support the Category Management cross-agency priority goal, which focuses on streamlining the acquisition process. During FY 2015, NASA made significant progress on a number of strategic sourcing vehicles, including the following:

- Solutions for Enterprise-Wide Procurement (SEWP) V is a multi-award, government-wide acquisition contract vehicle focused on commercial IT products and product-based services. For NASA, SEWP V achieved total cost savings and avoidance of approximately $4.1 million, including an estimated $255 thousand in administrative costs.
- The Enterprise License Management Team (ELMT) manages Agency enterprise licenses and maintenance agreements, negotiating economy-of-scale pricing for selected software used by the Agency. ELMT achieved a total estimated cost savings and avoidance of $26.4 million for NASA.
- NASA's Information Technology (IT) Infrastructure Integration Program (I3P) is transforming NASA's IT infrastructure services from a Center-based model to an enterprise-based management and provisioning model. The scope of I3P is broad, entailing consolidation and centralized management of IT services in the areas of Tier 1 service desk and ordering, Web services and technologies, enterprise business and management applications, integrated network and communications services, end user services, and data center services. I3P achieved an estimated $14.6 million in cost savings and avoidance across several different Agency-wide service contracts.
- The NASA Shared Services Center (NSSC) consolidates and standardizes business activities from across NASA. NSSC performs select business activities for all NASA Centers in financial management, human resources, information technology, procurement, and business support services.

The Office of Procurement continues to achieve savings for the Agency through increased contract efficiencies and reduced transaction costs, including by reducing contract lead times, using less complex evaluation procedures when appropriate, reducing the number of task orders, consolidating software licenses, reducing the use of award fee contracts, and reducing the number of incremental funding and deobligation actions. However, NASA would like to see continued progress in this area in the upcoming years. The methodology and systems used across the Agency to track procurement lead-times are not yet optimized. Although Centers are capturing lead-time data, the information is difficult to extract and report from the current electronic systems, so is not readily available.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Achieve savings through effective use of both Federal-level and Agency-level strategic sourcing approaches.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 30 Green	AMO 15 8 Green
Planned Future Performance						
For FY 2016: AMO-16-8: Achieve savings through effective use of both Federal-level and Agency-level strategic sourcing approaches.						
For FY 2017: AMO-17-8: Achieve savings through effective use of both Federal-level and Agency-level strategic sourcing approaches.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Achieve savings through increased contract efficiencies and reduced transaction costs in NASA procurements.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO-14-8 Yellow	AMO-15-9 Yellow
Planned Future Performance						
For FY 2016: AMO-16-9: Achieve savings through increased contract efficiencies and reduced transaction costs in NASA procurements.						
For FY 2017: AMO-17-9: Achieve savings through increased contract efficiencies and reduced transaction costs in NASA procurements.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Explanation of Rating

The Office of Procurement made progress on its planned initiatives in FY 2015 to increase contract efficiencies, including through the strategic procurement of IT initiatives, reverse auctioning, reducing and managing high-risk contract actions, peer review savings, and reducing procurement lead times. However, NASA is still working to optimize the methodology and systems used across the Agency to track procurement lead-times. As a result, NASA rated AMO-15-9 yellow. This shortfall did not affect NASA's overall progress towards achieving Performance Goal 3.1.6.

Performance Goal 3.1.7

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Ensure that NASA continues progress towards implementing statutory or Executive Order targets and goals reflected in its annual Sustainability Plan.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.1.7 Green	3.1.7 Yellow
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

NASA has a sustainability policy to execute its mission without compromising the planet's resources. Sustainability provides a unique opportunity to continuously improve the resilience of NASA's space and ground asset operations and performance. Sustainability also involves taking action now to provide a future where the environment and living conditions are protected. In implementing sustainability practices, NASA manages risks to its mission, the environment, and the local communities. To this end, NASA seeks to use public funds efficiently and effectively, promote the health of the planet, and operate in a way that benefits its neighbors. More information is available in the Strategic Sustainability Performance Plan (SSPP).

In June 2015, the Office of Management and Budget (OMB) released the January 2015 Scorecard on Sustainability/Energy. The OMB Scorecard shows data for FY 2014. NASA continues to devote significant effort and focus toward meeting its sustainability goals, and received green ratings in five out of seven metrics on the scorecard. Following were some of NASA's key sustainability activities as reported on the scorecard:

- NASA reduced its energy consumption per gross square feet (Btu/GSF) by 26 percent, receiving a yellow rating on the scorecard. The reasons include the demolition of facilities, resulting in a reduction in GSF without a commensurate reduction in energy usage; cold climate, resulting in increased energy usage at several Centers; and issues with the delivery of landfill gas at the Goddard Space Flight Center (GSFC), resulting in increased natural gas usage. Data for FY 2015 will be available in January 2016.
- NASA increased its inventory of sustainable buildings to 15.3 percent, measured by GSF, meeting its multiyear goal.
- NASA generated 8.9 percent of its electricity from renewable energy sources, exceeding the target of 7.5 percent, and receiving a green rating on the scorecard. NASA accomplished this goal by generating on-site renewable energy, purchasing green power, and purchasing renewable energy credits. Data for FY 2015 will be available in January 2016.

NASA's sustainability efforts also support the Climate Change cross-agency priority goal.

More information is available at NASA's Office of Strategic Infrastructure (OSI) website.

Performance Improvement Plan

OSI will continue to ensure that all new building design and construction meets the targets and goals within the SSPP. GSFC has addressed the delivery issues with landfill gas, and NASA's Centers are focusing on energy conservation measures.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) by 30 percent from 2003 baseline under 42 U.S.C. 8253.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO-14-20 Yellow	AMO-15-10 Yellow
Planned Future Performance						
For FY 2016: AMO-16-10: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) to meet the target set by the Office of Management and Budget for FY 2016 in the Sustainability and Energy Scorecard.						
For FY 2017: AMO-17-10: Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) to meet the target set by the Office of Management and Budget for FY 2017 in the Sustainability and Energy Scorecard.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Explanation of Rating

NASA reduced its energy consumption by 26 percent, receiving a yellow rating on the scorecard. The reasons include the demolition of facilities, resulting in a reduction in gross square feet without a commensurate reduction in energy usage; cold climate, resulting in increased energy usage at several Centers; and issues with the delivery of landfill gas at GSFC, resulting in increased natural gas usage. GSFC has addressed the delivery issues with landfill gas, and Centers are focusing on energy conservation measures.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Attain 15 percent sustainable building inventory by 2015.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 21 Green	AMO 15 11 Green
Planned Future Performance						
For FY 2016: AMO-16-11: Meet sustainable building inventory target (percentage of gross square footage of inventory meeting guiding principles) set by the Office of Management and Budget for FY 2016 in the Sustainability and Energy Scorecard.						
For FY 2017: AMO-17-11: Meet sustainable building inventory target (percentage of gross square footage of inventory meeting guiding principles) set by the Office of Management and Budget for FY 2017 in the Sustainability and Energy Scorecard.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Ensure that at least 10 percent of electricity consumed is generated from renewable energy sources.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 22 Green	AMO 15 12 Green
Planned Future Performance						
For FY 2016: AMO-16-12: Ensure that a percentage of electricity consumed is generated from renewable energy sources, to meet the target set by the Office of Management and Budget for FY 2016 in the Sustainability and Energy Scorecard.						
For FY 2017: AMO-17-12: Ensure that a percentage of electricity consumed is generated from renewable energy sources, to meet the target set by the Office of Management and Budget for FY 2017 in the Sustainability and Energy Scorecard.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Performance Goal 3.1.8

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Enhance reach and effectiveness of programs and projects that engage the public.	6.4.2.1 Green	6.4.2.1 Green	6.4.2.1 Green	3.1.8 Green	3.1.8 Yellow
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

The NASA Centers and mission directorates continue to populate the Communications Portfolio with Agency communications activities, but some activities are not being recorded. NASA's Office of Communications is developing an internal NASA communication strategy to help ensure greater use of the tool, including referencing the Portfolio tool in the revised *Communications and Material Review* (NASA Policy Directive 2521.1B), which was released in August 2015. NASA is conducting an assessment of every activity submitted to the Portfolio.

NASA increased its digital footprint by launching a new official presence on the social media platform Tumblr. The Office of Communications constantly monitors cutting edge social media platforms for adoption. Audience usage metrics for both NASA's traditional website and social media platforms continue to exceed expectations, particularly for the government sector. Customer satisfaction ratings for NASA's Web pages are among the highest in the Federal Government. The number of internal agency users on the social media dashboard monitoring tool Sprinklr continues to increase. As an example, NASA's Twitter account remains among both the most popular Twitter feeds in the Federal Government and among the most followed by Twitter users. As of September 2015, NASA had 12.6 million followers on Twitter, compared to an audience of 7.5 million a year ago.

The Office of Communications has developed a set of metrics to assess the reach and effectiveness of its communications activities. Reach is being measured in the context of the Agency's six major communications themes. An acquisition for an Office of Communications media measurement and

analytics tool has been conducted, proposals have been reviewed, and a vendor has been identified. The plan to procure the online software tool in FY 2016 is on schedule.

Performance Improvement Plan
As noted in the rating explanation, the Office of Communications is developing an internal NASA communication strategy to help ensure greater use of the tool.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Use current and emerging communications technologies, platforms, and methods to reach increasingly broad and diverse audiences.	No API this fiscal year	AMO 11 21 Green	AMO 12 21 Green	AMO 13 13 Green	AMO 14 13 Green	AMO 15 13 Green
Planned Future Performance						
For FY 2016: AMO-16-13: Use current and emerging communications technologies, platforms, and methods to reach increasingly broad and diverse audiences.						
For FY 2017: AMO-17-13: Use current and emerging communications technologies, platforms, and methods to reach increasingly broad and diverse audiences.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Develop a set of metrics by which to assess the reach and effectiveness of activities in the communications portfolio.	No API this fiscal year	AMO 11 22 Green	AMO 12 22 Green	AMO 13 14 Green	AMO 14 28 Green	AMO 15 14 Green
Planned Future Performance						
For FY 2016: AMO-16-14: Develop a set of metrics by which to assess the reach and effectiveness of activities in the communications portfolio.						
For FY 2017: AMO-17-14: Develop a set of metrics by which to assess the reach and effectiveness of activities in the communications portfolio.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: AMO-16-24: Develop a toolkit (clearinghouse) of NASA communications products to share with NASA's communications professionals and employees to help ensure that consistent and current content is utilized in communicating the Agency's results to the public.	
For FY 2017: AMO-17-24: Implement and maintain a toolkit (clearinghouse) of NASA communications products to share with NASA's communications professionals and employees to help ensure that consistent and current content is utilized in communicating the Agency's results to the public.	
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management

Performance Goal 3.1.9

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Manage coordination of advisory committees' (NASA Advisory Council and Aerospace Safety Advisory Panel) recommendations to the NASA Administrator.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.1.9 Green	3.1.9 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management				

FY 2015 Performance Results

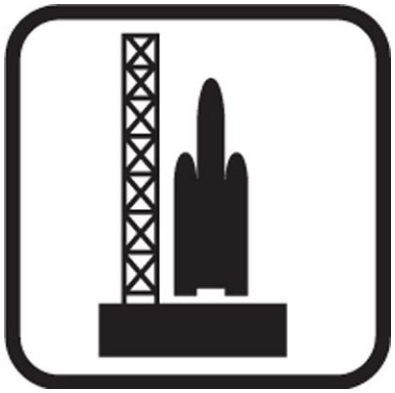
In addition to its work with international and interagency partners, the Office of International and Interagency Relations (OIIR) supports NASA's advisory committees, including the NASA Advisory Council (NAC), which provides advice and makes recommendations to NASA on Agency programs, policies, plans, financial controls, and other matters; and the Aerospace Safety Advisory Panel (ASAP), which evaluates NASA's safety performance and advises the Agency on ways to improve that performance. During FY 2015, OIIR coordinated NASA's response to nine NAC recommendations. It also led Agency-wide management oversight and legal compliance for NASA's six Federal Advisory Committee Act (FACA) committees, organized and implemented NASA federal advisory committee meetings, and prepared the ASAP 2014 Annual Report to Congress. FACA was enacted to ensure that advice by various advisory committees serving the Federal Government is objective and accessible to the public.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Provide NASA responses to advisory committees' recommendations made formally to the NASA Administrator.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 27 Green	AMO 15 15 Green
Planned Future Performance						
For FY 2016: AMO-16-15: Provide NASA responses to advisory committees' recommendations made formally to the NASA Administrator.						
For FY 2017: AMO-17-15: Provide NASA responses to advisory committees' recommendations made formally to the NASA Administrator.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency Management					

Performance Goal 3.1.10

Does not trend until FY 2016.
Planned Future Performance
For FY 2016 and 2017: 3.1.10: Between 2016 and 2017, demonstrate increased facility reliability by reducing spending on unscheduled maintenance by two percent annually.
Contributing Theme: Agency Management and Operations | **Contributing Program:** Agency Management

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: AMO-16-5: Reduce spending on unscheduled maintenance (out of total maintenance spending) by at least two percentage points.
For FY 2017: AMO-17-5: Reduce spending on unscheduled maintenance (out of total maintenance spending) by at least two percentage points.
Contributing Theme: Agency Management and Operations | **Contributing Program:** Agency Management



Strategic Objective 3.2

Ensure the availability and continued advancement of strategic, technical, and programmatic capabilities to sustain NASA's Mission.

Lead Office

Human Exploration and Operations Mission Directorate (HEOMD)

Goal Leader

Greg Williams, Deputy for Policy and Management, HEOMD

Contributing Programs

21st Century Space Launch Complex, Exploration Construction of Facilities (CoF), Launch Services, Rocket Propulsion Test, Space Communications and Navigation, Space Operations Construction of Facilities (CoF), Strategic Capabilities Assets Program

Budget for Strategic Objective 3.2

	Actual	Enacted	Requested	Notional			
Budget Authority (in $ millions)	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Total Budget	$853	—	$823	$780	$763	$743	$784

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has highlighted this strategic objective as a focus area for improvement.

Through the Strategic Review and Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Under Strategic Objective 3.2, multiple NASA programs provide critical services and strategic technical programmatic capabilities for the Agency. Recent examples of progress include the successful launches of missions such as the Soil Moisture Active Passive (SMAP) mission and the Magnetospheric Multiscale (MMS) mission via the Launch Services Program (LSP), and the Rocket Propulsion Test (RPT)

program has completed 453 successful tests with 98.7 percent test stand availability. Over the next several years, NASA's critical next steps are to complete the second new 34-meter deep-space antenna at Canberra by the end of FY 2016, continue development of the Space Network Ground Segment Sustainment (SGSS) project, provide valuable propulsion data to the SLS and Orion programs as they prepare for Exploration Missions 1 and 2, and continue to successfully launch the assigned NASA and civil sector robotic missions plus acquire new launch services for future NASA missions. Specific performance metrics for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. The NASA 2015 Strategic Review noted that areas for improvement for this strategic objective include challenges within the Space Communications and Navigation (SCaN) portfolio. These issues constitute significant budget and programmatic challenges to the Agency's critical network and communication activities.

For more information, highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 3.2: Ensure the availability and continued advancement of strategic, technical, and programmatic capabilities to sustain NASA's Mission.						
Performance Goal 3.2.1: Review the current state of the NASA test capabilities, known test requirements and test requests, and revise the Master Plan as needed.	Performance Goal 3.2.2: Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.	Performance Goal 3.2.3: Maintain a minimum of 95 percent delivery of the Space Communications network services that support NASA and other customers' mission success.	Performance Goal 3.2.4: Replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).	Performance Goal 3.2.5: Replace aging Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).	Performance Goal 3.2.6: Prioritize and complete launch and range complex modernization studies and projects to sustain government and commercial capabilities at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS).	Performance Goal 3.2.7: Ensure the strategic availability and maintenance of facilities that are necessary to meet the long-term needs and requirements of the Agency.
Annual Performance Indicators						
• SFS-15-2: Sustain 90 percent availability of test facilities to support NASA and other customers' planned test requirements.	• SFS-15-3: Sustain a 100 percent success rate with the successful launch of NASA managed expendable launches, as identified on the Launch Services Flight Planning Board manifest. • SFS-15-4: Complete acquisitions on time for NASA-managed expendable launches.	• SFS-15-5: Complete Tracking and Data Relay Satellite (TDRS)-L Initial Operational Capability (IOC).	• SFS-15-6: Complete the A4 Space Network Ground Segment Sustainment (SGSS) software increment delivery.	• SFS-15-7: Complete the antenna structure at Canberra Deep Space Communications Complex (CDSCC) for Deep Space Station-36 (DSS-36).	• ESD-15-4: Complete extension of utilities to support the first horizontal take-off, horizontal landing commercial partner at the Shuttle Landing Facility (SLF), and complete upgrades to the range telemetry systems.	• SC-15-1: Achieve a minimum of 80 percent overall availability of Strategic Capabilities Assets Program (SCAP) portfolio of assets which are necessary to meet the long-term needs and requirements of the Agency.

Summary of Performance for Strategic Objective 3.2

Performance Goal Ratings for Strategic Objective 3.2, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	7	7	--		--
2014	7	6	--	1	--
2013	6	5	1		--
2012	6	6	--		--

Annual Performance Indicator Ratings for Strategic Objective 3.2, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	8	8	--		--
2014	8	7	--	1	--
2013	5	4	1		--
2012	5	5	--		--
2011	5	4	1		--
2010	4	1	3		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 3.2.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Review the current state of the NASA test capabilities, known test requirements and test requests, and revise the Master Plan as needed.	5.3.1.1 Green	5.3.1.1 Green	5.3.1.1 Green	3.2.1 Green	3.2.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space and Flight Support	**Contributing Program:** Rocket Propulsion Test				

FY 2015 Performance Results

NASA's Rocket Propulsion Test (RPT) program is responsible for managing and sustaining the Agency's facilities for ground testing rocket engines. It works both to advance new test technologies and to reduce propulsion test costs. The RPT program prioritizes its limited resources to sustain its core test capabilities and meet customer test requirements. In addition, the RPT program is NASA's representative on the National Rocket Propulsion Test Alliance (NRPTA), which was established between NASA and the Department of Defense in 1998. The NRPTA helps shape the Federal Government's rocket propulsion test capabilities to better meet national test needs through intra- and interagency cooperation, and recommends solutions to provide the best overall value to taxpayers.

In FY 2015, the RPT program successfully met all customer test requirements. During FY 2015, the RPT program performed 453 tests for a total of 116,262 seconds of test time, while maintaining 98.7 percent test stand availability. The RPT program performed a series of tests of the RS-25 developmental rocket engine for the Space Launch System as part of the RS-25 engine's preparation for a return to deep-space missions. NASA is designing the SLS to carry humans deeper into space than ever before, to such destinations as an asteroid and Mars. Four RS-25 engines will power the core stage of the new vehicle. RS-25 engines formerly served as the Space Shuttle's main engines. They will be operated at slightly higher power levels to provide the additional thrust needed to power the SLS. The main goal of the series was to test the engine under simulated temperature, pressure, and other changes required by the SLS design. The first test in the series was in January, and the series concluded successfully at the end of FY 2015.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Sustain 90 percent availability of test facilities to support NASA and other customers' planned test requirements.	10SFS09 Yellow	SFS 11 1 Green	SFS 12 1 Green	SFS 13 1 Green	SFS 14 1 Green	SFS 15 2 Green
Planned Future Performance						
For FY 2016: SFS-16-2: Sustain 90 percent availability of test facilities to support NASA and other customers' planned test requirements.						
For FY 2017: SFS-17-2: Sustain 90 percent availability of test facilities to support NASA and other customers' planned test requirements.						
Contributing Theme: Space and Flight Support	**Contributing Program:** Rocket Propulsion Test					

Performance Goal 3.2.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.	5.4.1.1 Green	5.4.1.1 Green	5.4.1.1 Green	3.2.2 Green	3.2.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space and Flight Support	**Contributing Program:** Launch Services				

FY 2015 Performance Results

NASA's Launch Services Program (LSP) is responsible for the acquisition and management of expendable launch vehicle missions. LSP provides safe, reliable, cost-effective, and on-schedule launch services to NASA and NASA-sponsored payloads on expendable launch vehicle missions. LSP oversees all aspects of launch services, including launch vehicle engineering and manufacturing, launch operations and countdown management, and quality and mission assurance.

During FY 2015, LSP sustained a 100 percent success rate with the successful launches of two science payloads, the Soil Moisture Active Passive (SMAP) and Magnetospheric Multiscale (MMS) missions. SMAP was successfully launched on January 31, 2015, aboard a Delta II 7320 from Vandenberg Air Force Base, California. MMS was successfully launched on March 12, 2015, aboard an Atlas V-421 from Cape Canaveral Air Force Station, Florida.

During FY 2015, LSP successfully met customer requirements with launch service awards for three NASA-managed payloads:

- On November 20, 2014, NASA announced the launch service award for the Ionospheric Connection Explorer (ICON) mission to Orbital ATK for a Pegasus-XL. ICON is targeted to launch in June 2017 from the Reagan Test Site on Kwajalein Atoll in the Republic of the Marshall Islands.
- On December 16, 2014, NASA announced the launch service award for the Transiting Exoplanet Survey Satellite (TESS) mission to the Space Exploration Technologies Corporation for a Falcon 9 v1.1. TESS is targeted to launch in August 2017 from Cape Canaveral Air Force Station (CCAFS), Florida.
- On March 18, 2015, NASA announced the launch service award for the Solar Probe Plus (SPP) mission to United Launch Services for a Delta IV Heavy rocket. SPP is targeted to launch on July 31, 2018, also from CCAFS, Florida.

In addition, LSP is actively performing a Launch Service Task Order evaluation and competition for the Tracking Data and Relay Satellite (TDRS)-M mission.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Sustain a 100 percent success rate with the successful launch of NASA managed expendable launches, as identified on the Launch Services Flight Planning Board manifest.	10SFS11 Green	SFS-11-2 Yellow	SFS 12 2 Green	SFS 13 2 Green	SFS 14 2 Green	SFS 15 3 Green
Planned Future Performance						
For FY 2016: SFS-16-3: Sustain a 100 percent success rate with the successful launch of NASA-managed expendable launches as identified on the Launch Services Flight Planning Board manifest.						
For FY 2017: SFS-17-3: Sustain a 100 percent success rate with the successful launch of NASA-managed expendable launches as identified on the Launch Services Flight Planning Board manifest.						
Contributing Theme: Space and Flight Support	**Contributing Program:** Launch Services					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete acquisitions on time for NASA-managed expendable launches.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	SFS 14 3 Green	SFS 15 4 Green
Planned Future Performance						
For FY 2016: SFS-16-4: Complete acquisitions on time for NASA-managed expendable launches.						
For FY 2017: SFS-17-4: Complete acquisitions on time for NASA-managed expendable launches.						
Contributing Theme: Space and Flight Support	**Contributing Program:** Launch Services					

Performance Goal 3.2.3

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Maintain a minimum of 95 percent delivery of the Space Communications network services that support NASA and other customers' mission success.	5.4.3.1 Green	5.4.3.1 Green	5.4.3.1 Green	3.2.3 Green	3.2.3 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space and Flight Support	**Contributing Program:** Space Communications and Navigation				

FY 2015 Performance Results

The NASA Space Communications and Navigation (SCaN) program is responsible for Agency-wide operations, management, and development of all NASA space communications capabilities and enabling technology. The SCaN program manages and directs the ground-based facilities and services for three networks, including the Deep Space Network (DSN), Near Earth Network (NEN), and Space Network (SN), which span the globe and support over

100 space missions. The Space Network consists of a constellation of geosynchronous (Earth-orbiting) satellites named the Tracking Data Relay Satellite (TDRS) system, ground systems that operate as a relay system between satellites, satellites in low Earth orbit above 73 kilometers, and ground facilities. The Space Network maintains near-continuous communications with the International Space Station (ISS), the Hubble Space Telescope, and other satellites beyond low Earth orbit, and supports resupply missions to the ISS.

The Space Network is operated 24 hours a day, seven days a week, 365 days per year. Operations on the network run above 99.5 percent proficiency every month. Usually, the Space Network operates above 99.9 percent efficiency. During FY 2015, the Space Network exceeded its requirement of 95 percent delivery of network services, achieving an actual service delivery of 99.95 percent.

In addition, TDRS-L, which was launched in January 2014, went into operations in January 2015. The replenishment of the TDRS fleet will help to ensure that NASA's Space Network is able to continue to provide around-the-clock, high throughput communications services to NASA's missions, including the ISS.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete Tracking and Data Relay Satellite (TDRS)-L Initial Operational Capability (IOC).	10SFS07 Yellow	SFS 11 5 Green	SFS 12 5 Green	SFS 13 4 Green	SFS 14 4 Green	SFS 15 5 Green
Planned Future Performance						
For FY 2016: SFS-16-5: Complete the development of the Tracking and Data Relay Satellite (TDRS)-M Spacecraft and prepare it for storage.						
For FY 2017: SFS-17-5: Maintain a minimum of 95 percent delivery of the Space Communications network services that support NASA and other customers' mission success.						
Contributing Theme: Space and Flight Support	**Contributing Program:** Space Communications and Navigation					

Performance Goal 3.2.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).	5.4.3.2 Green	5.4.3.2 Green	5.4.3.2 Yellow	3.2.4 Red	3.2.4 Green
Planned Future Performance					
This performance goal does not continue past FY 2015.					
Contributing Theme: Space and Flight Support	**Contributing Program:** Space Communications and Navigation				

FY 2015 Performance Results

NASA's Space Communications and Navigation (SCaN) program manages the Space Network, which maintains near-continuous communications with the International Space Station (ISS), the Hubble Space Telescope, and other satellites beyond low Earth orbit, and resupply missions to the ISS. The Space

Network consists of a ground segment and a space segment. The ground segment comprises three facilities, including one located on Guam Island; and two located in New Mexico, one of which is the White Sands Test Facility.

The current ground system of equipment for the Space Network is approximately 30 years old, and is becoming increasingly difficult to operate and maintain. As newer systems replace older ones, it becomes more difficult for the older systems to interface with the new ones and function at full capacity.

The SCaN program initiated a sustainment effort, called the Space Network Ground Segment Sustainment (SGSS) project, to upgrade technology and sustain the Space Network operations for at least the next 25 years. This includes replacing or upgrading the ground segment at the White Sands Test Facility.

The SGSS project will be more than six months late relative to its original baseline commitment. In July 2015, NASA completed a replan of the SGSS project, which included Agency approval of a revised Key Decision Point (KDP)-C memorandum. The KDP-C review is an assessment of a project's readiness to move into full-scale development.

On September 4, 2015, all development and integration activities were successfully completed for the A4 SGSS software increment. The A4 software increment covers the tracking, telemetry, and control for the Tracking Data Relay Satellite system generation one and three satellites, high data rate communication relay modes, and remaining capability for a fully functional ground terminal. In FY 2016, NASA reclassified the SGSS project from a development project to a sustainment effort. While work will continue to upgrade the Space Network technology and sustain operations, NASA will no longer report on annual performance indicators for the SGSS project after FY 2015.

Annual Performance Indicator	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
For FY 2015: Complete the A4 Space Network Ground Segment Sustainment (SGSS) software increment delivery.	10SFS08 Yellow	SFS 11 6 Green	SFS 12 6 Green	SFS-13-5 Yellow	SFS 14 5 Red	SFS 15 6 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Space and Flight Support	**Contributing Program:** Space Communications and Navigation					

Performance Goal 3.2.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Replace aging Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).	5.4.3.3 Green	5.4.3.3 Green	5.4.3.3 Green	3.2.5 Green	3.2.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Space and Flight Support	**Contributing Program:** Space Communications and Navigation				

FY 2015 Performance Results

NASA's Space Communications and Navigation (SCaN) program manages the Deep Space Network, which is an international network of antennas that supports interplanetary spacecraft missions, space-based telescopes, and some select Earth-orbiting science missions. The Deep Space Network comprises three facilities, the Canberra Deep Space Communications Complex (CDSCC) in Australia; the Goldstone Deep Space Communications Complex in Fort Irwin, CA; and the Madrid Deep Space Communications Complex in Spain. The Deep Space Network supports NASA and non-NASA missions that explore the furthest points of the solar system. For example, the Deep Space Network plays a key role for NASA's Mars Reconnaissance Orbiter spacecraft, which in late FY 2015 detected signs of flowing water on Mars.

To meet ongoing demand for deep space communication services, SCaN is replacing its aging Deep Space Station (DSS) 70-meter antennas with a new generation of 34-meter antennas. Four 34-meter antennas are being arrayed in order to provide functionally equivalent capabilities to the 70-meter antenna at the CDSCC, which is over 40 years old. SCaN recently completed the first of two new 34-meter antennas, DSS-35, and is on schedule to complete the second, DSS-36. The two new antennas will be arrayed with the existing two 34-meter antennas to provide redundancy and eliminate the critical dependence on the old 70-meter antenna.

In August 2015, NASA completed the installation of the antenna structure on DSS-36. NASA expects to achieve initial operational status of DSS-36 in FY 2017.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the antenna structure at Canberra Deep Space Communications Complex (CDSCC) for Deep Space Station-36 (DSS-36).	No API this fiscal year	SFS 11 7 Green	SFS 12 7 Green	SFS 13 6 Green	SFS 14 6 Green	SFS 15 7 Green
Planned Future Performance						
For FY 2016: SFS-16-7: Initiate installation of electronics at Canberra Deep Space Communications Complex (CDSCC) for Deep Space Station (DSS)-36.						
For FY 2017: SFS-17-7: Achieve initial operational status of Deep Space Station (DSS)-36 at Canberra Deep Space Communications Complex (CDSCC).						
Contributing Theme: Space and Flight Support	**Contributing Program:** Space Communications and Navigation					

Performance Goal 3.2.6

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Prioritize and complete launch and range complex modernization studies and projects to sustain government and commercial capabilities at the Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS).	5.4.2.1 Green	5.4.2.1 Green	5.4.2.1 Green	3.2.6 Green	3.2.6 Green
Planned Future Performance					
This performance goal continues through FY 2016.					
Contributing Theme: Space and Flight Support	**Contributing Program:** 21st Century Space Launch Complex				

FY 2015 Performance Results

The 21st Century Space Launch Complex (21CSLC) is working to modernize the Kennedy Space Center (KSC). The enhanced complex will facilitate multiple launches of different vehicle types from different companies carrying both humans and cargo to space in a cost-effective and timely manner. Other important projects include enhancements to the range, payload processing capabilities, and environmental clean-up activities.

During FY 2015, 21CSLC continued implementation of the KSC Master Plan. KSC and the Cape Canaveral Air Force Station completed a Future State Definition study to modernize and sustain launch capabilities. In a partnership arranged with its respective commercial partners, KSC also completed the extension of the utilities needed to support the infrastructure for horizontal launch.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete extension of utilities to support the first horizontal take-off, horizontal landing commercial partner at the Shuttle Landing Facility (SLF), and complete upgrades to the range telemetry systems.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	ESD 14 4 Green	ESD 15 4 Green
Planned Future Performance						
For FY 2016: ESD-16-4: Complete a study of the Crawlerway, which will include an assessment of updated loads on Leg B, sampling (boring) data analysis, and development of a conditioning plan.						
For FY 2017: No API this fiscal year						
Contributing Theme: Space and Flight Support	**Contributing Program:** 21st Century Space Launch Complex					

Performance Goal 3.2.7

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Ensure the strategic availability and maintenance of facilities that are necessary to meet the long-term needs and requirements of the Agency.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.2.7 Green	3.2.7 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Strategic Capabilities Assets Program				

FY 2015 Performance Results

The NASA Strategic Capabilities Assets Program (SCAP) ensures that essential Agency test facilities are maintained in a state of readiness. SCAP maintains the skilled workforce and performs essential preventive maintenance to ensure that NASA's key capabilities and critical assets will continue to be available in the future to support the missions that require them; to ensure that capabilities include the right mix of the facilities, equipment, core competencies, and skilled staff; and to identify and prioritize NASA's essential assets, and implement strategic investment decisions to sustain, enhance, replace, modify, or dispose of them based on NASA and national needs. Core capabilities supported within SCAP include thermal vacuum chambers, simulators, and the Arc Jet Complex.

For the period ending in FY 2015, SCAP achieved an overall availability of 99.8 percent for its portfolio of assets. Availability was slightly below 100 percent due to a power supply failure at the Ames Arc Jet Interaction Heating Facility (IHF), which impacted one of the four test cells. The power supply has been replaced and the IHF is currently in service.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Achieve a minimum of 80 percent overall availability of Strategic Capabilities Assets Program (SCAP) portfolio of assets which are necessary to meet the long-term needs and requirements of the Agency.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	SC 14 1 Green	SC 15 1 Green
Planned Future Performance						
For FY 2016: SC-16-1: Achieve a minimum of 80 percent overall availability of Strategic Capabilities Assets Program (SCAP) portfolio of assets which are necessary to meet the long-term needs and requirements of the Agency.						
For FY 2017: SC-17-1: Achieve a minimum of 80 percent overall availability of Strategic Capabilities Assets Program (SCAP) portfolio of assets which are necessary to meet the long-term needs and requirements of the Agency.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Strategic Capabilities Assets Program					

Strategic Objective 3.3

Provide secure, effective, and affordable information technologies and services that enable NASA's Mission.

Lead Office

Office of the Chief Information Officer

Goal Leader

Renee Wynn, CIO

Contributing Programs

Agency IT Services

Budget for Strategic Objective 3.3

Budget Authority (in $ millions)	Actual FY 2015	Enacted FY 2016	Requested FY 2017	Notional FY 2018	Notional FY 2019	Notional FY 2020	Notional FY 2021
Total Budget	$176	—	$244	$249	$236	$240	$245

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

NASA, in consultation with the Office of Management and Budget, has highlighted this strategic objective as a focus area for improvement.

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. The Agency Information Technology (IT) Services Program falls under Strategic Objective 3.3, managed by the Office of the Chief Information Officer (OCIO). During the 2015 Strategic Review, NASA found that OCIO is on track for several performance metrics, including the Security Operations Center (SOC) upgrades and cross-agency priority (CAP) goals, such as the Smarter IT Delivery CAP goal. Specific

performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. During last year's Strategic Review, Strategic Objective 3.3 was rated as achieving satisfactory performance. For 2015, the OCIO assessed NASA's performance toward achieving Strategic Objective 3.3 for IT from a broader perspective (as opposed to only assessing the Agency IT Services Program). As a result, the assessment shows that NASA has the opportunity for significant strategic improvement. No single entity controls and oversees NASA's overall IT requirements, budget, resources, and results. Analyses show that areas (stovepipes) within the current IT management and operating models are unsustainable. OCIO identified a range of opportunities and strategic risks/challenges. OCIO plans to take the following near term actions:

- Implement a functionally aligned program for enterprise IT infrastructure services that focuses on sustainable, efficient, integrated, and secure IT to enable NASA's mission.
    - Based on internal management decisions and on new requirements from the Federal Information Technology Acquisition Reform Act (FITARA), changes to NASA's IT policy, governance, strategy, and/or management and operating models may be required.
- Implement an integrated risk management approach that addresses management of investment risk, IT program/project risk, and cybersecurity risk.
- Implement a portfolio management capability to optimize enablement of NASA's mission goals and objectives through the strategic application of IT.

These performance improvement actions will result in a transformation of the NASA IT management and operating models.

For more information, please see https://www.nasa.gov/offices/ocio/home/. Highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 3.3: Provide secure, effective, and affordable information technologies and services that enable NASA's Mission.					
Performance Goal 3.3.1: Enhance NASA's information security posture through implementation of automated security and privacy tools and technologies.	Performance Goal 3.3.2: Identify viable alternatives to support Federal and Agency mobility goals, supporting Work from Anywhere (WFA).	Performance Goal 3.3.4: By 2015, reduce the number of data centers to 22.	Performance Goal 3.3.5: By 2017, operate as a single NASA enterprise network and effectively utilize the bandwidth of the Communications Services Office (CSO) backbone for both corporate and mission data, enabling more efficient use of available capacity while improving performance with no degradation to mission services.	Performance Goal 3.3.6: Enhance NASA's data management through open data actions, research and development data access, and new data modeling and technologies.	Performance Goal 3.3.7: Increase the adoption of technologies and services such as cloud computing throughout NASA's infrastructure and mission, leveraging savings from solutions such as reduced capital expenditures from not owning hardware, benefits from new technology capabilities, and increased computing flexibility available with "pay as you go" services.
Annual Performance Indicators					
• AMO-15-16: Plan and implement security technology upgrades for the Security Operations Center (SOC). • AMO-15-25: Increase the security of NASA's information operations by implementing the FY 2015 target cross-agency priority cybersecurity capabilities, including Information Security Continuous Monitoring (ISCM), Identity, Credential, and Access Management (ICAM), and Anti-Phishing & malware defense.	• AMO-15-17: Publish the target architecture for Work from Anywhere (WFA) implementation with specific portfolio roadmaps and details.	• AMO-15-18: Maintain the FY 2015 schedule of ten data center consolidations contained in NASA Federal Data Center Consolidation Plan.	• AMO-15-26: Complete the Mission Next Generation Architecture (MNGA).	• AMO-15-27: Provide access to high-quality data that is available and accessible to spur innovation.	• AMO-15-29: Onboard two significant communities into the cloud in FY 2015.

Summary of Performance for Strategic Objective 3.3

Performance Goal Ratings for Strategic Objective 3.3, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	6	5	--	1	--
2014	3	1	2		--
2013	1		--		1
2012	1		1		--

Annual Performance Indicator Ratings for Strategic Objective 3.3, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	7	5	--	2	--
2014	3	2	1		--
2013	1		--		1
2012	1	1	--		--
2011	1	1	--		--
2010	--		--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 3.3.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Enhance NASA's information security posture through implementation of automated security and privacy tools and technologies.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.3.1 Yellow	3.3.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services				

FY 2015 Performance Results

NASA's Office of the Chief Information Officer (OCIO) made significant progress toward achieving this information security performance goal during FY 2015. OCIO's efforts also support the Cybersecurity cross-agency priority goal.

NASA completed the planned set of upgrades in FY 2015 for the Security Operations Center (SOC) at the Ames Research Center (ARC). The upgrades spanned across 27 Intrusion Detection Systems (IDS), increasing the Agency's readiness to combat cyber threats. These technology upgrades improve the SOC's capability to detect and prevent security incidents, increasing the ability to analyze system and network vulnerabilities across the enterprise as compared to known and evolving cyber threats.

In coordination with the Cybersecurity 30-day Sprint activity ordered by the Office of Management and Budget (OMB) in June 2015, NASA met the OMB-mandated goal of 100 percent personal identity verification (PIV) use for privileged account access and 76.7 percent PIV use for non-privileged access in FY 2015. Privileged PIV access is automatically enforced for accounts integrated into the NASA Consolidated Active Directory (NCAD), a directory structure used to store and manage information about computing networks and domains.

The Agency executed quarterly anti-phishing and malware defense training exercises, with results varying across quarters due to differences in the types of training exercises used. 100 percent of Agency users were included in the fourth quarter of FY 2015 phishing exercise as the result of NASA's increased software license for the exercises, up from less than 20 percent of Agency users in the third quarter of FY 2015.

NASA closed the Performance Improvement Plan for the FY 2014 Information Security Continuous Monitoring (ISCM) annual performance indicator. This IT security service is operating at 96.9 percent, surpassing the 95 percent Federal goal.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Plan and implement security technology upgrades for the Security Operations Center (SOC).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 17 Green	AMO 15 16 Green
Planned Future Performance						
For FY 2016: AMO-16-17: Plan and implement Continuous Diagnostics and Mitigation (CDM) Phase 1 tools and technologies into the NASA environment.						
For FY 2017: AMO-17-17: Plan and implement Continuous Diagnostics and Mitigation (CDM) Phase 2 tools and technologies into the NASA environment.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Increase the security of NASA's information operations by implementing the FY 2015 target cross-agency priority cybersecurity capabilities, including Information Security Continuous Monitoring (ISCM), Identity, Credential, and Access Management (ICAM), and Anti-Phishing & malware defense.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 15 25 Green
Planned Future Performance						
For FY 2016: AMO-16-25: Increase the security of NASA's information operations by implementing the FY 2016 target cross-agency priority cybersecurity capabilities, including Information Security Continuous Monitoring (ISCM); Identity, Credential, and Access Management (ICAM); and anti-phishing and malware defense.						
For FY 2017: AMO-17-25: Increase the security of NASA's information operations by implementing the FY 2017 target cross-agency priority cybersecurity capabilities, including Information Security Continuous Monitoring (ISCM); Identity, Credential, and Access Management (ICAM); and anti-phishing and malware defense.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services					

Performance Goal 3.3.2

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Identify viable alternatives to support Federal and Agency mobility goals, supporting Work from Anywhere (WFA).	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.3.2 Green	3.3.2 Green
Planned Future Performance					
This performance goal does not continue past FY 2015.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services				

FY 2015 Performance Results

NASA's Office of the Chief Information Officer (OCIO) obtained consensus on the target architecture for Work from Anywhere (mobility) implementation with the domain architects and published the architecture in the enterprise architecture tool in the third quarter of FY 2015, completing this performance goal. Work From Anywhere is an arrangement that allows employees to work from a location other than their office or cubicle, either on a regular or an ad hoc basis. OCIO's target architecture was designed to drive improvements in workforce mobility and productivity by providing infrastructure and applications that increase mobile access to enterprise capabilities and information.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Publish the target architecture for Work from Anywhere (WFA) implementation with specific portfolio roadmaps and details.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 18 Green	AMO 15 17 Green
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services					

Performance Goal 3.3.4

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
By 2015, reduce the number of data centers to 22.	5.2.2.4 Green	5.2.2.4 Yellow	5.2.2.4 White	3.3.4 Yellow	3.3.4 Red
Planned Future Performance					
This performance goal does not continue past FY 2015.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services				

FY 2015 Performance Results

As of the end of FY 2015, NASA's Office of the Chief Information Officer (OCIO) had closed 29 of NASA's 59 data centers since the beginning of the effort to reduce the number of data centers, resulting in 37,769 square feet of white space closed for disposal or repurposing. The OCIO expects to have closed a total of 31 data centers by the end of calendar year 2015. Due to budget reductions and delays in new facility construction, NASA will not reduce its number of data centers to 22 by the end of 2015. NASA's data center consolidation plan is located and maintained in the Office of Management and Budget (OMB) Portal, which NASA updates when data center closure dates are rebaselined (e.g., due to construction schedule changes).

Performance Improvement Plan

NASA updates the OMB Portal when data center closure dates are rebaselined, including the updated closure date changes detailed below for the remaining data center consolidations.

Due to budget reductions and uncertainties that have impacted planned facility upgrades at the Goddard Space Flight Center (GSFC), the following facility closure dates have been rebaselined:

- GSFC's Consolidated Engineering (GSFCDC4), which was delayed from third quarter FY 2015 to first quarter FY 2016.
- National Space Science (GSFCDC3) data center, delayed from third quarter FY 2015 to fourth quarter FY 2017.
- Solar Data Analysis (GSFCDC5) data center, delayed from third quarter FY2015 to fourth quarter FY 2017.
- Code 300 (GSFCDC14) data center, delayed from third quarter FY 2015 to first quarter FY 2016.

All scheduled data center closures at Kennedy Space Center (KSC) slipped due to eight-to-nine month construction delays for the new KSC Core data center. The KSC facilities affected include:

- Space Station Processing Facility (KSCDC3) data center, which was delayed from third quarter FY 2014 to third quarter FY 2016.
- Launch Services Program (KSCDC4) data center, delayed from third quarter FY 2015 to third quarter FY 2016.
- Launch Control Center (KSCDC3) data center, delayed from third quarter FY 2015 to fourth quarter FY 2017.

The two remaining data centers scheduled for closure at Langley Research Center (LaRC) are pending the completion of the new Langley Data Center (LDC) Core data center. The two affected facilities include:

- LDC Mars Exploration Vehicle (LaRCDC11) data center, which was delayed from third quarter FY 2015 to fourth quarter 2016.
- LDC Computational Fluid Dynamic (LaRCDC13) data center, delayed from first quarter FY 2015 to fourth quarter FY 2016.

The data center consolidation project team will continue to request quarterly status updates from the NASA Center contacts regarding their progress towards meeting the consolidation schedule.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Maintain the FY 2015 schedule of ten data center consolidations contained in NASA Federal Data Center Consolidation Plan.	No API this fiscal year	AMO 11 15 Green	AMO 12 15 Green	AMO-13-8 White	AMO-14-7 Yellow	AMO 15 18 Red
Planned Future Performance						
For FY 2016: No API this fiscal year						
For FY 2017: No API this fiscal year						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services					

Explanation of Rating
See the FY 2015 Performance Results and Performance Improvement Plan for Performance Goal 3.3.4 for an explanation of the rating for this annual performance indicator.

Performance Goal 3.3.5

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
By 2017, operate as a single NASA enterprise network and effectively utilize the bandwidth of the Communications Services Office (CSO) backbone for both corporate and mission data, enabling more efficient use of available capacity while improving performance with no degradation to mission services.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.3.5 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services				

FY 2015 Performance Results
NASA continues to make progress toward achieving this performance goal. The expected completion of the Mission Next Generation Architecture (MNGA) project has shifted beyond the end of FY 2015 into the first quarter of FY 2016, because the vendor cannot confirm the completion date for the commercial upgrade at NASA's White Sands Test Facility and Ames Research Center. NASA expects this schedule shift to impact the completion of subsequent network transformation efforts for this performance goal, although some of the schedule shift will be mitigated by changing the phasing of site migration to the new infrastructure. MNGA will implement the new Mission Network architecture required to support emerging and upcoming mission concepts and requirements using the Communications Services Office backbone infrastructure wherever possible to reduce overall cost and improve service delivery for wide area Mission Network services.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Complete the Mission Next Generation Architecture (MNGA).	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 15 26 Red
Planned Future Performance						
For FY 2016: AMO-16-26: Complete the Consolidated Network Operations System (CNOS) project.						
For FY 2017: AMO-17-26: Complete the Mission Backbone Transition (MBT) project.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services					

Explanation of Rating
NASA's Office of the Chief Information Officer will review the MNGA project as part of its Monthly Program Status Review to ensure that the project meets its revised delivery date in the first quarter of FY 2016.

Performance Goal 3.3.6

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Enhance NASA's data management through open data actions, research and development data access, and new data modeling and technologies.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.3.6 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services				

FY 2015 Performance Results
NASA released over 30,000 datasets and 40 application programming interfaces during FY 2015 through its public online portal at https://data.nasa.gov, supporting the Federal Open Data cross-agency priority goal. Datasets available on NASA's data portal are automatically listed on the government-wide website, Data.gov. NASA's data portal also includes developer resources to help users build applications that utilize NASA's data, as well as robust data visualization tools to increase the public understanding of the datasets. NASA's Office of the Chief Information Officer (OCIO) also developed a Data Management Strategy White Paper, with participation from across the Agency, to guide NASA's data management investments.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Provide access to high-quality data that is available and accessible to spur innovation.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 15 27 Green
Planned Future Performance						
For FY 2016: AMO-16-27: Provide information architecture to manage NASA's data more efficiently.						
For FY 2017: AMO-17-27: Enable customers to utilize information architecture to drive opportunities for new insights using NASA data.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services					

Annual Performance Indicator
For FY 2015: Does not trend until FY 2016.
Planned Future Performance
For FY 2016: AMO-16-28: Enable access to NASA R&D data and publications by securely integrating with shared hosting and data infrastructure.
For FY 2017: AMO-17-28: Expand availability of R&D data and publications through secure use of shared hosting and data infrastructure.
Contributing Theme: Agency Management and Operations | **Contributing Program:** Agency IT Services

Performance Goal 3.3.7

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Increase the adoption of technologies and services such as cloud computing throughout NASA's infrastructure and mission, leveraging savings from solutions such as reduced capital expenditures from not owning hardware, benefits from new technology capabilities, and increased computing flexibility available with "pay as you go" services.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.3.7 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations | **Contributing Program:** Agency IT Services					

FY 2015 Performance Results

NASA continues to take advantage of new technologies to more efficiently deliver end user IT services to NASA's workforce, including a sustained focus on onboarding Agency communities into managed cloud environments to drive cost efficiencies and the use of common tools and processes. During FY 2015, NASA migrated the Web Services cloud environment onto the Agency's Cloud Services Service Office (CSSO) cloud contract with Amazon. During this period, NASA also established the Marshall Space Flight Center's Marshall and Agency Computing Services (MACS) Managed Cloud Environment (MCE) in Amazon Web Services.

This work supports the Smarter IT Delivery cross-agency priority goal, as well as the Office of Management and Budget mandate to consider "Cloud-First" when making new or lifecycle investments to increase agencies' use of cloud computing instead of owning and operating computing hardware, such as servers.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Onboard two significant communities into the cloud in FY 2015.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 15 29 Green
Planned Future Performance						
For FY 2016: AMO-16-29: Onboard two significant communities into the cloud in FY 2016.						
For FY 2017: AMO-17-29: Onboard two significant communities into the cloud in FY 2017.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services					

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: AMO-16-30: Implement at least one new technology solution that improves efficiency and the effectiveness of end user service delivery to NASA's workforce.	
For FY 2017: No API this fiscal year	
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services

Performance Goal 3.3.8

Does not trend until FY 2016.
Planned Future Performance
For FY 2016 and 2017: 3.3.8: By 2017, increase Agency business systems performance and efficiency by upgrading NASA's business systems infrastructure and modernizing business applications with no degradation to business services.
Contributing Theme: Agency Management and Operations | **Contributing Program:** Agency IT Services

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: AMO-16-31: Complete the Phase-3 Operations Readiness Review (ORR) of the NASA Aircraft Management Information System - Logistic Upgrade (NAMIS-LU).	
For FY 2017: AMO-17-31: Complete the NASA Aircraft Management Information System – Logistic Upgrade (NAMIS-LU) project.	
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2016.	
Planned Future Performance	
For FY 2016: AMO-16-32: Complete the NASA Enterprise Applications Competency Center (NEACC) release 16.1, a significant business systems upgrade.	
For FY 2017: No API this fiscal year	
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services

Annual Performance Indicator	
For FY 2015: Does not trend until FY 2017.	
Planned Future Performance	
For FY 2016: No API this fiscal year	
For FY 2017: AMO-17-18: Complete the Contract Management Transformation (CMT) project.	
Contributing Theme: Agency Management and Operations	**Contributing Program:** Agency IT Services

Strategic Objective 3.4

Ensure effective management of NASA programs and operations to complete the mission safely and successfully.

Lead Office

Office of Safety and Mission Assurance (OSMA); Office of the Chief Engineer (OCE); and Office of the Chief Health and Medical Officer (OCHMO).

Goal Leader

Hal Bell, Deputy Chief, Safety and Mission Assurance

Contributing Programs

Safety and Mission Success

Budget for Strategic Objective 3.4

Budget Authority (in $ millions)	Actual FY 2015	Enacted FY 2016	Requested FY 2017	Notional FY 2018	Notional FY 2019	Notional FY 2020	Notional FY 2021
Total Budget	$165	—	$170	$174	$179	$182	$186

Note: For explanation of budget table, please see the "How to Read the Strategic Objective Information" section in the introduction to Part 3.

Progress Update

Through the Strategic Review and the Agency's other performance management processes, NASA reviews recent accomplishments and near term plans for the Agency's strategic objectives and programs. Program elements managed by the Office of the Chief Engineer, Office of Safety and Mission Assurance, and the Office of the Chief Health and Medical Officer fall under Strategic Objective 3.4. These program elements together are more broadly referred to as "Safety and Mission Success." These programs work to protect the health and safety of the NASA workforce and improve the likelihood that NASA's programs, projects, and operations are completed safely and successfully. During the 2015 Strategic Review, NASA found no major changes from

the 2014 Strategic Review assessment, and performance metrics for Safety and Mission Success are all on track. In the near term, Safety and Mission Success will continue to ensure effective management of NASA programs and operations to complete the mission safely and successfully. Specific performance measures for the next two years can be found in the FY 2016 and FY 2017 Annual Performance Plans in the performance goal and the annual performance indicator tables below.

The Strategic Review also addresses long-term strategic outcomes, alignment, and key management challenges for each strategic objective, as well as across NASA's portfolio of activities. A challenge for this strategic objective include the fact that NASA's mission requires working in many unforgiving environments, including the upper atmosphere, low Earth orbit, and deep space. Safety and Mission Success offices work to ensure mission safety and success given these environmental challenges, but Safety and Mission Success faces resource constraints. Some areas of concern regarding Safety and Mission Success disciplines include aviation safety, human factors, non-destructive evaluation, nuclear flight safety, pressure systems, and technical risk and statistical analysis.

For more information, highlighted achievements during FY 2015 are detailed in the *FY 2015 Agency Financial Report*. Information on the strategies for achieving this strategic objective can be found in the *NASA 2014 Strategic Plan*.

FY 2015 Performance Measures

Strategic Objective 3.4: Ensure effective management of NASA programs and operations to complete the mission safely and successfully.	
Performance Goal 3.4.1: Assure the safety and health of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, quality assurance, and health and medical policies and procedures.	Performance Goal 3.4.2: Implement the policies, procedures and oversight to continuously improve the probability of technical and programmatic mission success.
Annual Performance Indicators	
• AMO-15-19: Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2015. • AMO-15-20: Maintain a Total Case Rate and Lost Time Case Rate that meets or exceeds the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative. • AMO-15-21: Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2015, based on a five-year running average (that also excludes launched flight hardware).	• AMO-15-22: Ensure 100 percent of Category 1 and 2 projects use Agency Safety and Mission Success policy, procedures and independent assessments focused on both technical and programmatic mission success. • AMO-15-23: Ensure that 100 percent of the engineering and programmatic workforce has access to the standards and knowledge base needed to maintain and build their skills.

Summary of Performance for Strategic Objective 3.4

Performance Goal Ratings for Strategic Objective 3.4, FY 2012 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	2	2	--		--
2014	2	2	--		--
2013	1	1	--		--
2012	1	1	--		--

Annual Performance Indicator Ratings for Strategic Objective 3.4, FY 2010 through FY 2015

Fiscal Year	Total	Green	Yellow	Red	White
2015	5	5	--		--
2014	5	5	--		--
2013	3	3	--		--
2012	3	3	--		--
2011	3	1	--	2	--
2010	1	1	--		--

Past fiscal years do not include annual performance indicators that do not trend to the current fiscal year annual performance indicators.

Performance Goal 3.4.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Assure the safety and health of NASA's activities and reduce damage to assets through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, quality assurance, and health and medical policies and procedures.	5.2.1.1 Green	5.2.1.1 Green	5.2.1.1 Green	3.4.1 Green	3.4.1 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Safety and Mission Success				

FY 2015 Performance Results

In FY 2015, NASA assured the safety and enhanced the success of its activities through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, quality assurance, and health policies and procedures. This was demonstrated by the following:

- There were no fatalities or permanent disabling injuries to the public from NASA activities.
- NASA's Total Case Rate and Lost Time Case Rate were under the injury and illness goals established in the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative. The POWER initiative encourages the collection and analysis of data on the causes and consequences of frequent or severe injury and illness, and prioritizes safety and health management programs that have proven effective in the past.
- The non-mission failure damage costs were significantly below the five-year running average.

More information is available on NASA's Office of Safety and Mission Assurance website.

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2015.	10SMS01 Green	AMO 11 9 Green	AMO 12 9 Green	AMO 13 4 Green	AMO 14 4 Green	AMO 15 19 Green
Planned Future Performance						
For FY 2016: AMO-16-19: Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2016.						
For FY 2017: AMO-17-19: Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during FY 2017.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Safety and Mission Success					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Maintain a Total Case Rate and Lost Time Case Rate that meets or exceeds the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.	No API this fiscal year	AMO 11 10 Red	AMO 12 10 Green	AMO 13 5 Green	AMO 14 5 Green	AMO 15 20 Green
Planned Future Performance						
For FY 2016: AMO-16-20: Maintain a Total Case Rate and Lost Time Case Rate that meets or exceeds the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.						
For FY 2017: AMO-17-20: Maintain a Total Case Rate and Lost Time Case Rate that meets or exceeds the goals of the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Safety and Mission Success					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Reduce damage to NASA assets (excluding launched flight hardware) by two percent during FY 2015, based on a five-year running average (that also excludes launched flight hardware).	No API this fiscal year	AMO 11 11 Red	AMO 12 11 Green	AMO 13 6 Green	AMO 14 6 Green	AMO 15 21 Green
Planned Future Performance						
For FY 2016: AMO-16-21: Reduce damage to NASA assets (excluding launched flight hardware) in FY 2016 to a level less than the historical annual average.						
For FY 2017: AMO-17-21: Reduce damage to NASA assets (excluding launched flight hardware) in FY 2017 to a level less than the historical annual average.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Safety and Mission Success					

Performance Goal 3.4.1

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Implement the policies, procedures and oversight to continuously improve the probability of technical and programmatic mission success.	No PG this fiscal year	No PG this fiscal year	No PG this fiscal year	3.4.2 Green	3.4.2 Green
Planned Future Performance					
This performance goal continues through FY 2016 and FY 2017.					
Contributing Theme: Agency Management and Operations	**Contributing Program:** Safety and Mission Success				

FY 2015 Performance Results

NASA is implementing the policies, procedures, and oversight necessary to continuously improve the probability of technical and programmatic mission success. Projects are assigned to Category 1, 2, or 3 based on the estimated lifecycle costs and priority level. During FY 2015, 100 percent of Category 1 and 2 projects complied with Safety and Mission Success policies and procedures. Specifically, all Category 1 and 2 projects that conducted lifecycle reviews also were subject to independent assessments; all Category 1 and 2 projects either were executing to an approved plan, or were in an approved rebaseline planning cycle; and the NASA Engineering and Safety Center had the capability and capacity to accept all requested assessments of Category 1 and 2 projects. In addition, the entire engineering and programmatic workforce had access to the standards and knowledge base necessary to achieve or maintain their project manager certification requirements.

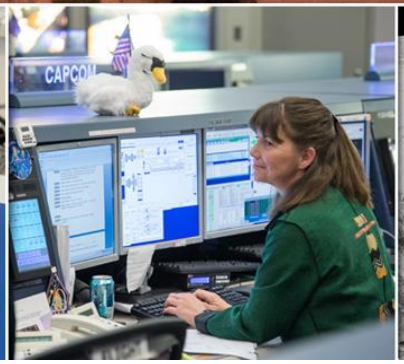
More information is available on the NASA websites for the Office of the Chief Engineer, Office of the Chief Health and Medical Officer, and Office of Safety and Mission Assurance.

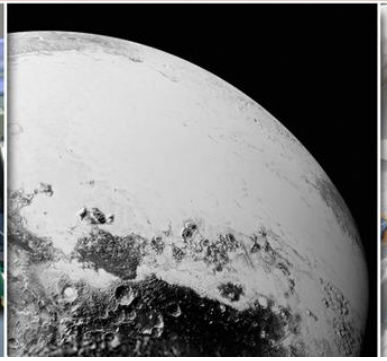
Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Ensure 100 percent of Category 1 and 2 projects use Agency Safety and Mission Success policy, procedures and independent assessments focused on both technical and programmatic mission success.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 15 Green	AMO 15 22 Green
Planned Future Performance						
For FY 2016: AMO-16-22: Ensure 100 percent of Category 1 and 2 projects use Agency Safety and Mission Success policy, procedures and independent assessments focused on both technical and programmatic mission success.						
For FY 2017: AMO-17-22: Ensure 100 percent of Category 1 and 2 projects use Agency Safety and Mission Success policy, procedures and independent assessments focused on both technical and programmatic mission success.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Safety and Mission Success					

Annual Performance Indicator	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
For FY 2015: Ensure that 100 percent of the engineering and programmatic workforce has access to the standards and knowledge base needed to maintain and build their skills.	No API this fiscal year	No API this fiscal year	No API this fiscal year	No API this fiscal year	AMO 14 16 Green	AMO 15 23 Green
Planned Future Performance						
For FY 2016: AMO-16-23: Ensure that 100 percent of the engineering and programmatic workforce has access to the standards and knowledge base needed to maintain and build their skills.						
For FY 2017: AMO-17-23: Ensure that 100 percent of the engineering and programmatic workforce has access to the standards and knowledge base needed to maintain and build their skills.						
Contributing Theme: Agency Management and Operations	**Contributing Program:** Safety and Mission Success					

Part 4
Supporting Information








Changes to the FY 2016 Performance Plan

Each fiscal year, NASA's budget request to Congress contains an Annual Performance Plan (APP) that aligns with the funds requested. Changes to a performance plan are generally reflected in the next year's budget request, if the changes are known before the request is sent to Congress. If a change occurs after, then it is reflected in the APP. NASA updates measures in the APP when the final appropriation differs from the amount requested, or if Congressional or Executive direction places a different emphasis on programs relative to what was initially requested. Additionally, the dynamic nature of research and development can lead to shifting priorities. This may result in NASA no longer pursuing activities originally identified in the APP or placing greater emphasis on other activities.

NASA's policy has been to allow one of the following actions if programs are impacted by Congressional budget action via an appropriations or authorization law or Executive direction places a different emphasis on programs:

- Eliminate the performance measure (do not rate the performance measure);
- Change the targeted performance (rate at the new target); or
- Move the measure to the next year's APP (do not rate until the following year).

If priorities have shifted due to the dynamic nature of research and development, and the activity is no longer pursued, NASA generally retains the measure and does not reduce the target, but rather reflects this via a white rating. If emphasis is shifted onto a program for which there was no measure, NASA may choose to add a measure and rate it, to reflect the priority of that activity. Details on NASA's approach to rating measures and setting criteria are in "Part 1: Performance Management at NASA."

FY 2016 Performance Plan Update

NASA submitted the FY 2016 Performance Plan with its FY 2016 President's Budget Request in February 2015. Since then, NASA reviewed and updated the FY 2016 measures in light of the contents of the FY 2017 President's Budget Request, in consultation with the Office of Management and Budget. Additionally, NASA has revised the plan to address typographical errors and other minor inaccuracies.

The list shows all measures that have been updated.

1.1.5: ERD-16-3 – Demonstrate concepts and technologies for extended extravehicular activity (EVA).

1.1.6 – Formulate robotic mission for overall Asteroid Redirect Mission (ARM).

1.1.6: ERD-16-1 – Complete the Asteroid Redirect Robotic Mission (ARRM) integrated requirements review.

1.2.1 – Increase the occupancy of the International Space Station's (ISS's) internal and external research facilities by adding new instruments and capabilities. (Agency Priority Goal)

1.2.1: ISS-16-1 – Increase facility occupancy beyond the FY 2015 baseline.

1.2.5: ISS-16-5 – Deliver to the International Space Station three physical sciences payloads and conduct successful Cold Atom Laboratory Pre-Ship Review.

1.2.5: ISS-16-10 – Organize a Science Definition Team and define the research objectives and requirements for a series of experiments to be conducted within the framework of the GeneLab open science concept and complete the definitions for two experiments.

1.4.4: HE-16-8 – Complete Solar Orbiter Collaboration (SOC) Solar Orbiter Heliospheric Imager (SoloHI) and Heavy Ion Sensor (HIS) instrument Pre-Ship Reviews (PSRs).

1.5.2: PS-16-14 – Complete Juno Jupiter orbit insertion.

1.5.6 – By December 2017, launch at least two missions in support of Strategic Objective 1.5.

1.6.5: AS-16-6 – Begin Wide-Field Infrared Survey Telescope (WFIRST) mission formulation.

1.7.1: ST-16-1 – Initiate at least 165 activities to research, study, or develop concepts for new technologies.

1.7.1: ST-16-3 – Create seven opportunities for advancement beyond Phase II SBIR/STTR.

1.7.2: ST-16-4 – Complete at least 75 percent of Game Changing Development program milestones, as established at the beginning of the fiscal year.

1.7.3: ST-16-5 – Complete three major milestones for small spacecraft projects to demonstrate game changing or crosscutting technologies in space.

1.7.3: ST-16-6 – Complete three major milestones for Technology Demonstration Mission (TDM) technology development projects.

2.1.3 – Advance airframe and engine technologies to enable the development of future generations of ultra efficient air vehicles that minimize environmental impact.

2.1.5: AR-16-7 – Mature the safety risk assessment tools to validate and demonstrate safety metrics for real-time system-wide safety assurance.

2.1.6: AR-16-8 – Deliver data, analysis, and recommendations based on integrated simulation and flight test series with simulated traffic or live vehicles to the RTCA Special Committee on Minimum Operational Performance Standards (MOPS) for Unmanned Aircraft Systems to support development of the final MOPS.

2.2.3: ES-16-3 – Demonstrate planned progress in detecting and predicting changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle.

2.2.7: ES-16-9 – Advance at least 40 percent of Earth science applications projects one Applications Readiness Level.

2.2.8: ES-16-18 – Complete Earth Venture Instrument (EVI)-3 selections.

2.2.8: ES-16-19 – Complete the Landsat 9 Mission Definition Review (MDR).

2.4.1: ED-16-1 – Provide significant, direct student awards in higher education to (1) students across all institutional categories and levels (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, and (4) persons with disabilities at percentages that meet or exceed the national enrolled percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics for a minimum of two of the four categories.

3.1.7: AMO-16-10 – Reduce energy intensity (energy consumption per gross square feet, or Btu/gsf) to meet the target set by the Office of Management and Budget for FY 2016 in the Sustainability and Energy Scorecard.

3.1.7: AMO-16-12 – Ensure that a percentage of electricity consumed is generated from renewable energy sources, to meet the target set by the Office of Management and Budget for FY 2016 in the Sustainability and Energy Scorecard.

3.1.10 – Between 2016 and 2017, demonstrate increased facility reliability by reducing spending on unscheduled maintenance by two percent annually.

3.2.6: ESD-16-4 – Complete a study of the Crawlerway, which will include an assessment of updated loads on Leg B, sampling (boring) data analysis, and development of a conditioning plan.

3.3.1: AMO-16-17 – Plan and implement Continuous Diagnostics and Mitigation (CDM) Phase 1 tools and technologies into the NASA environment.

3.3.6: AMO-16-28 – Enable access to NASA R&D data and publications by securely integrating with shared hosting and data infrastructure.

3.3.8 – By 2017, increase Agency business systems performance and efficiency by upgrading NASA's business systems infrastructure and modernizing business applications with no degradation to business services.

3.3.8: AMO-16-31 – Complete the Phase-3 Operations Readiness Review (ORR) of the NASA Aircraft Management Information System–Logistic Upgrade (NAMIS-LU).

3.3.8: AMO-16-32 – Complete the NASA Enterprise Applications Competency Center (NEACC) release 16.1, a significant business systems upgrade.

This list shows all measures that have been removed.

1.2.5: ISS-16-4 – Carry out the NASA Research Announcement-selected research in the Rodent Research-3 project.

1.2.5: ISS-16-9 – Complete the data collection for the International Space Station Identical Twins Study, designed to better understand human genetic expression changes during spaceflight.

2.3.2 – Implement a process that enables the Agency to define and lead the Agency Grand Challenge.

2.3.2: ST-16-8 – Establish at least two new “open innovation” mechanisms that leverage external support for the Asteroid Grand Challenge.

3.2.4 – Replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).

3.2.4: SFS-16-6 – Complete the A5 Space Network Ground Segment Sustainment (SGSS) software increment delivery.

3.2.6: SFS-16-8 – Complete activities and close out the 21st Century Space Launch Complex Program.

Image Captions and Credits

Part 1 Divider

Top, Image Reveals Charon's Complex and Violent History

NASA's New Horizons spacecraft returned images of Pluto's largest moon, Charon, that reveal a surprisingly complex and violent history. Taken on July 14, 2015, just before the spacecraft's closest approach to the moon, the image shows a landscape covered with mountains, canyons, landslides, surface color variations, and more. A belt of fractures and canyons just north of Charon's equator—four times as long as the Grand Canyon and twice as deep in places—indicate a titanic geological upheaval in the moon's past. Credit: NASA/JHU-APL/SwRI

Bottom Left, Technicians Take Apart a Five-Segment Booster After a Hot Fire Test

Orbital ATK technicians detach the center forward segment from the forward segment of NASA's five-segment booster. The booster shows scorching from the two-minute static test conducted on March 11, 2015, the first of two ground tests to support qualification of the boosters that will help launch the first flight of the Space Launch System (SLS). Credit: Orbital ATK

Bottom Center, Preparing a Sample for Testing

Microbiologist Christina Khodadad (left) prepares a sample of tap water for testing in the RAZOR EX microbial monitor inside the Molecular Biology Lab in the Neil Armstrong Operations and Checkout Building at NASA's Kennedy Space Center. Assisting with the demonstration test is Monsi Roman, NASA RAZOR project manager from Marshall Space Flight Center. RAZOR is a microbial monitor that amplifies, measures, and detects the presence of targeted microorganisms. If successful, the system has the potential to replace current microbial monitoring hardware on the International Space Station. Credit: K. Shiflett, NASA

Bottom Right, Students Prepare Parachutes for Drop Test

Undergraduate student teams from Valencia College in Orlando, Florida, prepare to release their parachutes from the mobile launcher at NASA's Kennedy Space Center on July 1, 2015. This drop-test competition of the student-designed parachutes will determine if they are capable of safely delivering a 16.9-fluid-ounce bottle of water from a height of 250 feet. Photo credit: A. Watson, NASA

Part 2 Divider

Top, Earth Imaged from Suomi-NPP

This natural-color composite image of Earth was assembled from data acquired on April 9, 2015, by the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (Suomi-NPP) spacecraft. Credit: NASA image by Norman Kuring, NASA's Ocean Biology Processing Group using Suomi NPP data

Bottom Left, Astronaut Virts in ISS Cupola

NASA astronaut Terry Virts looks out of the International Space Station's cupola during Expedition 43. Credit: NASA

Bottom Center Left, Sediment in Mars's Gale Crater Deposited by Water

Using data from the Curiosity rover, scientists have determined that, long ago, water helped deposit sediment into Gale Crater, where the rover landed more than three years ago. The sediment deposited as layers that formed the foundation for Mount Sharp, the mountain found in the middle of the crater today. This is a view of the "Kimberley" formation taken by the Curiosity rover. The strata in the foreground dip towards the base of Mount Sharp, indicating flow of water toward a basin that existed before the larger bulk of the mountain formed. Credit: NASA/JPL-Caltech/MSSS

Bottom Center Right, Star Cluster Shines with Young Stars

This composite image shows NGC 1333, a star cluster populated with many young stars that are less than two million years old—very young for stars expected to burn for billions of years. The image combines X-rays from NASA's Chandra X-ray Observatory (shown in pink) with infrared data from NASA's Spitzer Space Telescope (shown in red), as well as optical data from the Digitized Sky Survey and the National Optical Astronomical Observatory's Mayall four-meter telescope on Kitt Peak (red, green, blue). Credit: NASA/CXC/JPL-Caltech/NOAO/DSS

Bottom Center Right, Testing Completing on SLS Scale Models

In September 2015, engineers at NASA's Marshall Space Flight Center completed base heating testing on two-percent scale models of the Space Launch System (SLS) propulsion system. Sixty-five hot-fire tests using the mini models provided data on the convective heating environments that the base of the rocket will experience during ascent. Credit: NASA

Part 2

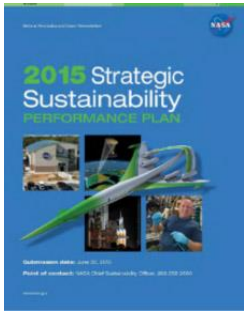
Agency Priority Goal: Exploration Systems Development
The image is an artist's concept of NASA's Space Launch System 70-metric-ton configuration, launching to space with the Orion spacecraft. Credit: NASA

Agency Priority Goal: International Space Station
On September 30, 2014, the International Space Station's Canadarm2 and Dextre, also known as the Special Purpose Dextrous Manipulator, carries the Rapidscat instrument assembly after removing it from the trunk of the Space Exploration Technologies Corporation (SpaceX) Dragon cargo ship (upper right). The Rapidscat was then maneuvered for attachment to the nadir adapter, which was affixed to the ISS's Columbus laboratory. Credit: NASA

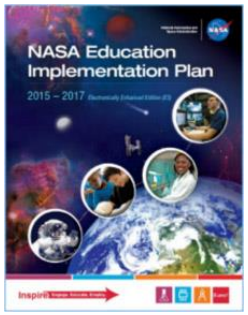
Agency Priority Goal: Commercial Crew Transportation
NASA's commercial crew partners continue to make progress maturing their transportation systems. Credit, clockwise from top left: Blue Origin/Boeing/SpaceX/Sierra Nevada

Agency Priority Goal: James Webb Space Telescope
Inside a giant clean room at NASA's Goddard Space Flight Center in October 2014, the pathfinder telescope, a flight-like backplane center section of the James Webb Space Telescope, stands fully assembled. Teams of engineers built and aligned the pathfinder telescope to rehearse assembly and testing before the actual telescope is built. Credit: C. Gunn, NASA

Cross-Agency Priority Goal: Cybersecurity
The NASA cybersecurity logo urges IT users to Stop|Think|Connect as a best practice to safeguard IT equipment and infrastructure from cyber attacks. Credit: NASA



Cross-Agency Priority Goal: Climate Change (Federal Actions)
NASA's *2015 Strategic Sustainability Performance Plan*, shown here, outlines the Agency's path to achieve requirements set in Executive Order 13693, Planning for Federal Sustainability in the Next Decade, signed by President Obama on March 19, 2015. The Executive Order built upon and expanded requirements for greenhouse gas management, energy conservation, renewable energy, and sustainable buildings outlined in previous Executive Orders and Presidential Memorandums. Credit: NASA

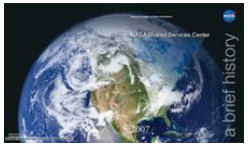


Cross-Agency Priority Goal: STEM Education

The *NASA Education Implementation Plan: 2015-2017*, shown here, outlines the roles and responsibilities that NASA Education has in approaching and achieving the Agency's and Administration's strategic goals in science, technology, engineering, and mathematics (STEM) Education. Credit: NASA

Cross-Agency Priority Goal: Smarter IT Delivery

According to Amazon, which provides cloud computing services, NASA has the largest exposure of any Federal Government agency in the public Cloud. The NASA in the Cloud logo is shown here. Credit: NASA



Cross-Agency Priority Goal: Shared Services

NASA Shared Services Center: A Brief History, shown here, is an overview of the creation of the NASA Shared Services Center (NSSC), a public-private partnership between NASA, the states of Mississippi and Louisiana, and a service provider, Computer Sciences Corporation (CSC). Credit: NASA

Cross-Agency Priority Goal: People and Culture

NASA introduced the Innovation Awards in 2014 to recognize, encourage, and celebrate the spirit of innovative behavior. The NASA workforce selects the winner in each category. The Innovation Awards logo is shown here. Credit: NASA

Part 3 Divider

Top, NASA and Boeing Test Green Aeronautics Technologies

In spring 2015, NASA completed a series of flight experiments with Boeing's ecoDemonstrator 757 airplane that tested technologies for reducing fuel consumption and emissions. The ecoDemonstrator is shown flying over Washington state, where it conducted test flights in April. Credit: NASA

Bottom Left, Engineer Examines a Ceramic Coating

Materials research engineer Bryan Harder examines coatings deposited on silicon carbide parts in the Plasma Spray-Physical Vapor Deposition Rig at NASA's Glenn Research Center. The rig is designed to apply thin, smooth ceramic coating materials to protect silicon carbide parts. The scientists and engineers also are studying its potential for creating coatings for other technologies, like fuel cells, batteries, sensors, and space applications. Credit: NASA

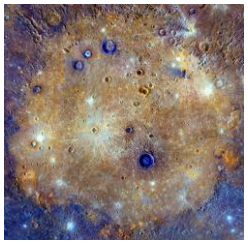
Bottom Center Left, Students Collaborate on a Project
Students participating in the Virginia Aerospace Science and Technology Scholars (VASTS) program collaborate with a NASA Langley Research Center mentor on a project on July 25, 2015. VASTS is an interactive online science, technology, engineering, and mathematics learning experience, highlighted by a seven-day residential summer academy at Langley Research Center. Credit: NASA

Bottom Center, Algae Bloom in Lake St. Clair
On July 28, 2015, the Landsat 8 satellite captured images of algal blooms around the Great Lakes, visible as swirls of green in this image of Lake St. Clair and in western Lake Erie. Algae in this basin thrive when abundant nutrients (many from agricultural runoff) combine with sunlight and warm water temperatures. Credit: J. Stevens, NASA/U.S. Geological Survey

Bottom Center Right, LDSD Recovery Off of Kauai
Two members of the U.S. Navy's Mobile Diving Salvage Unit 1 Explosive Ordnance Detachment work on recovering the test vehicle for NASA's Low-Density Supersonic Decelerator (LDSD) project. The saucer-shaped LDSD craft splashed down June 8, 2015, in the Pacific Ocean off the west coast of the Kauai, Hawaii, after a four-hour experimental flight test that investigated new technologies for landing future robotic and human Mars missions. Credit: U.S. Navy

Bottom Right, SDO Watches a Solar Flare
NASA's Solar Dynamics Observatory (SDO), which watches the Sun constantly, captured an image of a solar flare on June 22, 2015, and again on June 25, shown here. The first flare was classified as an M6.6 flare and the second was M7.9. M-class flares are one-tenth the size of the most intense flares, X-class flares. The number provides more information about its strength. An M2 is twice as intense as an M1, an M3 is three times as intense, and so on. Credit: NASA/SDO

Strategic Goal 1



Background, Mercury's Caloris Basin in Enhanced Color
This mosaic of Mercury's Caloris basin is an enhanced-color composite overlain on a monochrome mosaic of images taken by NASA's MESSENGER spacecraft. MESSENGER took the images while the Sun was at off-vertical angles, so that shadows would clearly define the shape of geologic features. Credit: NASA/JHU-APL/Carnegie Inst. of Washington

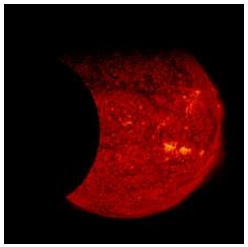
Upper Left, Astronaut Kelly Tweets Photo of Aurora
Astronaut Scott Kelly tweeted this photograph of an aurora with the caption, "Another pass through #Aurora. The sun is very active today, apparently. #YearInSpace." Credit: S. Kelly, NASA

Bottom Left, Orion Exploration Flight Test Prepared for Launch

On December 3, 2014, the Mobile Service Tower at Cape Canaveral Air Force Station's Space Launch Complex 37 rolls back in preparation for Orion's Exploration Flight Test. The Orion test article is mounted on top of a Delta IV Heavy rocket. Credit: K. Shiflett, NASA

Bottom Second from Left, Antares Rocket Takes Flight

An Orbital ATK Antares rocket, one of NASA's commercial partners for cargo delivery to the International Space Station, launches from Wallops Flight Facility. Credit: B. Ingalls, NASA



Bottom Center Left, SDO Views Double Eclipse

For the very first time, the Solar Dynamics Observatory (SDO) observed both Earth and the Moon block its view of the Sun at the same time (on September 13, 2015). First Earth blocked out the entire Sun for an hour. When it moved aside, the Moon was also blocking a portion of the Sun. Of course, none of this was visible from Earth. Due to SDO's elliptical orbit, occasionally Earth or the Moon blocks its view of the Sun, but this double alignment was a first. Visit Goddard Space Flight Center's SDO site to view mp4 movies of this eclipse. Credit: NASA/SDO

Bottom Center Right, Curiosity Takes a Low-Angle Selfie

This low-angle self-portrait of NASA's Curiosity Mars rover shows the vehicle at the site from which it reached down to drill into a rock target called "Buckskin" on lower Mount Sharp. The selfie combines several component images taken by Curiosity's Mars Hand Lens Imager (MAHLI) on August 5, 2015, during the 1,065th Martian day, or sol, of the rover's work on Mars. For scale, the rover's wheels are 20 inches in diameter and about 16 inches wide. This view is a portion of a larger panorama, available at PIA19807. Credit: NASA/JPL-Caltech/MSSS

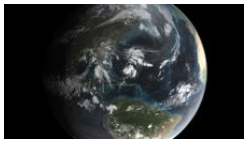
Bottom Second from Right, A Not-So Tranquil Lagoon

This image shows the center of the Lagoon Nebula, an object with a deceptively tranquil name, in the constellation of Sagittarius. The region is filled with intense winds from hot stars, churning funnels of gas, and energetic star formation, all embedded within an intricate haze of gas and pitch-dark dust. Credit: NASA/ESA/J. Trauger, JPL

Bottom Right, Inspecting the Low-Density Supersonic Decelerator

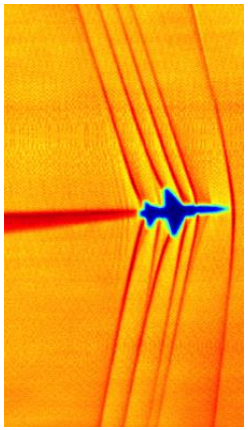
NASA's Jet Propulsion Laboratory (JPL) Low-Density Supersonic Decelerator (LDSD) Project Manager Mark Adler, left, and JPL LDSD Project Principal investigator Ian Clark inspect the LDSD test vehicle on May 28, 2015, at the U.S. Navy's Pacific Missile Range Facility, in Kauai, Hawaii. Credit: NASA

Strategic Goal 2



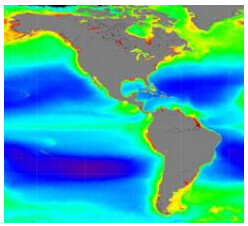
Background, GPM Observes as Joaquin Becomes a Hurricane

The Global Precipitation Measurement (GPM) mission, a joint mission of NASA and the Japan Aerospace Exploration Agency (JAXA), captured this view of Joaquin on September 29, 2015. Joaquin became a tropical storm on September 28 midway between the Bahamas and Bermuda and then intensified into a hurricane on the 29th. Credit: NASA's Scientific Visualization Studio Data provided by the joint NASA/JAXA GPM mission



Upper Left, Watching a T-38C Make Waves

This schlieren image of shock waves created by a T-38C in supersonic flight was captured using the Sun's edge as a light source and then processed using NASA-developed code. Researchers at the Armstrong Flight Research Center and Ames Research Center have developed new schlieren techniques based on modern image processing methods. Shock waves, represented by distortions of the background pattern in a series of images, are accentuated using special mathematical equations. This method requires only simple optics and a featured background, that is one with a speckled appearance such as the cratered lunar surface or the mottled appearance of the Sun when viewed through certain filters. Credit: NASA



Bottom Left, Algal Communities Highlighted

NASA pioneered the field of global ocean color observations with the SeaWIFS satellite sensor, which provided data for maps like this one from 1997 to 2010. It shows milligrams of chlorophyll per cubic meter of seawater, with dark blue the lowest and red the highest concentrations. NASA has long used satellites to observe the global ocean's microscopic algal communities, which play a significant role in the ocean's ecology and the global carbon cycle. Credit: NASA

Bottom Center, Young Explorers at Earth Day
At NASA's 2015 Earth Day event in Washington, DC, young visitors learn about the New Horizons mission while one of them holds a model of the spacecraft. Credit: NASA

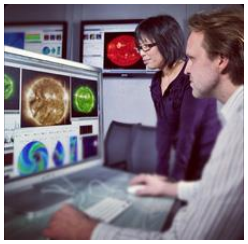
Bottom Right, Investing in the Future of Innovation
NASA's Robonaut 2, a dexterous humanoid robot, holds a sphere with examples of technologies that help drive exploration and innovation. Through its Technology Transfer Program, NASA works to ensure that technologies developed for missions in exploration and discovery are broadly available to the public, maximizing the benefit to the Nation. Credit: NASA

Strategic Goal 3

Background, SMAP Launches into the Night Sky
A Delta II rocket with the Soil Moisture Active Passive (SMAP) observatory onboard launches from Vandenberg Air Force Base, California, on January 31, 2015. Credit: B. Ingalls, NASA

Upper Left, Testing Wheels in the Lab to Better Understand Wheel Damage on Mars
To understand the effects of wheel damage on traction performance, the Jet Propulsion Laboratory sent a set of the wheels currently on the Mars Curiosity rover over to the Glenn Research Center (GRC) for performance evaluation. GRC technician Ariana Miller checks the wheel mount and drive hardware assembly on a Curiosity wheel for tests at the Traction and Excavation Capabilities Lab. Curiosity's aluminum wheels began accumulating more holes as compared with the first 12 months of the rover's mission on Mars. At the time, Curiosity was crossing terrain studded with sharp, embedded rocks. By early 2014, changes in route planning and driving methods slowed the pace of wheel damage. The tests at GRC are part of the rover mission's efforts to understand how the damage occurs, develop methods for further reducing the pace of damage, and anticipate how accumulation of damage to the wheels could affect performance. Credit: NASA

Bottom Left, Countdown to Deep Space Continues with Latest RS-25 Test
On August 13, 2015, NASA conducted a 535-second test of its Space Launch System (SLS) RS-25 rocket engine to collect engine performance data. Operators at Stennis Space Center's A-1 Test Stand conducted the test series to qualify an all-new engine controller and put the upgraded former Space Shuttle main engines through the rigorous temperature and pressure conditions they will experience during an SLS mission. Credit: NASA



Bottom Center, Information Technology Is Critical to NASA's Programs
Space weather forecasters work on a computer technique to improve NASA's ability to predict the path and impact of severe solar storms. Effective information technologies and processes are critical crosscutting dependencies that enable NASA's mission and mission support success. Credit: NASA

Bottom Right, Safety Training Sharpens Skills
A firefighter dons protective gear to prepare for a training simulation at Kennedy Space Center (KSC). The Special Rescue Operations firefighters, with NASA Fire Rescue Services in the Protective Services Office at KSC, practice firefighting skills and sharpen the skills needed to help rescue personnel during emergency operations. Credit: K. Shiflett, NASA

Part 4 Divider

Top, Morning Dawns Behind Orion Atop a Delta IV Heavy Rocket
A Delta IV Heavy rocket with NASA's Orion spacecraft mounted on top stands witness to a beautiful Florida sunrise on December 4, 2014. The next day, NASA launched the Exploration Flight Test, testing the Orion spacecraft for the first time. The spacecraft, which was uncrewed for the test, orbited Earth twice, reaching an altitude of approximately 3,600 miles above Earth before splashing down in the Pacific Ocean. Credit: B. Ingalls, NASA

Bottom Left, Flight Campaign Studies Radar Detection of Ice Crystal Icing
NASA researchers fly a DC-8 research plane, outfitted with state of the art radar and sophisticated meteorological probes, in Fort Lauderdale, Florida, to detect ice crystal icing conditions. Data collected from NASA's research will define requirements for future commercial radar products, provide the avionics industry with good scientific principles and measures for the detection of ice crystal icing conditions, and add additional data for engine icing standards updated earlier in 2015. Credit: P. Merlin, NASA

Bottom Center Left, Small Satellites to Demonstrate Swarm Communications and Autonomy
An engineer conducts final inspection of Nodes CubeSats at Ames Research Center. NASA's two Nodes small satellites hitched a ride to the International Space Station (ISS) on the fourth Orbital ATK cargo mission, which launched on December 6, 2015. Once aboard the ISS, the satellites will settle in for a two-to-three month stay until deployed into low Earth orbit in early 2016. Credit: NASA

Bottom Center, Monitoring Communications as Cygnus Leaves the ISS
Inside the International Space Station control room in the Johnson Space Center's Mission Control Center, astronaut Cady Coleman, spacecraft communicator (CAPCOM), monitors communications during the grapple and unberthing of the Orbital ATK Cygnus cargo ship from the nadir port of the Harmony module on the ISS. Credit: NASA

Bottom Center Right, Compiled Images Creates a Unique, Detailed Perspective of Pluto

This synthetic perspective view of Pluto, shows what it would look like to be approximately 1,100 miles above Pluto's equatorial area, looking northeast over the dark, cratered, informally named Cthulhu Regio toward the bright, smooth, expanse of icy plains, informally called Sputnik Planum. The entire expanse of terrain seen in this image is 1,100 miles across. The images were taken as New Horizons flew past Pluto on July 14, 2015, from a distance of 50,000 miles. Credit: NASA/JHU-APL/SwRI

Bottom Right, Outreach Astronaut Visits with a Young Explorer at Virginia Tech Science Festival

Langley Research Center's (LaRC's) outreach astronaut visits with a child at the first annual Science Festival hosted by Virginia Tech, held on October 4, 2014. LaRC provided several exhibits on exploration, technology, and science. Credit: D.C. Bowman, NASA