National Aeronautics and Space Administration

NASA Strategic Plan 2014

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A 'Blue Marble' image of the Western Hemisphere taken from the VIIRS instrument aboard the Suomi NPP Earth-observing satellite. They are composite images using a number of swaths of the Earth's surface taken on January 4, 2012.
Image Credit (all images): NASA

Letter from the Administrator

We stand at a pivotal moment in space exploration. Humankind is making plans to further extend its reach into the solar system, and NASA is leading the way. Our orbiting outpost, the International Space Station (ISS), is home to a crew of astronauts from across the world conducting research and learning how to live and work in space. We have robotic explorers probing diverse regions of the solar system, including one that has entered the vast region of interstellar space. And we are preparing for a challenging mission to capture and redirect an asteroid for human exploration—a stepping stone to future human exploration of Mars.

While NASA and its international partners strive to achieve these exploration goals, we are also witnessing the birth of a new commercial space industry. Commercial space ventures ranging from asteroid mining to lunar missions to space tourism are emerging, and NASA is partnering with U.S. industry to accelerate technological progress while being prudent stewards of Federal tax dollars and assets. Once again, American spacecraft are transporting cargo to the ISS and in the near future, this will include crew transportation.

When we explore the solar system and the universe, we gain knowledge about the dynamics of the Sun and planetary system and whether we are alone, with Kepler's discovery to date of a few Earth-sized planets. When we push the boundaries of aeronautics, we bring safer, faster, and more efficient air travel to the American public. When we investigate the effects of space on our astronauts, we reveal new medical knowledge that has the potential to help people on Earth suffering ailments, such as arthritis or kidney stones. When we study the Earth from space, we not only reveal the marvelous complexity that enables our planet to support life, but we also gain valuable insight into climate change and weather patterns that translate into better warning and response times for dangerous weather events and natural disasters. All this work grows the American economy and improves the lives of people around the world.

Our long-term goal is to send humans to Mars. Over the next two decades, we will develop and demonstrate the technologies and capabilities needed to send humans to explore the red planet and safely return them to Earth. One of the steps toward this goal is a proposed mission to find, capture, redirect a near-Earth asteroid safely into the Earth-Moon system, and then send astronauts to explore it. This mission will allow us to further develop new technologies and test mechanisms and techniques for human operations in deep space, as well as help us understand potential future threats to human populations posed by asteroids.

This strategic plan outlines our vision for the future and provides a clear, unified, and long-term direction for all of NASA's activities. This plan is the foundation on which we will build and measure success on our programs and projects. We will use this plan to align resources to accomplish our goals in the best way possible.

Our strategic goals are:

1. Expand the frontiers of knowledge, capability, and opportunity in space.
2. Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.
3. Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.

The three strategic goals guide our major initiatives, including missions to an asteroid and Mars; they also focus on returning tangible benefits of cutting-edge technology development, as well as ensuring sustainability, accountability, and transparency in our operations. This strategic plan is focused on creating a future that leverages our preeminence in science and technology to extend humanity's reach into space, improve life on Earth, protect our home planet, encourage innovation, and strengthen the American economy. In particular, we are emphasizing commercial space transportation, the use of the ISS for research, developing the James Webb Space Telescope, and developing space technology and building capabilities for human space exploration. I encourage you to read this plan to learn more about the detailed strategic objectives we have identified as milestones for these goals.

Our strategic direction reflects and aligns NASA's full spectrum of activities to accomplish national priorities in civil aeronautics research, space exploration, science, and advanced research and development. However, NASA, along with the rest of the Federal Government, must operate within today's fiscal realities. We also face a future skill gap and increased competition for workers. We are working to address an aging infrastructure.

We face challenges, but we also have the will, the motivation, and the people to realize our ambitions. Making the impossible possible is what Americans expect of its space agency. We embrace this new environment as an opportunity to challenge our thinking about how we achieve our goals.

NASA's vision of the future is clear. We will continue the human and robotic exploration of space. We will develop new technologies for use in air, space, and here on Earth. We will be a part of a strong, high-tech economy. We will increase our understanding of the universe and our place in it, while caring for and protecting our planet. We will make air travel more efficient, safe, and clean. And our workforce will continue to inspire and inform learners of all ages. We will realize this vision in collaboration with our traditional partners in industry, academia, and other national space agencies while seeking the participation of many other segments of the American public.

NASA is proud to be the agency leading our Nation into the future and continuing America's legacy of pushing the boundaries of human imagination and innovation. We look forward to sharing this adventure with the American people.

Charles F. Bolden, Jr.
Administrator

Achieving Our Vision and Mission

The United States is a world leader in the pursuit of new frontiers, discoveries, and knowledge. NASA performs a unique role in America's leadership in space. We have landed people on the Moon, sent spacecraft to the Sun and almost every planet in the solar system, and launched robotic explorers to travel beyond it. All the work NASA does benefits Americans and people around the world. NASA's budget is spent on Earth, supporting a strong economy and creating spinoffs that improve the quality of life.

Since 1958, NASA has amassed a rich history of unique scientific and technological achievements in human space flight, aeronautics, science, and space applications, including the International Space Station (ISS), improved aircraft safety, and dozens of robotic interplanetary probes, including the first man-made object to reach interstellar space, Voyager 1. These achievements are based on the guiding principles, which are in NASA's authorizing legislation, the National Aeronautics and Space Act (the "Space Act," found at 51 U.S.C. sec. 20101 et seq.). The Space Act directs us to:

- Plan, direct, and conduct aeronautical and space activities;
- Arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations;
- Provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof;
- Seek and encourage, to the maximum extent possible, the fullest commercial use of space;
- Engage in a program of international cooperation; and
- Encourage and provide for Federal Government use of commercially provided space services and hardware, consistent with the requirements of the Federal Government.

Our future success and global leadership will be determined largely by the investments and innovations we make today in scientific research, technology, and our workforce. NASA's focus has always been, and will always be, to discover, invent, and demonstrate new technologies, tools, and techniques that will allow our Nation to explore space while improving life on Earth. This is our passion, our purpose, and what drives our Vision and Mission.

Our Vision

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

Our Mission

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

NASA's Vision and Mission statements remind us of our purpose and our path. NASA's Vision leads to a future with an American-made launch capability supporting cutting-edge science, technology, and human exploration with strong technology and aeronautics programs. We will continue to push the frontier of space. We will develop new technologies for use in air, space, and on the ground. We will be a part of a strong, high-tech economy, and we will continue to partner with other nations to create a better world. We will increase our understanding of the universe and our place in it.

Our Mission statement outlines our fundamental purpose and role in bringing that Vision to life. As the Nation's leading organization for research and development in aeronautics and space, we are explorers and innovators who create and use our unique tools and capabilities for the benefit of the Nation and the world.

Foundations for Our Strategic Plan

Strategic planning at NASA begins with our Vision and Mission, shared core values, and broad overarching approach. NASA's core values of safety, integrity, teamwork, and excellence guide individual and organizational behavior. NASA's overarching approach consists of practices that each organization within NASA employs in developing and executing their plans to achieve our strategic goals. Each of these values guide our leadership in making decisions that optimize performance and stewardship in the current environment. Constant attention to these core values leads to mission success.

Core Values

Safety

NASA's constant attention to safety is the cornerstone upon which we build mission success. We are committed, individually and as a team, to protecting the safety and health of the public, our team members, and those assets that the Nation entrusts to us.

Integrity

NASA is committed to maintaining an environment of trust, built upon honesty, ethical behavior, respect, and candor. Our leaders encourage this virtue in the NASA workforce by fostering an open flow of communication on issues among all employees without fear of reprisal. At NASA, we regard and reward employees for demonstrating integrity. Building trust through ethical conduct as individuals and as an organization is a necessary component of mission success.

Teamwork

NASA's most powerful asset for achieving mission success is a multi-disciplinary team of diverse, competent people across NASA Centers. Our approach to teamwork is based on a philosophy that each team member brings unique experience and important expertise to project issues. Recognition of and openness to that insight improves the likelihood of identifying and resolving challenges to safety and mission success. We are committed to creating an environment that fosters teamwork and processes that support equal opportunity, collaboration, continuous learning, and openness to innovation and new ideas.

Excellence

To achieve the highest standards in engineering, research, operations, and management in support of mission success, NASA is committed to nurturing an organizational culture in which individuals make full use of their time, talent, and opportunities to pursue excellence in both the ordinary and the extraordinary.

Overarching Approach

- **Invest** in next-generation technologies and approaches to spur innovation;
- **Inspire** students to be our future scientists, engineers, explorers, and educators through interactions with NASA's people, missions, research, and facilities;
- **Expand** partnerships with international, intergovernmental, academic, industrial, and entrepreneurial communities, recognizing them as important contributors of skill and creativity to our missions and for the propagation of our results;
- **Commit** to environmental stewardship through Earth observation and science, and the development and use of green technologies and capabilities in NASA missions and facilities; and
- **Safeguard** the public trust through transparency and accountability in our programmatic and financial management, procurement, and reporting practices.

Our strategic direction reflects and aligns NASA's full spectrum of activities to accomplish national priorities in civil aeronautics research, space exploration, science, and advanced research and development. Building on our progress in fostering openness and transparency in Government, we consulted both internal and external stakeholders, including Congress, to identify challenges and opportunities NASA faces in the coming years as we execute this strategic plan. Understanding and mitigating these challenges, while taking advantage of the opportunities, allows us to plan more effectively and ensures that we can accomplish our goals.

For example, other nations are building space programs and may become competitors. But they may also become partners. Opportunities for cooperation can expand our potential and add to our collective accomplishments. Cooperation on the ISS taught us the benefits and intricacies of collaboration in space. Collaborating with more international partners in our endeavors enhances capabilities and enables missions that would otherwise not be possible, but also increases the complexity of planning each mission.

NASA is working on new ways to do business, investing in new technology, and increasing the sustainability, accountability, and transparency in our operations.

- **Finding new ways to do business**

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

- **Investing in cutting-edge technologies**

  As we prepare for the proposed missions to an asteroid and then to Mars, and for the doubling of the global commercial aviation fleet in 20 years, we are entering an exciting time in which we will push the very boundaries of research and technology development. We are implementing a new space technology development and test program with partners from industry, academia, and other nations. This program will facilitate our objectives of building, flying, and testing new technologies that have the potential to increase capabilities, decrease costs, and expand opportunities for future space activities. As the enabler for safe, efficient, and affordable modern air travel, our research and technologies have formed the DNA of all modern aircraft. Through cutting-edge aeronautics research to solve technical challenges driven by global demands for mobility and mitigation of environment impact due to aviation, we will bring transformative innovations to usher National and global air transportation systems into the 21st Century.

- **Increasing sustainability, accountability, and transparency**

  We must invest wisely to ensure sustainable and reliable support for NASA's missions. This means careful management of our infrastructure and workforce. It may also require accepting higher risk on some mission activities. While we strive for sustainability, we must maintain our commitment to the American public to be responsible stewards of the resources entrusted to us. We are sharing our data, our successes, and our setbacks with the public at an unprecedented level. Through our transparency, we want the Nation to understand both why and how our challenging work will create a brighter future.

In the words of visionary computer scientist, Alan C. Kay, "The best way to predict the future is to invent it." NASA is working to invent the future through new technologies and new ways of doing business, and our strategic plan reflects this approach.

Our Strategic Plan and Priorities

This plan outlines the strategic direction, goals, and priorities we will pursue to make our Vision of the future a reality. We have identified three strategic goals that will strengthen NASA's ability to accomplish its Mission and contribute to U.S. preeminence in science and technology, improve life on Earth, and help protect Earth, while also benefiting the American economy. Each strategic goal is discussed in detail in the next section of this plan. Our strategic goals are each supported by several strategic objectives. The first strategic goal focuses on expanding knowledge, capability, and opportunity in space. The second strategic goal focuses on our work to improve the understanding of and life on Earth. Finally, the third strategic goal focuses on major management priorities and challenges.

Strategic Goals

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.

Strategic Objectives

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

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

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

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

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

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

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

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

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

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

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;

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;

Ensure the availability and continued advancement of strategic, technical, and programmatic capabilities to sustain NASA's Mission;

Provide secure, effective, and affordable information technologies and services that enable NASA's Mission; and

Ensure effective management of NASA programs and operations to complete the mission safely and successfully.

Strategic Goals and Objectives

Strategic Goal 1

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

For more than 50 years, NASA has continually expanded the boundaries of science, technology, and imagination. Technologies and ideas that once only existed in the realm of science fiction have become science fact. Proving that the seemingly impossible is possible, NASA helps maintain U.S. leadership in space and creates new generations of space entrepreneurs and enthusiasts who believe humanity's future lies among the stars.

This goal, to expand the frontiers of knowledge, capability, and opportunity in space, encapsulates a cycle of discovery. Every advance in our knowledge provides us unique insights and opportunities to improve our understanding of the universe, which leads to enhanced capabilities in space and on Earth. This, in turn, raises new questions and leads not only to new answers, but also new tools. Expanding our knowledge, capabilities, and opportunities in space is critical for remaining a global leader and returning the dividends of discovery back to Earth.

(Above) Expedition 35 Flight Engineer Chris Cassidy against the Earth's limb during an inspection and repair spacewalk aboard the International Space Station in May 2013. Fellow Flight Engineer Tom Marshburn is reflected in the visor.

Over the next decade, we will develop the new technologies that will open the space frontier for private industry, non-profit organizations, and citizen explorers. We will leverage the ISS one-of-a-kind research and technology development facilities as a test bed for future human exploration missions to deep space, improving how we live, and work in space. We will promote use of the unique micro-gravity environment on the ISS for industrial and academic science and research. We will work with commercial partners to ensure a strong U.S. capability for launching crew and cargo into space. We will complete development of next-generation space systems like the Space Launch System (SLS) and the Orion Multi-Purpose Crew Vehicle to take us past low Earth orbit, and set a pathway to Mars and beyond. We will deploy the James Webb Space Telescope (JWST) to glimpse back in time to the formation of the first stars and galaxies, while our New Horizons mission will uncover knowledge about Pluto and Kuiper Belt objects in the farthest reaches of our solar system. We will advance our understanding of the Sun, its interactions with the solar system, and its impact on the space environment and travel.

NASA's mission continues to broaden our knowledge of the solar system and the universe, develop new technologies, and expand human and robotic exploration capabilities. The achievements of these efforts will benefit the Nation, maintain U.S. leadership in space exploration, and help lead humanity's journey into space. The knowledge and capabilities NASA builds will open new opportunities for discovery and ensure NASA is prepared for the challenges and rewards that come from space exploration.

Expanding the frontiers of knowledge, capability, and opportunity in space is an enduring and core goal for NASA. In the past decade alone, we increased our knowledge of the universe as evidenced by the discovery of more than 2,000 planets in other solar systems. Closer to home, we have expanded our exploration capabilities and sent out robotic sentinels to explore our solar system. The Curiosity rover landed more than 225 million kilometers from Earth and is actively exploring Mars. It has already accomplished its major science goal, discovering a location that could have supported microbial life in the past. We are planning to deepen our knowledge of the working of the interior of planetary bodies by placing a highly sensitive seismometer and associated geophysical instruments on the surface of Mars with the InSight mission. In 2020, we will continue our robotic exploration of Mars with a rover largely built upon the successful Curiosity rover and equipped with new, advanced instruments for in situ studies. It will prepare a scientifically selected cache of Mars samples that may be returned to Earth in the future for detailed analysis seeking possible signs of ancient life.

We are undertaking the detailed examination of near-Earth asteroids to determine what they can tell us about the early solar system, and whether any of these objects pose a threat to Earth. We are expanding our Near Earth Object Observation program, to find candidates for the proposed asteroid mission, and to catalogue asteroids larger than 140 meters across. Specifically, NASA will seek to increase the number of asteroid observations by the amateur astronomer community as a part of the Asteroid Grand Challenge. In 2016, we will launch the OSIRIS-REx mission to robotically approach and return a sample from a carbonaceous asteroid. This will aid in our investigation of planet formation and the origin of life in our solar system, as well as our understanding of asteroids that could impact Earth.

NASA is defining a bold new asteroid initiative that includes planning for an ambitious new mission to identify, capture, and redirect an asteroid to a stable lunar orbit, where astronauts may explore it. The mission will also include an increased role for innovative partnerships and approaches to help us amplify efforts to identify and track asteroids and protect us from any potential threats. This mission

aligns our science, space technology, and human exploration capabilities while engaging new partners and seeking innovative ideas to achieve this bold human and robotic mission. The proposed asteroid mission will advance our solar system exploration capabilities, while helping us learn how to mitigate the danger posed by asteroids crossing Earth's orbit. The second component of the asteroid initiative, the Asteroid Grand Challenge, is to find all asteroid threats to human population and know what to do about them. It is an effort to reach beyond traditional boundaries and encourage partnerships and collaboration with a variety of organizations to solve this global problem. The overall effort will include resources from partners, thus increasing the impact of NASA's initial funding.

NASA has achieved great things for our Nation by embracing bold challenges while managing the associated risks to human lives and assets. Throughout our history, NASA's explorer spirit has led us deeper into the unknown, where we continue to learn from our endeavors.

The missions we pursue under this goal help address national challenges and are allowing us to take advantage of unique opportunities to bring benefits to the Nation. For example:

- **We are moving forward with critical research and technology demonstrations on the ISS.**

  Great advances in understanding human health have come from research on the ISS, which can help prepare us for long-duration space travel, as well as improve the quality of life for aging populations on Earth.

- **We are contributing to healthy, cutting-edge manufacturing and aerospace sectors.**

  For SLS, we are using 3D manufacturing technology to print custom parts for the system, marking a revolution in manufacturing.

- **We are enabling a robust commercial space industry.**

  We are leveraging our public-private partnerships to lower launch costs and create more opportunities for commercial space flight. NASA and its commercial partners have succeeded in maturing commercial cargo transportation capabilities to the point where NASA can buy cargo transport services to the ISS on a commercial basis. We are now working to achieve the same for crew transport to and from the ISS.

- **We are adding to the scientific understanding that may be needed to protect Earth.**

  Recent asteroid passes and the asteroid that exploded over Russia in February 2013 have underscored that we live on a fragile planet in the midst of a chaotic universe. We have been working for years to identify asteroids that could impact Earth. Our proposed asteroid initiative, comprised of both a bold new mission to an asteroid and a global grand challenge to find all asteroid threats to human populations, will help identify the threats posed by some asteroids as well as teach us how to possibly avoid future impacts.

- **We are moving outward, beyond low Earth orbit, into the broader solar system.**

  We are developing SLS and the Orion to carry astronauts farther into space than humans have ever been.

As we make progress toward this goal, we further the knowledge and capabilities of humanity and

we open the door to countless opportunities–in research, technology development, space travel, the exploration of celestial bodies, and the development of commercial markets in space and on Earth. Moreover, we contribute to our Nation's continued role as a leader in space. As we learn more about the universe and improve our ability to explore and live in space, we fuel the innovation that will drive tomorrow's breakthroughs. NASA is proud to be the U.S. agency charged with reaching for the stars and pushing the limits of human knowledge, capabilities, and opportunities. Together with industry, academia, the general public, and other space agencies, we can build a bright future.

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.

NASA engineers and contractors conduct a water impact test of an 18,000-pound (8,165-kilogram) test version of the Orion spacecraft at NASA's Hydro Impact Basin. The first space-bound Orion capsule will launch on Exploration Flight Test-1 or EFT-1, an uncrewed launch planned for 2014. This test will see Orion travel farther into space than any human spacecraft has gone in more than 40 years. Orion will carry astronauts into space, providing emergency abort capability, sustaining the crew during space travel, and ensuring safe re-entry and landing.

Lead office: Human Exploration Operations Mission Directorate

Objective Overview:

Over the next decades, NASA intends to erase the boundaries to human exploration of space. We want to open new frontiers beyond low Earth orbit to humankind. NASA is expanding human exploration by developing the capability to transport humans to and from deep space, enabling the exploration of other planets and asteroids within our solar system using innovative, advanced technologies.

As a starting point, exploring deep space requires the capability to transport cargo and crew beyond low Earth orbit, or farther than 2,000 kilometers beyond Earth. NASA is developing a new transportation system that includes a crew capsule, a heavy-lift launch vehicle, and supporting ground facilities and systems.

NASA is developing technologies to enable the additional capabilities that will be required the farther away from Earth we travel. These include the capabilities for in-space propulsion, in-space operations, long-duration habitation, and other systems to support humans in hostile environments. Precursor robotics, robotic missions that investigate candidate destinations and provide vital information to prepare for human explorers, will lay the groundwork for humans to achieve new milestones in deep space.

The capability to transport humans to and from deep space will leverage incremental development of exploration capabilities that seed future discoveries and innovation, and eventually lead to creation of a permanent, long-term human space presence in the solar system. Our exploration of deep space will reward us with new knowledge. While new knowledge increases our understanding of our planet, our solar system, our universe, and ourselves, Americans expect tangible benefits and applications that we can use on Earth. If the past is prologue, scientists and entrepreneurs will generate new uses for the knowledge and technology resulting from NASA's investments in exploration systems, and this in turn will grow the U.S. economy.

Objective Strategy:

Voyages: Charting the Course for Sustainable Human Space Exploration outlines NASA's strategy for human exploration in deep space. First, it is capability-driven. Each capability provides a specific function that solves an exploration challenge, and in combination with other capabilities, it will advance human presence into our solar system. Second, it is multi-destination. Rather than creating specialized, destination-specific hardware, this provides adequate flexibility to carry out increasingly complex missions to a range of destinations over time. NASA is developing a core set of evolving capabilities to ensure that the Nation's space program is robust, sustainable, and flexible.

We recognize that human space exploration is a global endeavor that must include international partners, and have engaged the international community to jointly develop the *Global Exploration Roadmap*. The roadmap begins with the ISS and then identifies potential paths for human exploration of the solar system, describing a logical sequence of robotic and human missions. The ISS is the cornerstone of future deep-space habitation and exploration activities. Lessons learned from the construction and assembly of the ISS will guide future mission operations for servicing, pre-deploying, or constructing systems in cis-lunar or deep space. Knowledge gained from research and technology demonstrations on the ISS will enable us to design and build future deep space explorations systems.

However, developing the technologies and capabilities for humans to safely explore beyond the bounds of Earth presents challenges.

- **Maintaining Key Schedules**

  NASA is focusing on maintaining key schedules for missions in development, while funding ongoing and new research activities necessary to design future human exploration systems. Using a leaner, more efficient insight and oversight approach, NASA has partnered with industry to develop more cost-effective design and manufacturing techniques to build the systems necessary for exploration. One means is rapid prototyping and flight demonstration of new technologies.

- **New Processes and Tools**

  Although humans have operated space stations in low Earth orbit for over 40 years, we continue to evolve the tools and techniques necessary for deep space exploration. NASA is working to overcome radiation, logistics, and long-term reliability challenges; meet mission constraints; and ensure safe and efficient transport throughout deep space. Future exploration missions in cis-lunar space or beyond will require complex operational staging and phasing to ensure crew, cargo, and exploration systems all successfully arrive at the correct destination. New operational procedures for autonomous rendezvous and docking will be necessary to enable safe and effective missions.

- **Selecting an Asteroid**

  Because there are thousands of known Near Earth Asteroids (NEAs) and likely many more to be discovered, one of the first challenges of a NEA mission is choosing the ideal destination. Distance is another challenge. Although some NEAs pass close to Earth, even within the Moon's orbit, larger and more interesting NEA destinations may be tens of millions of miles away. To reach these NEAs, astronauts would have to travel about six months for a roundtrip, which is a

long time to go without a resupply of water, food, or air—longer than has ever been attempted in space. Therefore, NASA has chosen to bring a small asteroid to us: robotically redirecting an asteroid to a safe orbit around the Moon and visiting it with astronauts via SLS and Orion.

- **Long Mission Durations**

  With current propulsion systems, it will take humans over six months to reach Mars, and due to available flight trajectories, astronauts will either have to leave within 30 days or stay on the surface for more than 500 days. These mission durations significantly exceed our demonstrated capability to sustain life in space without direct support from Earth. Mars missions will also have to overcome several health challenges, such as radiation and the potential health hazard of Martian dust. Once a crew embarks on the longest, farthest, and most ambitious space exploration mission in human history, they will need to be self-sufficient and flexible enough to adapt to changing and unforeseen circumstances. NASA has a multi-pronged approach to address this challenge. We are working with our ISS partners to fly a "one-year increment" on the ISS for an astronaut and a cosmonaut in 2015. And we are working with the broader science and engineering community to develop and fly an in situ resource utilization (ISRU) experiment on NASA's planned Mars 2020 rover mission.

Contributing Programs:

Orion Multi-Purpose Crew Vehicle Program, Space Launch System Program, Exploration Ground Systems Program, and Advanced Exploration Systems

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.

In the ISS's Kibo laboratory, NASA astronaut Chris Cassidy, Expedition 36 flight engineer, conducts a session with a pair of bowling-ball-sized free-flying satellites known as Synchronized Position Hold, Engage, Reorient, Experimental Satellites, or SPHERES. Each satellite is self-contained with power, propulsion, computers, and navigation equipment. The results are important for satellite servicing, vehicle assembly and formation flying spacecraft configurations.

Lead office: Human Exploration Operations Mission Directorate

Objective Overview:

NASA's contribution to society starts with scientific and technological achievement, but extends much further. We are using our resources to spur exploration as well as the new and robust commercial space market. The continued operation of the ISS is critical to achieving NASA's and the Nation's goals in science, technology, and human spaceflight. The ISS is the world's only orbiting, microgravity research and development (R&D) laboratory where researchers may perform multidisciplinary research and technology development to prepare for our exploration of the solar system. Results of research projects will continue to yield benefits in areas such as human health, telemedicine, physical science, Earth observations, space science, and education programs that inspire future scientists, engineers, and space explorers. The Center for Advancement of Science in Space (CASIS), is the sole manager of the ISS National Laboratory, which is a portion of the ISS, and is working to maximize use of the ISS for research in space. The Administration's decision to extend ISS operations until at least 2024 will allow us to maximize its potential and maintain American leadership in space.

The ISS is proving to be a catalyst for the growing commercial space enterprise, as well as a critical springboard for our future space exploration goals. NASA is buying hundreds of millions of dollars of cargo flights from new commercial launch services providers. With the collaboration of five space agencies, 15 nations, and private companies, the ISS is a model for cooperation on future human space exploration missions beyond low Earth orbit.

Objective Strategy:

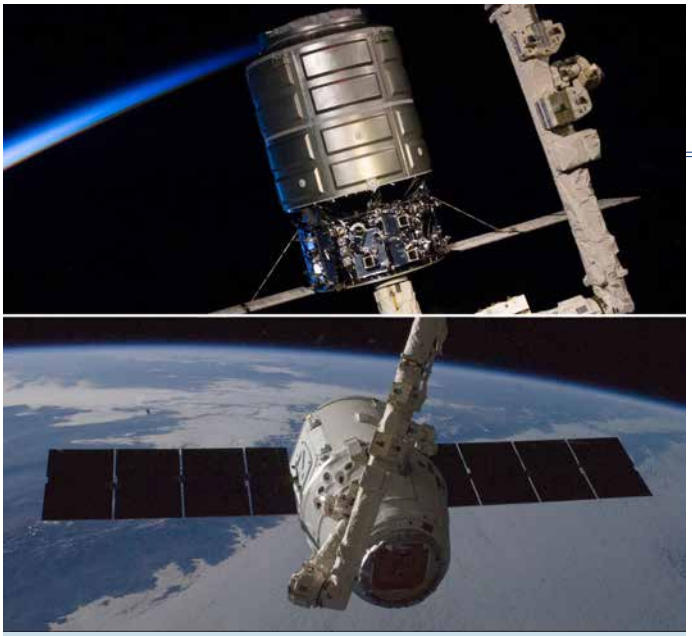
To achieve this objective, we are designing and developing an exploration architecture that includes the technologies, systems, and operational processes, which can be tested and demonstrated

onboard the ISS. The ISS is an outstanding location to test and mature selected technologies and processes, such as environmental control and life support, communications, and navigation and power and propulsion systems, which are required for exploration missions. Research performed on the ISS is essential to understanding how the human body responds and adapts to microgravity and the environment of space. Human research conducted on the ISS will help mitigate the health risks anticipated on exploration missions, such as visual impairment and intracranial pressure, pharmacology, nutrition, and muscle maintenance. We will continue to use innovative approaches on the ISS to develop new means to achieve sustainable exploration of the solar system.

Contributing Programs:

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

Objective 1.3: Facilitate and utilize U.S. commercial capabilities to deliver cargo and crew to space.



A little more than two years after the end of the Space Shuttle Program, the United States now has available two space transportation systems capable of delivering science experiments and supplies from U.S. soil to the ISS. The rockets and spacecraft developed by NASA's partners Orbital Sciences Corp. (top) and SpaceX (bottom) significantly increased NASA's ability to conduct new scientific investigations aboard the orbiting laboratory. All current and planned U.S. experiments aboard the station will be facilitated in some way by a SpaceX or Orbital Sciences resupply mission.

Lead office: Human Exploration Operations Mission Directorate

Objective Overview:

Partnerships with American industry to enable U.S. commercial crew transportation to low Earth orbit will stimulate a commercial industry, promote job growth, and expand knowledge, as well as supply the ISS. NASA envisions commercial human spaceflight to low Earth orbit becoming a robust, vibrant, profit-making commercial enterprise with many providers and a wide range of private and public users. Our role in this enterprise is to provide expertise, incentives, and opportunities to the emerging human space flight industry. We will purchase transportation services to meet our International Space Station crew rotation and emergency return obligations. A vibrant, job-creating, profit-making transportation system for humans and cargo to low Earth orbit will significantly contribute to the national economy.

Objective Strategy:

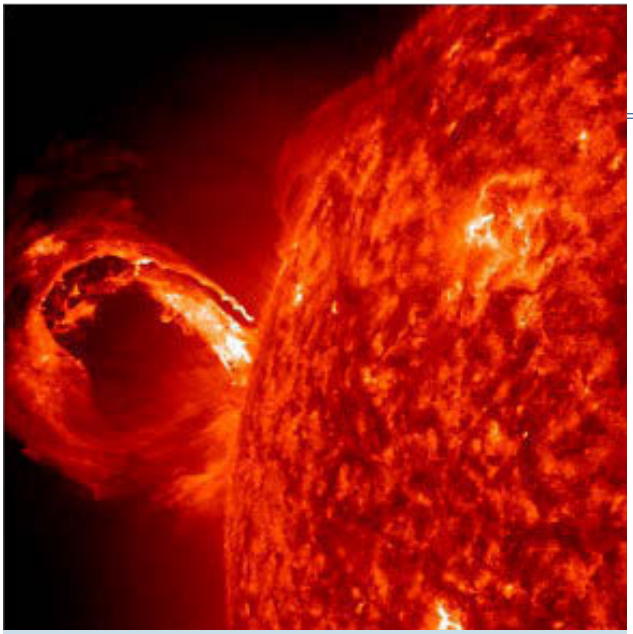
To facilitate and utilize commercial space capabilities, NASA will continue to work with U.S. industry partners to identify and enable emerging commercial space capabilities. This strategy will encourage innovative and entrepreneurial efforts between NASA and the private sector. NASA's existing partnerships with industry have made significant progress in the maturation of commercial human space transportation systems to low Earth orbit.

One of our key challenges in pursuit of this objective is our ability to sustain longer-term gains in the continued development of both the transportation and commercial products and services markets. The current competitive environment provides strong incentives for U.S. industry to meet or exceed NASA's safety requirements, and provides an incentive to industry partners to invest in this endeavor.

Contributing Programs:

Commercial Crew Program

Objective 1.4: Understand the Sun and its interactions with Earth and the solar system, including space weather.



In an increasingly technological world, space weather is a serious matter. Solar flares can temporarily alter the upper atmosphere, creating disruptions with signal transmission from a GPS satellite to Earth, causing it to be off by many yards. Another phenomenon produced by the Sun could be even more disruptive. Known as a coronal mass ejection (CME) these solar explosions propel bursts of particles and electromagnetic fluctuations into Earth's atmosphere. Those fluctuations could induce electric fluctuations at ground level that could blow out transformers in power grids. Particles can also collide with crucial electronics onboard a satellite and disrupt its systems.

Lead office: Science Mission Directorate

Objective Overview:

The domain of heliophysics ranges from the interior of the Sun, to the upper atmosphere and near-space environment of Earth (above 50 kilometers), and outward to a region far beyond Pluto where the Sun's influence wanes against the forces of interstellar space. Earth and the other planets of our solar system reside in this vast extended atmosphere of the Sun, called the heliosphere, which is made of electrified and magnetized matter entwined with penetrating radiation and energetic particles. To increase our understanding of the heliopshere, we seek to answer fundamental questions about this system's behavior: What causes the Sun to vary? How do geospace, planetary space environments, and the heliosphere respond? What are the impacts to humanity?

The emerging science of interplanetary space weather is crucial to NASA's human and robotic exploration objectives beyond Earth's orbit. Humans are presently confined to low Earth orbit, where the planetary magnetic field and the body of Earth itself provide substantial protection against solar storms. Eventually, though, astronauts will travel to distant places where natural shielding is considerably less. Our new long-term exploration initiatives directly rely on our ability to successfully understand, predict, and mitigate impacts of interplanetary space weather.

Objective Strategy:

Scientific priorities for future science missions are guided by the decadal surveys published by the National Academies. The goal of the decadal surveys is to articulate the priorities of the scientific community, and is therefore the starting point for our strategic planning process in Earth and space science. The scientific priorities for heliophysics are guided by the decadal survey, *Solar and Space Physics: A Science for a Technological Society*, published in 2012. Studying the Sun, the heliosphere, and other planetary environments as an interconnected system is critical for understanding the implications for Earth and humanity as we venture forth through the solar system. To that end, the NASA heliophysics program seeks to perform innovative space research missions to understand: (1) the Sun and its variable activity; (2) how solar activity impacts Earth and the solar system; and (3) fundamental physical processes that are important at Earth and throughout the universe by using space as a laboratory. Heliophysics also seeks to enable research based on

these missions and other sources to understand the connections among the Sun, Earth, and the solar system for science and to assure human safety and security both on Earth and as we explore beyond it. A heliophysics roadmap has been developed to advance these scientific objectives and respond to the recommendations outlined in the decadal survey, as well as plan for the longer term. The roadmap includes technology development efforts and scientific research priorities to enable future missions in the priority areas. NASA leadership and program managers actively monitor and manage risks and external factors that pose challenges to our heliophysics science missions. Below, we describe our approach to managing some of the key challenges:

- **Mission Cost Estimation and Management**

  To better control mission cost estimation and management, we transformed how we manage programs and projects, acquisition strategies, and procurements, particularly for our most complex science missions. In particular, we have strengthened program and project management, established more rigorous cost estimation practices, gathered numerous external and internal cost estimates, and incorporated multiple, formal decision points as gates to the next stage of development. Following these steps in the last three years, six missions have launched either under or within their cost and schedule baselines, demonstrating progress in improving NASA's mission cost estimation and management tools. NASA is committed to controlling mission cost for the long-term. We will continue to be rigorous in maintaining these practices and taking additional steps to continue to improve schedule and cost performance to ensure that implementation is consistent throughout projects and programs.

- **Meeting Scientific and Societal Needs**

  NASA's heliophysics scientific research not only advances our understanding of the Sun-Earth-heliosphere system, but also is of growing importance to our Nation's economic well-being and security. Conditions on our variable Sun, its solar wind and atmosphere interact with Earth's electromagnetic environment and result in phenomena known as space weather. These events can disrupt communications, navigation, satellite operations, and electric power distribution. A severe geomagnetic storm has the potential to cause significant socioeconomic loss, as well as impacts to national security. To meet national and societal space weather needs, NASA coordinates its space weather activities with several interagency partners through the National Space Weather Program. NASA's fleet of spacecraft provides observations of solar and geophysical events that are incorporated into operational space weather forecasts and satellite anomaly assessments for use by the Nation. As many of the missions are well past their prime mission lifetime, NASA and the operational partner agencies are studying ways to develop new mission and instrument capabilities that will enable improved space weather prediction algorithms and models. We also develop partnerships with international organizations to enhance our understanding of the heliophysics and the science of space weather.

Contributing Programs:

Heliophysics Research Program, Living with a Star Program, Solar Terrestrial Probes Program, and Heliophysics Explorer Program

Objective 1.5: Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.

A Curiosity self-image taken by the MAHLI (Mars Hand Lens Imager) camera on the robotic arm. The rover is at Rocknest, having taken several soil samples (bottom left) in Gale Crater, with Mt Sharp in the background. Findings indicate that chemical conditions in Gale Crater were once capable of supporting microbial life. Samples determined that Martian soil contains abundant and easily accessed amounts of water.

Lead office: Science Mission Directorate

Objective Overview:

Planetary science continues to expand our knowledge of the solar system, with active missions and Earth-based research programs exploring all the way from Mercury to Pluto and beyond. We seek to answer fundamental questions: How did our solar system form and evolve? Is there life beyond Earth? What are the hazards to life on Earth?

Robotic exploration is the principal method we use to explore the solar system, and is an essential precursor to human exploration of space. Ground-based observations, experiments, theoretical work, and analysis of extraterrestrial materials supplement our space-based assets. Each progression from flybys, to orbiting spacecraft, to landers and rovers, to sample return missions helps advance our understanding of the formation of planetary bodies, the chemical and physical history of the solar system, and the conditions that are capable of sustaining life. The successful Mars Science Laboratory Curiosity, for example, is allowing us to explore the potential habitats for past life on Mars.

Our investment in planetary science helps us protect Earth by identifying and characterizing celestial bodies and environments that may pose threats to our planet. Further, planetary science programs add to the pool of knowledge necessary for future human exploration missions. In support of the Asteroid Grand Challenge, we will enhance our Near Earth Objects Observation program to improve the detection and characterization of potential asteroid candidates for robotic and crewed exploration.

Objective Strategy:

Scientific priorities for future planetary science missions are guided by the recommendations of the decadal surveys published by the National Academies. The goal of the decadal surveys is to articulate the priorities of the scientific community, and the surveys are therefore the starting point for NASA's strategic planning process in science. The most recent planetary science decadal survey, *Vision and Voyages for Planetary Science in the Decade 2013 - 2022*, was released in 2011. This report recommended a balanced suite of missions to enable a steady stream of new discoveries and capabilities to address challenges such as sample return missions and outer planet exploration. NASA's Planetary Science Division is working to implement a balanced portfolio within the available budget and based on the decadal survey that will continue to make exciting scientific discoveries

about our solar system.

NASA leadership and program managers actively monitor and manage risks and external factors that pose challenges to our planetary science missions. Below, we describe our approach to managing some of the key challenges:

- **Mission Cost Estimation and Management**

  To better control mission cost estimation and management, we transformed how we manage programs and projects, acquisition strategies, and procurements, particularly for our most complex science missions. In particular, we have strengthened program and project management, established more rigorous cost estimation practices, gathered numerous external and internal cost estimates, and incorporated multiple, formal decision points as gates to the next stage of development. Following these steps in the last three years, six missions have launched either under or within their cost and schedule baselines, demonstrating progress in improving NASA's mission cost estimation and management tools. NASA is committed to controlling mission cost for the long-term. We will continue to be rigorous in maintaining these practices and taking additional steps to continue to improve schedule and cost performance to ensure that implementation is consistent throughout projects and programs.

- **Availability of Plutonium 238**

  Plutonium 238 (Pu-238) activates and sustains the electrical power systems for spacecraft and planetary probes that cannot rely on solar energy because the Sun is too distant, not consistently observable, or too obscured. NASA's current supply of Pu-238 will be exhausted between 2017 and 2020, but working with the Department of Energy under a reimbursable agreement, NASA is in the process of developing the infrastructure, power system, and flight safety and handling procedures of Pu-238 for domestic production.

Contributing Programs:

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

Objective 1.6: Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars.

A technician stands in front of six JWST primary mirror segments, which, when combined with the observatory's 12 other mirrors, will allow scientists to see the universe light up with the first stars and galaxies that formed after the Big Bang. The JWST is the scientific successor to the Hubble Space Telescope and is scheduled to launch in 2018.

Lead office: Science Mission Directorate

Objective Overview:

NASA leads the Nation and the world on a continuing journey to answer profound questions: How does the universe work? How did we get here? Are we alone? The scope of astrophysics is truly breathtaking, ranging from the birth of the universe and the development of stars and galaxies over cosmic time, to the search for life on planets around other stars.

NASA's astrophysics missions explore the extreme physical conditions of the universe and study the building blocks of our own existence at the most basic level: the space, time, matter, and energy that created the universe. Our telescopes have already measured the current age of the universe to be about 13.7 billion years and have uncovered remarkable new phenomena, such as the mysterious dark energy that dominates the universe. In the future, they will probe the origin and destiny of the universe, including the first moments of the Big Bang and the nature of black holes, dark energy, dark matter, and gravity.

We seek to understand the origin and evolution of the universe, as well as understand the processes for life on other planets. NASA's observatories allow astronomers to explore the processes of formation of stars, galaxies, and planets. We have observed star formation occurring when the universe was at only a few percent its current age. The upcoming James Webb Space Telescope (JWST) will allow us to uncover the mysteries of star formation at an even earlier age, as well as study in detail planets around other stars.

We are navigating a voyage of unprecedented scope and ambition: seeking to discover and study planets orbiting around other stars and to explore whether they could harbor life. NASA's astrophysics missions, in conjunction with ground-based telescopes, have already confirmed the existence of over 2,000 extrasolar planets. Of even greater interest, we are now finding that there are many small, rocky extrasolar planets where liquid water could exist. In the future, NASA's telescopes will continue this breathtaking journey, discovering new planets and observing signatures that could indicate possibilities for life.

Objective Strategy:

Scientific priorities for future astrophysics missions are guided by the decadal surveys published by the National Academies. The goal of the decadal surveys is to articulate the priorities of the scientific community, and is therefore the starting point for our strategic planning process in Earth and space science. The scientific priorities for astrophysics are outlined in the decadal survey, *New Worlds,*

New Horizons in Astronomy and Astrophysics, published in 2010. These include understanding the scientific principles that govern how the universe works; probing cosmic dawn by searching for the first stars, galaxies, and black holes; and seeking and studying nearby habitable planets around other stars. We developed an *Astrophysics Implementation Plan* to advance these scientific objectives and respond to the recommendations outlined in the decadal survey. This plan includes technology development efforts, design studies, and scientific research to enable future space telescopes in the priority areas. Looking towards the longer term, NASA Advisory Council's Astrophysics Subcommittee developed the Astrophysics Roadmap that provides a compelling 30-year vision for astrophysics. The roadmap takes a long-range view and highlights the science possibilities over the next 30 years and provides the inspiration and rationale for continuing American leadership and investment in our astrophysics programs.

NASA leadership and program managers actively monitor and manage risks and external factors that pose challenges to our astrophysics science missions. Below, we describe our approach to managing some of the key challenges:

- **Mission Cost Estimation and Management**

  To better control mission cost estimation and management, we transformed how we manage programs and projects, acquisition strategies, and procurements, particularly for our most complex science missions. In particular, we have strengthened program and project management, established more rigorous cost estimation practices, gathered numerous external and internal cost estimates, and incorporated multiple, formal decision points as gates to the next stage of development. Following these steps in the last three years, six missions have launched either under or within their cost and schedule baselines, demonstrating progress in improving NASA's mission cost estimation and management tools. NASA is committed to controlling mission cost for the long-term. We will continue to be rigorous in maintaining these practices and taking additional steps to continue to improve schedule and cost performance to ensure that implementation is consistent throughout projects and programs.

- **Technology Development and Demonstration**

  To continue solving the mysteries of the universe and to study planets around other stars, NASA will need to develop and launch space telescopes that are more powerful than the current generation of space telescopes. New space telescopes will need to be larger and more capable without being heavier or more expensive. NASA is investing substantially in the technologies necessary to realize these future space observatories, and we are working with partners in the NASA Space Technology Program, industry, and other Government agencies to develop and infuse new technologies.

Contributing Programs:

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

Objective 1.7: Transform NASA missions and advance the Nation's capabilities by maturing crosscutting and innovative space technologies.

NASA's X-1 Robotic Exoskeleton would help astronauts stay healthier in space with the added benefit of assisting those with physical disabilities here on Earth.

Lead office: Space Technology Mission Directorate

Objective Overview:

NASA invests in cross-cutting, transformational space technologies that have high potential for offsetting mission risk, reducing costs, and advancing existing capabilities, which makes achieving more challenging missions possible. These technologies enable a new class of space missions; strengthen our Nation's leadership in space-related science, technology, and industrial base; and foster a technology-based U.S. economy.

Drawing on talent from our workforce, academia, small business, and the broader space enterprise, NASA delivers innovative solutions that dramatically improve technological capabilities for our mission and the Nation. Development and infusion of these new capabilities improves the reliability of future missions and is vital to reaching new heights in space and sending American astronauts to new destinations, such as an asteroid or Mars.

Objective Strategy:

New pioneering technologies will increase the Nation's capability to perform space science, operate in space, and enable deep space exploration. Significant progress in technology areas, such as in-space power systems, solar electric propulsion, radiation protection, next generation life-support, human robotic systems, cryogenic fluid handling, and entry descent and landing capabilities, are essential for future science and human exploration missions. Developing these solutions will stimulate the growth of the Nation's economy by creating new markets in areas such as nanotechnology, robotics, advanced manufacturing, and synthetic biology. Space technology enables future space missions and simultaneously improves life on Earth.

NASA's Space Technology Mission Directorate (STMD) investment strategy addresses the broad range of technology areas identified in our Space Technology Roadmaps, as prioritized by the National Academies. This portfolio approach spans the entire technology life cycle, utilizing a combination of early stage conceptual studies, discovering entirely new technologies (technology readiness level (TRL) 1-3); rapid competitive development and ground-based testing (TRL 3-5) to determine feasibility; and flight demonstrations in a relevant environment to complete the final step toward mission infusion (TRL 5-7). This comprehensive portfolio approach, encompassing both near-term and long-term development, enables the discovery and advancement of necessary technologies that may fundamentally change the way we live and explore our world and the universe.

The Space Technology portfolio draws upon talent from across the space enterprise and leverages

partnerships with industry, academia, other Government agencies, and international partners. We strive to be a model organization, demonstrating lean technology development through effective and efficient practices and principles. Through challenging new missions, multi-use technologies, and stimulation of commercial space markets, NASA's STMD expands capabilities in space and on Earth.

NASA leadership and program managers actively monitor and manage risks and external factors that pose challenges to technology development and maturation. Below, we describe our approach to managing key challenges:

- **The unique nature of NASA science and exploration technology needs**

  The objectives that science and exploration technology solutions must satisfy are often unique to NASA's Mission. Traditional market forces that drive commercial technology developments do not necessarily align with NASA's needs. NASA investments in technology development value partnerships and innovation, incentivizing the creation of new markets while achieving NASA technology goals.

Contributing Programs:

Crosscutting Space Technology Development, Exploration Technology Development, and Small Business Innovative Research/Small Business Technology Transfer

Strategic Goal 2

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

NASA is committed to improving life right here on Earth. Whether developing new aircraft technologies for safer, more efficient air travel, uncovering the complexities of Earth's natural systems, or transferring technologies to the commercial marketplace, NASA has a record of accomplishment in advancing understanding of Earth and helping to improve life for its inhabitants. Every discovery NASA makes, all knowledge gained through our space endeavors, and every advance in technology benefits us on Earth.

We take pride in our ability to inspire people of all ages in the United States and around the world through our pursuits. From landing robots on Mars to teaching in classrooms around the country, we are excited to provide opportunities for people everywhere to engage and participate with us as we push the boundaries of human knowledge and exploration.

NASA will continue to advance research in aeronautics to enable both sustainable and efficient air transportation. Understanding our home planet and improving life on it is central to our mission and is a critical national priority. As we make new discoveries about Earth and environmental change, we are protecting our economic vitality and learning how to be better stewards of our home planet.

(Above) Astronauts aboard the ISS photographed these striking views of Pavlof Volcano in May 2013. The oblique perspective from the ISS reveals the three dimensional structure of the ash plume, which is often obscured by the top-down view of most remote sensing satellites.

The effects of climate change are all around us–more severe storms and hurricanes, droughts, and other natural disasters have both a human toll and an economic toll. NASA is working to understand the mechanisms and possible actions Federal, state, and local agencies and organizations and communities can take to minimize the impacts of environmental change.

NASA improves life on Earth by enhancing our economy through aeronautics research to enable more efficient air transportation. NASA has a long and successful history of pioneering technology breakthroughs that underlie most modern aviation systems. The millions of people and trillions of dollars in cargo that fly every year on commercial aircraft are benefiting from years of NASA research and collaboration with other agencies to get to their destinations faster and with greater safety.

NASA contributes to economic vitality and innovation through the transfer of technologies that generate new revenue for private companies or help foster creation of entirely new ventures. We lend expertise, facilities, and innovations to other Federal agencies and entrepreneurs. From emerging commercial launch providers to robotic mining ventures, NASA is working with U.S. companies to find the right way to encourage these nascent industries–whether through helping to advance key technologies, purchasing launch services for crews to low Earth orbit, lending expertise, or providing launch opportunities to small businesses conducting research.

The missions we pursue under this goal address national priorities and directly benefit both our Nation and the global community. For example:

- **We are tracking and characterizing the mechanisms of environmental change.**

  Our assets in space and on Earth are giving us unprecedented insight into the Earth system and how we can minimize the impacts of environmental change.

- **We are building the next generation air transport system.**

  Together with our partners in other agencies, we are bringing to life a future vision that will enable transformative change to the entire air transportation system.

- **We are strengthening the economy.**

  We are transferring knowledge and technologies, which strengthens the economy though innovation, increased revenue, and job creation.

- **We are cultivating a strong future workforce.**

  We are cultivating scientific literacy and a strong future workforce through STEM education.

As NASA makes progress in understanding Earth and improving the quality of life on it, we benefit through innovations in air travel and new products, services, and companies entering the marketplace. We gain greater understanding of how we can preserve and protect our natural resources while minimizing the impacts of natural disasters on our lives and our livelihoods. As part of our commitment to inspiring the Nation and the world, we will reach out to the public and share our missions and progress.

Objective 2.1: Enable a revolutionary transformation for safe and sustainable U.S. and global aviation by advancing aeronautics research.

The sub-scale experimental X-48C Hybrid Wing Body flies over Rogers Dry Lake in California. The X-48C is a modification of NASA's X-48B blended wing body aircraft modified to evaluate the low-speed stability and control of a low-noise version of a hybrid-wing-body design. The concepts and technologies being demonstrated through these test aircraft could find their way into all types of new aircraft over the next 20 years, enabling more sustainable, environmentally friendly aviation.

Lead office: Aeronautics Research Mission Directorate

Objective Overview:

Aviation is the transportation mode that connects nations, cities, businesses, and people to support a growing and vital global economy. Within the United States, aviation is essential to economic well-being. Aviation contributes more than $1.0 trillion annually to the U.S. economy and supports more than 10 million direct and indirect jobs, including more than one million manufacturing jobs. Aviation comprises more than five percent of the total U.S. gross domestic product. In the United States, more than $1.5 trillion in freight is transported by air every year and air travelers alone spend more than $635 billion a year. Globally, the aviation system is growing rapidly with the potential for more than five times as many passengers and 10 times the cargo in 2050 as today. Since our establishment, NASA has continually advanced America's aviation system to improve our quality of life and productivity on Earth.[1 2]

NASA contributes unique innovations to aviation through our research activities. These innovations serve as key enablers for the role of U.S. commercial aviation in sustaining American commerce and safe, environmentally sustainable mobility, and hence the Nation's economic well-being. NASA's role is to explore early stage concepts and ideas, develop new technologies and operational procedures through foundational research, and demonstrate the potential of promising new vehicles, operations, and safety technology in relevant environments. We are focused on the most appropriate cutting-edge research and technologies to overcome a wide range of aeronautics technical challenges for the Nation's and the world's current and future air transportation system.

Objective Strategy:

To continue our leadership in aviation innovation and enable a revolutionary transformation of the aviation system, NASA is focused on six major research areas, or thrusts, for the long-term future of aviation. These research thrusts utilize the full capability of NASA's in-house aeronautics expertise. Through high-risk, high-reward research and technology development, NASA seeks to enable: safe, efficient growth in global operations; innovation in commercial supersonic aircraft; ultra-efficient

commercial vehicles; transition to low-carbon propulsion; real-time, system-wide safety assurance; and assured autonomy for aviation transformation.

Each thrust is designed to address an important area of research and technology development that will further U.S. leadership in the aviation industry and enhance global mobility. Our research is performed with an emphasis on multi-disciplinary collaboration focused on the critical, integrated challenges aligned to the six research thrusts–what we refer to as convergent research. Together, these research thrusts combine to enable safe, sustainable growth in the overall global aviation system, while pioneering transformative capabilities that will create game-changing opportunities.

We work with our partners in other Government agencies, aligned with the principles, goals, and objectives of the *National Aeronautics Research and Development Policy* and its related *National Aeronautics Research and Development Plan*, to achieve our missions. We also partner with industry and academia to support new and innovative concepts and technologies, and with international counterparts to leverage complementary investments. These partnerships enable innovation, research, and efficient technology transfer.

In pursuit of this objective, we encounter and manage several challenges, including:

- **Inherent Risk**

  We pursue challenging, cutting-edge technology advances and aeronautics research goals that are inherently high-risk. In accepting this risk, we gain valuable knowledge and advance the capabilities of NASA, even when results fall short of expectations. By increasing our knowledge base and developing potential new solutions, we are able to make better-informed decisions regarding committing future research resources and pursuing promising high-return investments.

- **Domestic Partnership Influences**

  Our domestic aeronautics partnerships enable us to leverage investments in support of mutual objectives and avoid duplication of effort. They ensure we are moving forward on the right challenges and improve the transition of research results to users. Through continual coordination with our partners, we mitigate the risk that challenges faced by partners in turn negatively influence our schedules and research output.

- **Growing System Demands**

  As demand for greater global mobility increases, so too does the pressure for the current aviation system to evolve to accommodate that demand, reduce environmental impacts, and improve safety. Because the rate of system change may be greater than that achievable through incremental change, NASA may need to reach for more transformational concepts, which inherently carry more technical and acceptance risk.

- **Strategic Global Partnerships**

  Many developing economies are rapidly developing infrastructure and embracing next generation technologies, and partners around the world increasingly have advanced technical capabilities which complement our own. By carefully fostering international partnerships in pre-competitive areas, NASA supports the efficient and safe growth in global aviation important to the United States and improves the potential for leveraging their investments to reduce duplication while bringing knowledge back into NASA's research programs to improve our own capabilities.

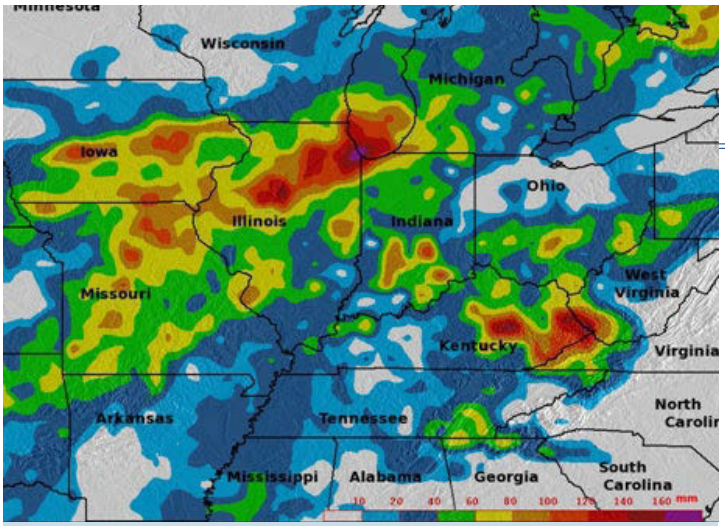
Contributing Programs:

Airspace Operations and Safety Program, Advanced Air Vehicles Program, Integrated Aviation Systems Program, and Transformative Aeronautics Concepts Program

[1] "The Economic Impact of Civil Aviation on the U.S. Economy," August 2011, FAA, (http://www.faa.gov/air_traffic/publications/media/FAA_Economic_Impact_Rpt_2011.pdf)

[2] "IATA Vision 2050," Page 61, IATA, February 2011, Table 16, PDF. (http://www.iata.org/pressroom/facts_figures/documents/vision-2050.pdf)

Objective 2.2: Advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet.



In April 2013, significant flooding occurred in the Midwest and the surrounding region because of extreme amounts of rainfall. NASA's Tropical Rainfall Measuring Mission (TRMM) satellite provides core data sets for such events. TRMM is a research satellite designed to help understand the water cycle in the current climate system. By covering the tropical and semi-tropical regions of Earth, TRMM provides much needed data on rainfall and the heat release associated with rainfall. TRMM data helps begin the process of understanding the interactions between water vapor, clouds, and precipitation that is central to regulating the climate system.

Lead office: Science Mission Directorate

Objective Overview:

Earth's changing environment impacts every aspect of life on our planet and climate change has profound implications on society. Studying Earth as a single complex system is essential to understanding the causes and consequences of climate change and other global environmental concerns. NASA addresses the issues and opportunities of climate change and environmental sensitivity by answering the following questions through our Earth Science programs: How is the global Earth system changing? What causes these changes in the Earth system? How will Earth's systems change in the future? How can Earth system science provide societal benefits?

NASA's Earth science programs shape an interdisciplinary view of Earth, exploring the interaction among the atmosphere, oceans, ice sheets, land surface interior, and life itself, which enables scientists to measure global and climate changes and to inform decisions by Government, organizations, and people in the United States and around the world. We make the data collected and results generated by our missions accessible to other agencies and organizations to improve the products and services they provide, including air quality indices, disaster prediction and response, agricultural yield projections, and aviation safety.

Objective Strategy:

The Earth Science program portfolio comprises the following areas: flight mission development, research, applications development, and technology development. These areas are responsible for conducting and sponsoring research, collecting and disseminating new observations, developing new technologies and predictive capabilities, and demonstrating innovative and practical uses of the program's data and results for societal benefit. In addition, we develop partnerships with other national and international organizations to enhance economic security and environmental stewardship to benefit society.

Scientific priorities for future Earth Science missions are guided by the recommendations of the decadal surveys published by the National Academies, and also are responsive to national priorities. The most recent Earth science decadal survey, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*, was released in 2007. In 2010, NASA released

the report *Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space*. Coupled together, the reports recommended a balanced suite of missions to enable the study of Earth's global climate and the environmental impacts of climate change.

Our leadership and program managers actively monitor and manage risks and external factors that pose challenges to our Earth science missions. Below, we describe our approach to managing some of the key challenges:

- **Mission Cost Estimation and Management**

  To better control mission cost estimation and management, we transformed how we manage programs and projects, acquisition strategies, and procurements, particularly for our most complex science missions. In particular, we have strengthened program and project management, established more rigorous cost estimation practices, gathered numerous external and internal cost estimates, and incorporated multiple, formal decision points as gates to the next stage of development. Following these steps in the last three years, six missions have launched either under or within their cost and schedule baselines, demonstrating progress in improving NASA's mission cost estimation and management tools. NASA is committed to controlling mission cost for the long-term. We will continue to be rigorous in maintaining these practices and taking additional steps to continue to improve schedule and cost performance to ensure that implementation is consistent throughout projects and programs.

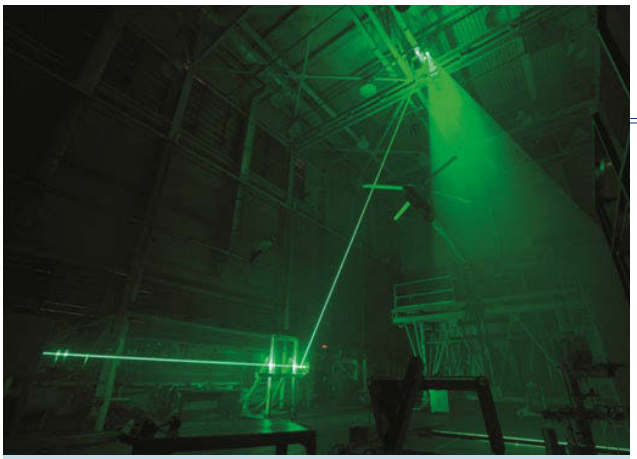
- **Meeting Scientific and Societal Needs**

  NASA's scientific research advances our understanding of Earth while allowing the Nation's decision makers, first responders, and scientific communities to observe the climate and predict extreme weather. Sustained global Earth observations are needed to monitor and study Earth's climate system, land use, and land cover change. NASA is studying the best options and approaches for conducting continuous measurements to meet current societal needs, while continuing to enhance our Nation's global observing capabilities, data systems, and research base required to advance Earth system science and enable further improvements in the products and services that are provided by our partners to citizens around the world.

Contributing Programs:

Earth Science Research Program, Earth Systemic Missions Program, Earth System Science Pathfinder Program, Earth Science Multi-Mission Operations Program, and Applied Sciences Program

Objective 2.3: Optimize Agency technology investments, foster open innovation, and facilitate technology infusion, ensuring the greatest national benefit.



Partnering with NASA, Innovative Scientific Solutions Inc. (ISSI) developed pressure-sensitive paint technology for gathering data from high-speed, unstable surfaces such as rotorcraft blades. The innovation gives NASA new capabilities in aeronautics, and ISSI now sells the product worldwide. Pictured here is a wind tunnel test using a helicopter model equipped with ISSI's paint.

Lead office: Office of the Chief Technologist

Objective Overview:

NASA's missions require that we expand the boundaries of our technological capabilities to explore our solar system, increase our understanding of space, and improve life on Earth. Innovation and invention are the necessary elements that will enable this progress and shape our future. Efficient management of technology investments is more critical than ever. NASA, like other technology development organizations, both Government and commercial, must balance technology investments and promote successful innovation with limited resources.

To optimize the technology portfolio, we seek to align mission directorate technology investments, eliminate duplication, and lower costs while providing critical capabilities that support missions and longer-term national needs. We strive to develop tools and processes to manage the technology portfolio, find better ways to analyze our portfolio, identify mission needs, create roadmaps, set priorities, establish partnerships, and engage scientists, engineers, and the public to invent extraordinary technologies for our future.

Objective Strategy:

NASA's space technology investments will be guided by the Strategic Space Technology Investment Plan (SSTIP), an actionable plan that lays out the strategy for developing technologies essential to the pursuit of NASA's mission and national goals. The SSTIP prescribes a framework and focused approach to guide near-term investment while ensuring the portfolio has the breadth to provide needed capabilities for the next 20 years. This plan will be updated biennially, incorporating emerging technologies, new mission needs, priorities, and partnerships. It will enable NASA to effectively integrate key stakeholder investment strategies in a common-focused approach, to sustain NASA's technological edge and provide benefits to the Nation.

Using innovative approaches to problem solving such as prizes, challenges, and collaborations, we will harness innovators, creating diverse pools of solvers that address NASA problems, advance technology development in a flexible, "on demand" way, and lower mission design costs to leverage Government dollars for technological breakthroughs. NASA embraces participation from partners in industry, academia, and the larger aerospace community with mutual interests in development of breakthrough capabilities that support our aeronautics and aerospace goals, and national priorities. Strategic partnerships are designed to expand and strengthen our ability to execute its mission, and range from non-traditional partnerships to systematic engagements with local, regional, state, national,

and international partners. These partnerships enable us to leverage funding, capabilities, and expertise within and outside NASA to address technology barriers and advance technology. NASA is committed to developing all types of partnerships, including high-impact, multi-disciplinary collaborations to help provide solutions to ambitious yet achievable national targets that advance science, technology, and innovation.

As NASA develops critical components that prove themselves in the lab and advance from prototype to usable system, we will find innovative and better ways to successfully infuse the new technology into our missions, encouraging use beyond the original mission-specific purpose and increase infusion of these technologies into the American economy.

NASA's technology development activities will produce a robust supply of promising technologies that are critical to our missions, have applications to many industries, and boost our economy through the creation of new jobs and markets. We will continue to promote the availability of NASA technologies for use by the U.S. public and private sectors, and accelerate the technology-to-market cycle, enabling realization of benefits more quickly. NASA's growing number of patents, licenses, and software usage agreements demonstrate the giant leap of progress embodied by the technological advances in hardware and software made each year. NASA will make steps to improve the transfer of technology, paving the way for new advances and emerging technologies to serve as the foundation for new products and services, continuing the growth of our economy.

We have a large and diverse technology portfolio consisting of more than 1,000 active projects. Tracking and analyzing this work provides the basis for aligning investments across NASA to reduce costs, increase capability, and provide technologies for the future. Partnering with other Government agencies, U.S. industry, academia, and international entities can enable further progress. Successfully capturing the relevant features of these projects requires an internal cultural change, where mission directorates and offices provide such data openly and work collaboratively to remove internal barriers, creating technology portfolio optimization across NASA. The result of this optimization can be reduced duplication; better synergy among projects, and better use of NASA-developed technology. Further, NASA's chief scientist and chief technologist advise and advocate for NASA on matters concerning NASA-wide science and technology policy and programs. They encourage and foster integration and cooperation across NASA.

Once technology has been developed, we transfer the technology to external users, fostering the development of new products, services, and markets that benefit our Nation. There are a number of challenges that impact our ability to achieve this technology transfer objective. NASA must patent strategically—i.e., only when doing so accelerates transfer of the technology to U.S. industry—and must have an appropriate number of patent attorneys, intellectual property experts and technology transfer experts to do so.

Finally, once technology is transferred, measuring the actual benefit to the Nation is difficult. We have established a few mechanisms to determine the positive impact of our technology transfer; however, the data is incomplete because external users are not required to report to NASA on the positive impact of technology innovations. Despite the risks to success, we are seeking to improve technology-development tracking, analysis, portfolio decision-making, and technology transfer, enabling NASA and the Nation to receive the greatest possible return on investment.

Contributing Programs:

Partnership Development and Strategic Integration

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.

NASA Education addresses national needs in STEM education such as providing unique, STEM-based learning opportunities to populations underrepresented and underserved in STEM. This NASA Education event with the Homeless Children's Playtime Project provided students at the DC General Emergency Family Shelter in Washington, DC with an opportunity to interact with an astronaut, view shuttle models and spacesuits, and learn about NASA's exciting missions.

Lead office: Office of Education

Objective Overview:

NASA's education programs work in collaboration with other Federal agencies to improve the quality of science, technology, engineering, and math (STEM) education in the United States, which supports both NASA's strategic plan and the Administration's STEM policy. To maintain a globally competitive Nation, our education programs develop and deliver activities that support the growth of NASA's and the Nation's STEM workforce, help develop STEM educators, engage and establish partnerships with institutions, and inspire and educate the public. NASA's contribution to STEM education brings immediate benefits to schools and other institutions, while helping to ensure that future generations of Americans will have the technical skills needed to continue NASA's missions. We will continue to engage and involve the public and other stakeholders in our activities, and work to build an open, transparent and participatory organization.

Through effective use of our assets in our STEM education programs, we are able to share NASA's inspirational activities with a broader audience. NASA STEM engagement activities provide learners of all ages the chance to engage in science, technology, engineering, and math, and to understand the value of STEM in their lives. Our learners include: primary, secondary, and higher education students; parents and guardians; formal and informal educators and higher education faculty; and the general public at large. The quality of life we enjoy today is the direct result of the inspiration and achievements of scientists, engineers, mathematicians, and technologists of yesterday. We pursue our objective to ensure future generations of STEM professionals are inspired, experienced, and capable of achieving even greater accomplishments in STEM-related fields. We pursue this objective through a portfolio of NASA-unique STEM experiential learning opportunities (e.g. grants, internships, fellowships, scholarships, workshops) and challenges. These creative applications of NASA-related knowledge encourage innovation, critical thinking, and problem-solving skills, which are characteristics required of our Nation's future STEM workforce.

Objective Strategy:

Our strategy for progressing toward this objective has two components, strategic partnerships and delivery via strategic lines of business. NASA engages in strategic partnerships with intergovernmental, academic, industrial, entrepreneurial, and international communities to ensure NASA's education mission and vision reach a wider and diversified audience. We are determined to do more with less. We facilitate partnerships that support the evolution of our portfolio of projects and strategic objective. We achieve this by defining specific benefits and outcomes for each partnership, systematically managing the lifecycle of partnerships, and leveraging each organization's resources appropriately.

One of our key strategies for achieving effective partnerships in support of our strategic objective is our continued participation in the Administration's Committee on STEM Education (CoSTEM). Through that committee, we work closely with all relevant stakeholders as plans are created and unfold in support of the STEM coordination effort across Federal agencies. This venue allows us to share our best practices and ensure the committee is aware of the inspiring and unique content, assets, and programming that NASA Education can share via partnerships with other institutions and agencies.

NASA's Office of Education leverages its new organizational structure, which includes four key lines of business, and the NASA Office of Education Infrastructure Division (OEID) to enhance our effectiveness and efficiency as we progress in our strategic objective. The four key lines of business are centered on national STEM areas of need—educator professional development, institutional engagement, STEM engagement for all learners, and NASA internship, fellowship, and scholarship opportunities—and they will enable us to ensure our education investments are unique and non-duplicative. The OEID supports NASA's approach to STEM education by implementing the principles of transparency, participation, and collaboration throughout all of its education activities. Through strategic planning, collaborating with the Office of the Chief Information Officer, and supporting the areas of performance assessment, dissemination and Web services, information technology, and communications support using a systematic approach, the OEID lays the foundation for NASA education excellence. The OEID provides support that improves education policy and decision-making, provides better education services, and ensures more effective administration.

Contributing Programs:

Aerospace Research and Career Development Program and STEM Education and Accountability Program

Strategic Goal 3

Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.

NASA is proud to be the U.S. agency charged with exploring the unknown in space and driving new advances in aerospace science and technology on behalf of the American public. Reaching for the stars requires dedicated, knowledgeable people and cutting-edge facilities and capabilities to provide the tools and support necessary to carry out our ambitious tasks. We strive to accomplish our mission with the utmost care—recognizing that we are stewards of taxpayer dollars, critical human capital, and one-of-a-kind facilities. We maintain a large and diverse set of technical capabilities and assets to support NASA missions and the work of other Federal agencies and the private sector to test, validate, and optimize innovations.

We understand that a skilled, valued, and diverse workforce is central to creating and maintaining the capabilities to explore the solar system and beyond and for understanding our home planet. NASA will continue to maintain and ensure the availability and safety of critical capabilities and facilities necessary for advancing our space-, air-, and Earth-based activities. We will provide the vision and leadership to advance critical spaceflight capabilities and ensure American launch vehicles can support our exploration activities. Our activities support a skilled, innovative, and diverse workforce

(Above) Contamination control engineers conduct a review of the James Webb Space Telescope's Mid-Infrared Instrument, as part of the standard receiving inspection. They are looking for the tiniest traces of dust or contamination which would have to be remedied because cleanliness is critical for such a sensitive instrument.

and the safety of that workforce. Further, we strive for management excellence and sustainable practices that assure the wisest uses of our resources.

Our goal is to support all of NASA's space-, air-, and Earth-based research and innovation activities producing the best return on the Nation's investment. We will diligently work to ensure that NASA has the resources necessary to further exploration and aeronautics, understand Earth, transfer knowledge, and share NASA's story. We will continue to engage and involve the public and other stakeholders in our activities and work to build an open, transparent, and participatory organization.

As part of this pursuit, we must ensure that our facilities, resources, and plans are sustainable. This means exploring new ways of doing business. We will advance our efficiency and sustainability through wise investments and innovative approaches to resource management, including divesting ourselves of infrastructure no longer needed, so that we can achieve our core mission within our budget.

The missions we pursue under this goal helps to address national challenges and allow us to take advantage of unique opportunities to bring benefits to the Nation. For example:

- **We are investing wisely**

  We are prioritizing investments and finding innovative ways to operate and sustain our capabilities.

- **We are sustaining and exercising critical national capabilities**

  We are ensuring that cutting-edge capabilities and facilities are maintained and used for advancing innovation and discovery.

- **We are increasing our accountability to the American public**

  We are providing unprecedented transparency into our operations and our performance so that we can share our successes and setbacks with the American public.

We will ensure that innovators, both inside and outside NASA, have access to the critical capabilities entrusted to us to help further NASA's exploration activities and to contribute to U.S. economic strength. Our work toward this goal will help maintain a robust scientific and technical workforce. Finally, we will ensure the long-term security and sustainability of NASA's resources and facilities.

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.

Helen Johnson, a Thermal Design Technician, works on one of the microsatellites before it and two others were shipped to Vandenberg Air Force Base for launch. NASA's highly skilled workforce shares the responsibility to perform challenging technical work with the highest levels of precision.

Lead office: Mission Support Directorate

Objective Overview:

NASA's workforce and institutional capabilities enable us to successfully conduct our missions. We are dedicated to innovation, bold ideas, and excellence, which enable us to provide the day-to-day operations required to support and achieve our missions.

People are our most important resource; without them, no mission can be achieved. We have a workforce that is skilled, competent, and dedicated. Our workforce is committed and passionate, and brings many dimensions of diversity, including ideas and approaches, to make our teams successful. To conduct our missions over the next 20 to 30 years, we must focus on attaining an increasingly diverse workforce with the right balance of skills and talents and provide an inclusive work environment in which employees with varying perspectives, education levels, skills, life experiences, and backgrounds work together and are fully engaged in NASA's Mission.

Objective Strategy:

Placing direct attention on diversity in the workforce is a strategy to further infuse the spirit of innovation into our workforce culture by ensuring that our workforce is equipped to acquire new skills demanded by missions, enhancing productivity, and motivating employees to find new solutions. One of the chief external challenges we face is attracting and building a cadre of science, technology, engineering, and math (STEM) leaders. We face competition from the private sector and academia in hiring top candidates for STEM professions. In addressing this challenge, we work to reach a broad pool of top-notch candidates in STEM disciplines and continue to cultivate an inclusive culture of innovation, one that ensures the near- and long-term well-being of our employees and enables them to work on the cutting edge of their technical or functional disciplines. We continue targeted outreach and recruitment efforts. In addition, we continue to use a variety of methods to increase inclusion and innovation in our workplace through our emphasis on work/life balance and continuous education and awareness opportunities on diversity and inclusion principles.

Our workforce depends on the availability of unique facilities, tools, capabilities, and services to successfully conduct our missions. Planning, operating, and sustaining this infrastructure and our essential services requires a number of critical institutional capabilities including management of:

human capital, finance, information technology, infrastructure, acquisitions, security, real and personal property, occupational health and safety, equal employment opportunity and diversity, small business programs, external relations, internal and external communications, stakeholder engagement, and other essential corporate functions. Providing strategic and operational planning and management over a wide range of functions and services ensures that resources are available when needed, and they support initiatives to help us operate in a more efficient and sustainable manner.

Sustainable management of our infrastructure ensures that our assets support our workforce in meeting mission requirements and schedules. Our strategy is to ensure our assets and overall footprint becomes more sustainable, efficient, and effective. For NASA, this means having a net zero growth in gross square feet in five years and reducing our footprint over the next 20 years. Across NASA, various programs and offices will support this strategy with activities that span demolition, outlease, recapitalization, and construction to mitigate mission risk, maintenance, and real property management, as well as implementing environmental and energy policies. NASA understands that diminishing resources such as workforce skills, funding, environmental systems, and technical capabilities, among others will be critical to achieving and sustaining success. To tackle these challenges, offices across NASA coordinate to optimize strategies for meeting mission requirements, whether that requirement is for equipment, a certain expertise provided by our workforce, or diversity of thought and experience to help foster innovation.

Contributing Programs:

Center Management and Operations, Agency Management, Institutional Construction of Facilities, and Environmental Compliance and Restoration

Objective 3.2: Ensure the availability and continued advancement of strategic, technical, and programmatic capabilities to sustain NASA's Mission

On February 11, 2013, NASA successfully launched the Landsat Data Continuity Mission (LDCM)/Landsat 8. This mission is currently providing repetitive acquisition of high resolution multi-spectral data of the Earth surface on a global basis. On May 30, 2013, NASA transferred control of LDCM/Landsat 8 to the United States Geological Survey.

Lead office: Human Exploration Operations Mission Directorate

Objective Overview:

We identify and prioritize our essential assets and implement strategic investment decisions to sustain, enhance, replace, modify, or dispose of them based on NASA and National needs. We ensure that our key capabilities and critical assets will be available in the future to support the missions that require them. For example, we provide launch services to NASA and civil sector missions, as well as an uninterrupted, reliable space communications network to allow data transmissions to Earth from space. Both of these capabilities are critical to making space missions feasible, safe, and efficient.

NASA's technical capabilities and assets support NASA missions as well as the work of others beyond NASA. Other Federal agencies and the private sector use our specialized facilities to test and evaluate items to mitigate risk and optimize engineering designs. We manage our technical capabilities and assets carefully through strategic investments and sustainable practices that ensure their readiness for NASA and other customers.

Objective Strategy:

Several NASA programs are dedicated to supporting this objective. For example, the Space Communications and Navigation Program manages the infrastructure, sustainment, and replenishment efforts necessary to maintain service capacity and capability consistent with our commitments and mission model. The Launch Services Program provides access to space for robotic missions through U.S. commercial industry.

Each of these programs and offices develop strategies to effectively deliver their contribution to the strategic objective, overcome challenges, and manage risks. These strategies complement our overarching efforts to keep critical capabilities available to support our missions and those of other customers.

Some of NASA's key strategies for this objective are:

- **Provide access to space**

  We have the responsibility, as the launch agent for the Nation's civil space sector, to certify and procure domestic commercial space transportation services for the launch of robotic science, communication, weather, and other civil sector missions. NASA relies on the Launch Services Program to provide robust, reliable, commercial, and cost-effective launch services. NASA achieves assured access to space through a competitive "mixed fleet" approach utilizing the breadth of U.S. industry's capabilities.

- **Ensure the continued full utilization of the NASA Space Network**

  The Space Network consists of a constellation of geosynchronous satellites, ground tracking stations for Earth missions, and the Deep Space Network and its associated ground elements. The network provides mission-critical communications services for the ISS, scientific satellites such as the Hubble Space Telescope, and numerous Earth-observing missions.

- **Manage capabilities effectively**

  NASA's Strategic Capabilities Assets Program (SCAP) is a corporately managed program that selects capabilities or types of assets ("asset classes") for prioritized investment and centralized management to support our needs. Some of these assets include thermal vacuum chambers, motion and space simulators, and wind tunnels. We are working to improve the overall management system of SCAP, including policies, guidance, hardware, software, databases, processes, procedures, and personnel. Our goal is to more efficiently and effectively manage SCAP's capabilities and assets and better collaborate with other Government agencies, academia, and industry. This effort will ensure that our current and future missions have access to needed capabilities and assets that are owned and operated by NASA and outside organizations. The improved management system is being designed and built to enable scaling and use—in part or in whole—for the management of newly identified portfolios of capabilities and assets. In support of NASA's mission, SCAP provides the vision and leadership for these nationally important assets and sustained support for their workforce, capability improvements, and new test technology development. By staying up to date on technological advances, industry demand, and issues that concern the public, we are able to make decisions on facility and capability investments and divestments.

Contributing Programs:

Space Communications and Navigation Program, 21st Century Space Launch Complex Program, Launch Services Program, Rocket Propulsion Testing Program, Exploration Construction of Facilities, Space Operations Construction of Facilities, and Strategic Capabilities Assets Program

Objective 3.3: Provide secure, effective, and affordable information technologies and services that enable NASA's Mission.

Onlookers watch the engaging "7 Minutes of Terror" video to learn about the entry, descent and landing system for NASA's Mars rover Curiosity from the engineers who designed the new landing system. Through the use of innovative information technologies and social media, NASA globally shared a vivid description of the Curiosity rover's final challenging moments before touchdown on August 6, 2012 (EDT). This video is available for you to view here.

Lead office: Office of the Chief Information Officer

Objective Overview:

Information technology (IT) is critical to NASA's infrastructure and mission success. To support NASA's missions effectively, we must inspire excellence in IT planning and service delivery across organizational and functional boundaries. We must find ways to use information technology that supports a more collaborative, geographically diverse and mobile working culture, keeps our IT skills and capabilities up-to-date to serve NASA's missions, and protects those missions from ever-evolving IT security threats.

Our approach to IT planning and service delivery emphasizes responsive innovation, transparency, and accountability. In planning, we take an agency-wide view that considers NASA's diverse mission needs to guide IT policy, investment decisions, and management practices. At the same time, our approach calls for rigorous assessments of investment trade-offs and sequencing to balance the cost, quality, and timing of our IT capabilities to optimize value while limiting mission risk. We will collaborate with NASA leaders to prioritize and sequence our information management investments to deliver the right blend of capabilities over time to effectively and affordably support NASA.

Objective Strategy:

Our invigorated customer focus will drive new capabilities to empower NASA's mobile workforce, simplify collaboration, and engage open public participation in our missions. At the same time, we will continue to improve service consistency and affordability by increasing the use of versatile "as-a-service" delivery models, such as cloud computing and inter- and intra-agency services. To maximize the potential of these approaches, we will evaluate opportunities to further consolidate our enterprise IT capabilities and pool our limited resources to optimize NASA's purchasing power. We will engage our workforce and sustain and develop the appropriate skills and training to chart and manage the ongoing IT transformation across NASA.

Maturing our cybersecurity practices and technologies will be at the forefront of our effort to ensure the secure and resilient delivery of mission support services. We recognize that cybersecurity is a critical driving force to protect the intellectual property, power of invention, and natural ingenuity that is at the heart of NASA. Risk-based information security will be embedded in our capabilities using an approach that balances reduced mission risk with affordability, in alignment with Federal cybersecurity priorities.

We have made significant progress in improving the effectiveness and efficiency of our IT systems.

We have simplified our enterprise information management architecture through the consolidation, standardization, and centralization of IT capabilities where appropriate. Through proactive and strategic management, we work to overcome IT challenges, such as:

- **Keeping pace with dynamic information technology while ensuring cybersecurity**

  New IT sourcing and delivery models, such as cloud computing, are continually evolving as business models and implementation approaches mature across Government and industry. Cyber threats, including advanced persistent threats, continue to evolve globally and NASA's capabilities to protect our information assets must evolve accordingly. These cybersecurity challenges will demand new workforce competencies, balanced collaboration, resource alignment, and timely, effective communications to proactively defend against this ever-changing threat environment.

- **Employing and supporting a variety of IT alternatives to drive productivity and new capabilities**

  In response to the increasingly interdependent way in which people work, we will work to provide the IT infrastructure and workforce training that supports employee mobility, collaboration, and information analytics.

We will continue integration and consolidation when appropriate to improve NASA's efficiency while aligning with forward-looking strategies including shared enterprise services and service delivery that take advantage of cloud computing's flexibility and scalability. Our strategies coupled with risk management will allow us to align NASA's resources to provide and support a cost-effective information management platform that will deliver mission-enabling capabilities.

Contributing Programs:

Agency IT Services Program

Objective 3.4: Ensure effective management of NASA programs and operations to complete the mission safely and successfully.

The NASA Workmanship Program, sponsored by the Office of Safety and Mission Assurance, provides sound uniform engineering and technical requirements and training courses for processes, procedures, practices, and methods that have been endorsed for NASA programs and projects. The quality criteria and training results in high quality electrical interconnects critical to the performance and longevity of missions, such as work on this science instrument, the Neutral Mass Spectrometer for the LADEE mission.

Lead office: Office of Safety and Mission Assurance, Office of the Chief Engineer, and Office of the Chief Health and Medical Officer

Objective Overview:

Safety and mission success programs protect the health and safety of the NASA workforce and improve the likelihood that NASA's programs, projects, and operations will be completed safely and successfully. NASA's commitment to safety and mission success extends to the American public, our employees, our commercial partners, and our contractors. We do this through an environment of trust and ethical behavior using diverse multidisciplinary teams that foster equal opportunity, collaboration, and continuous learning. We promote technical excellence and competence while ensuring safety, reliability, maintainability, quality engineering, and project management within NASA.

Objective Strategy:

Our strategy is based upon integration of both our program portfolio and mission support activities, while using our strong governance structure, risk analysis, and business practices. At the core of the our preventive approach to achieve safety, health, and mission success are:

- **Active engagement** with NASA programs and institutions to advise, advocate, and ensure safety and mission success;
- **Routine on-site inspections and regular self-audits** to ensure compliance with mandatory regulations, NASA policies, industry standards, and best practices;
- **Robust knowledge management and communities of practice** that capture and integrate lessons learned into future missions;
- **Multi-faceted training and development programs** to ensure the safety and mission success workforce has the necessary skills and capabilities; and
- **Comprehensive review processes** to identify and mitigate risks and analyze and understand failures when they occur. This strategy and practice provides a systematic approach to support mission success.

There is a broad spectrum of technical, operational, and environmental challenges and risks that threaten safety and mission success. We are particularly challenged to find innovative ways to protect our people, obtain adequate insight into the safety and probability of mission success for NASA

programs, address externally mandated requirements, and inform senior management of risks. Through proactive management, we remain vigilant. The systematic and timely execution of policy, process, training, assessments, and mishap investigations will continue to be used to anticipate, identify, and address the range of threats to NASA's mission success and explore manageable contingencies.

Contributing Programs:

Safety and Mission Success Program

Looking Forward

Our strategic plan provides us with a clear, unified, and long-term direction for all of our activities. We are committed to launching astronauts, cargo, and science from American soil to the ISS, and realizing the full research capability of our outpost in space. We are building the next great space observatory and will continue to explore our universe with a diverse portfolio of robotic science missions traveling throughout our solar system. And we are developing the technology and capabilities for human space exploration that will take us to an asteroid by 2025 and on to Mars in the 2030s. Humanity's future in space is bright and NASA is leading the way.

Appendices

Appendix A
Developing and Implementing NASA's Strategy

NASA's Vision and Mission reflect our continual pursuit of the long-term goals originally established in the National Aeronautics and Space Act of 1958, outlined in the latest National Space Policy, and emphasized through NASA Authorization Acts and national space and aeronautics policies throughout successive Administrations. The main theme of NASA's strategy, common among these documents, is exploration and research in space and aeronautics, together with international and domestic partners, for the benefit of humankind. Our exploration and research provides benefits by expanding the U.S. economy and increasing our understanding of the universe and the origin of life itself through innovations in science and technology as well as our applications in aeronautics, Earth science, space technology, and other areas.

Our strategic goals and objectives align with our Vision and Mission and reflect both national policies and legislation and the strategic direction and priorities set by the NASA Administrator in consultation with external and internal stakeholders. To ensure that Agency efforts align with our strategic goals and objectives, the NASA Administrator initiated a new effort to formulate a robust Agency strategy for implementation of the external guidance, to translate it into a cohesive portfolio of initiatives, and strategically align policy, programs, and resources. The Administrator created both a strategy implementation process and also refocused an existing council to formulate Agency strategy:

- The Strategy Implementation Planning process identifies Agency issues with long lead times. Through this process, the Administrator provides early-stage strategic direction on these issues. An important strategic question being addressed through these efforts is how to shape a portfolio that provides the most benefit to taxpayers, the national economy, and the world.

- The NASA Strategic Management Council (SMC) was refocused as a forum for formulation of the Agency's strategy. SMC membership includes senior leaders from NASA Headquarters and NASA's Centers. In this forum, the Agency developed NASA's strategic framework based on scenario planning; defined a vision for NASA's future; established an Agency-wide commitment among NASA's leaders on a common strategy to achieve that vision; and initiated a series of activities to focus on specific strategic tasks that will shape the Agency over time. Examples of SMC efforts include: enhancing innovation, assessing opportunities against risks, right-sizing NASA's infrastructure, developing a strategy for partnerships and workforce, impacting culture shift, and prioritizing the Agency's portfolio of activities. These efforts resulted in the articulation of a strategic direction for the whole Agency and stronger alignment of efforts across all NASA Centers.

This approach to setting strategic direction and priorities is rooted in the Agency's core values, and is based on open and transparent dialog among Agency leaders, and consultations with stakeholders. NASA's Mission Directorates, Centers, and other offices follow well-established processes for planning and prioritizing based on consultation with their respective stakeholder groups, while an all-inclusive Agency strategic process takes into account Agency issues and the whole spectrum of NASA stakeholder interests, budgets, and strategic choices. In addition, NASA consults with

Congress specifically on the strategic plan and incorporates its feedback to ensure the Agency's planning is in alignment with national priorities.

NASA's Strategic Management System is a collective set of processes that enables the Agency to perform strategic planning, establish goals and objectives, formulate and implement strategies, allocate resources effectively, and manage safe and successful programs and projects in accordance with applicable laws and policies. NASA's stakeholders expect the Agency to make strategic investments in both workforce and infrastructure to accomplish its missions, develop performance metrics to measure progress towards its strategic goals, and deliver on its performance commitments while operating effectively. This includes conducting rigorous program evaluations and research that inform strategic decision making. The Agency's Strategic Management System also includes tools and processes to increase our capacity for collecting and analyzing program results.

NASA's strategic planning processes create an overarching framework, which is supported by the various Agency organizations that work to accomplish the Agency's Vision and Mission. Long-term strategic planning provides the basis for the programmatic and institutional priorities of the Agency and informs strategic reviews. Strategic planning processes also help NASA identify how the Agency will manage challenges and risks that may be barriers to success.

NASA holds its leadership fully accountable for meeting near-term performance standards and metrics as well as progress towards long-term objectives. Program authorities and the Agency governance councils hold internal reviews on regular basis to monitor and evaluate performance and use the results to support internal management processes and decision making. The Chief Operating Officer (COO) is responsible for reviewing progress towards Agency program and project plans, and addresses cross cutting concerns that may impact mission performance against approved plans. Additionally, NASA's COO and Performance Improvement Officer review progress towards strategic objectives annually by assessing the impact of strategies, implementation of key activities (including multi-year performance goals, annual performance indicators, agency priority goals, and cross-agency priority goals), by leveraging evidence, evaluation, studies, and analysis to identify challenges, risk, and opportunities to ensure mission success.

External shifts in policy, economic conditions, the needs of external communities, partnerships, and industry, as well as changes in internal capabilities, constraints, and challenges, are key factors in NASA's ability to deliver on its organizational commitment to performance and provide maximum benefit to the American public.

To ensure success in a dynamic environment, NASA's long-term strategic planning process is ongoing and iterative to ensure flexibility in the event external guidance or circumstances change and revised strategies are necessary; and provides the basis for the programmatic and institutional priorities of the Agency. The strategic planning process informs the development of NASA's strategic plans and budget allocations, and helps identify how the Agency will deal with challenges and risks that may be barriers to success. NASA strives to be proactive in its strategy, reflecting the Agency's commitment to continued leadership in space exploration, technology, innovation, and scientific discovery.

Appendix B

FY14-FY15 Agency Priority Goals

This appendix incorporates NASA's FY14-FY15 agency priority goals (APGs) in the strategic plan. An APG supports improvements in near-term outcomes and advances progress toward longer-term, outcome-focused strategic goals and objectives in the Strategic Plan. It is a near-term result or achievement that leadership wants to accomplish that relies predominantly on agency execution to be accomplished. Agency priority goals reflect the top implementation-focused, performance priorities of Agency leadership and the Administration, and therefore do not reflect the full scope of our Mission.

Goal statements for the APGs are as follows:

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.

- This APG supports 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.

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.

- This APG supports 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.

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.

- This APG supports Objective 1.3: Facilitate and utilize U.S. commercial capabilities to deliver cargo and crew to space.

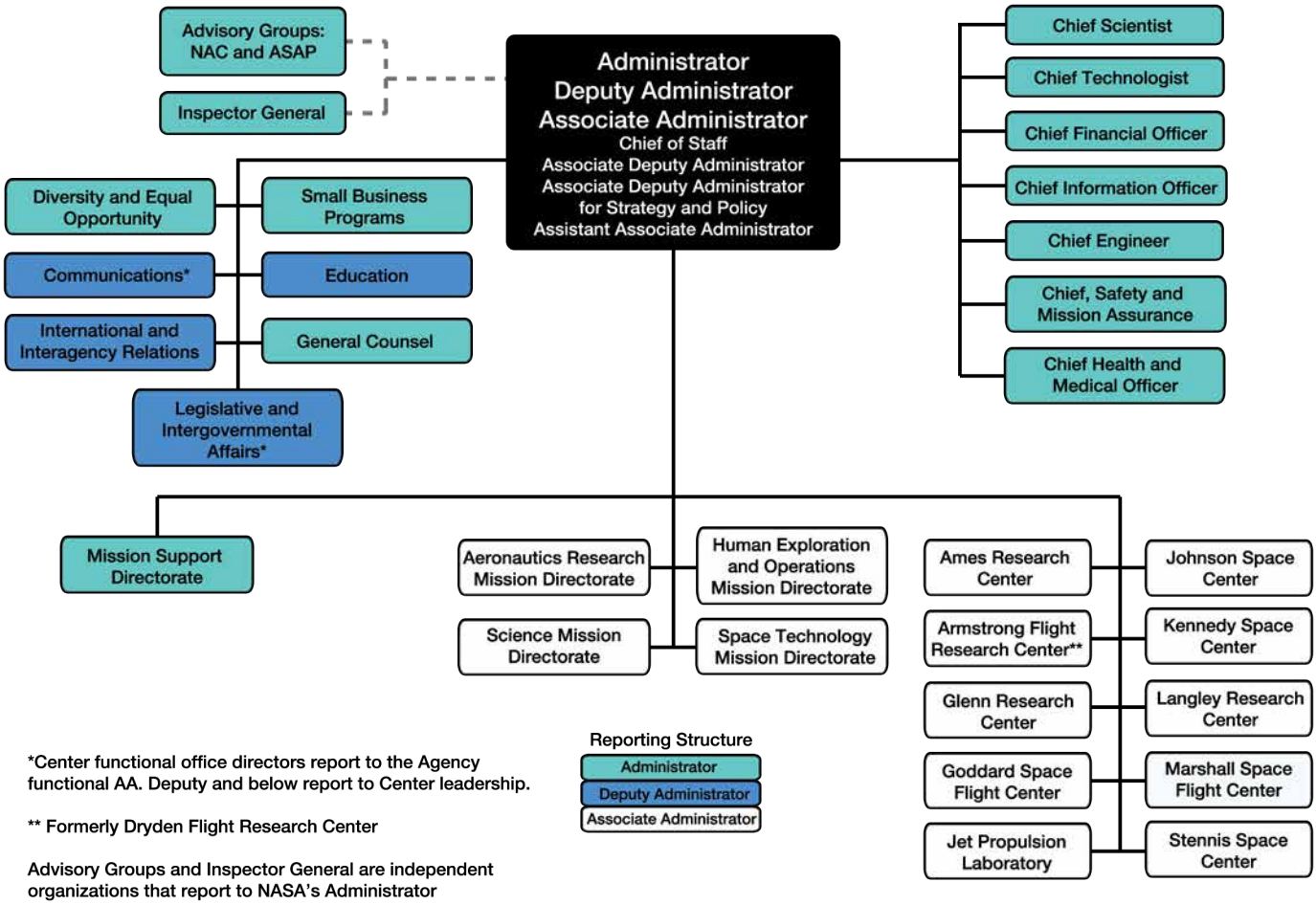
By October 2018, NASA will launch the James Webb Space Telescope, the premier space-based observatory. To enable this launch date, NASA will complete the James Webb Space Telescope primary mirror backplane and backplane support structures and deliver them to the Goddard Space Flight Center for integration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

- This APG supports Objective 1.6: Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars.

More information on these APGs, as well as NASA's contribution to Federal cross-agency priority goals, is available on http://www.performance.gov.

Appendix C

Organization and Structure



*Center functional office directors report to the Agency functional AA. Deputy and below report to Center leadership.

** Formerly Dryden Flight Research Center

Advisory Groups and Inspector General are independent organizations that report to NASA's Administrator

More information on each organization is available on http://www.nasa.gov.

Appendix D

Center and FFRDC[3] Strategic Goal Contributions

Overview

NASA Headquarters in Washington, DC provides overall guidance and direction to the Agency under the leadership of the Administrator. Nine Centers and one federally funded research and development center conduct the day-to-day work in laboratories, on air fields, in test facilities, and in control rooms. This skilled, diverse group of scientists, engineers, managers, and support personnel share the Vision, Mission, and strategic direction described in this plan. Together NASA employees perform the work that supports NASA's strategic goals and many of the Nation's priorities. This appendix highlights many of their contributions to advancing NASA's Mission.

Ames Research Center (ARC)

Strategic Goal 1: Ames Research Center manages and supports a variety of missions that advance exploration and science. ARC provides hardware and critical life science research payloads for ISS. To support technology development and exploration, the arc jet at ARC enables critical heat shield development for Orion as well as for commercial vehicles. In addition, ARC scientists and engineers provide expertise in small satellites, which expands our low cost opportunities for exploration. IRIS, a Heliophysics mission managed from ARC, will help us understand our relationship to the Sun. In support of planetary science, ARC's CheMin instrument on the Mars Science Laboratory's Curiosity rover enables an understanding of the Martian surface, while the LADEE mission provides an understanding of lunar dust dynamics. ARC also manages the Kepler mission, which is searching for exoplanets.

Strategic Goal 2: ARC provides leadership in developing innovative NextGen airspace tools, enabling automation for air traffic management, reduced weather and congestion delays, and higher fuel efficiency. ARC leads Airborne science missions for NASA providing observations of atmospheric, land, and ocean processes. ARC leads the NASA Earth Exchange (NEX), providing data sharing and promoting scientific collaboration to more rapidly advance our understanding of Earth's climate change.

Strategic Goal 3: ARC partners with a rich variety of leading non-traditional international partners, educational institutions, and high tech companies in Silicon Valley. These partnerships, many at our NASA Research Park, stimulate and enable new intellectual talent, ideas, and technologies to sustain and advance NASA's missions. ARC has over 200 partnerships and attracts nearly 1,000 summer students to work alongside NASA scientists and engineers, providing a rich future talent pipeline for the Agency.

Learn more about Ames Research Center at http://www.nasa.gov/centers/ames/.

Armstrong Flight Research Center (AFRC)

Strategic Goal 1: Armstrong Flight Research Center (formerly Dryden Flight Research Center) provides essential capabilities in carrying out many of the Agency's missions. AFRC supports the SLS control law development by using its test assets to simulate portions of the launch trajectory, continuing to be part of the launch abort system test team, and supporting the Commercial Crew Program. AFRC supports ISS operations by providing a communication link and the ability for tracking radars. In

[3] Federally Funded Research and Development Center

addition, AFRC supports the development of innovative space technologies through the management of the Flight Opportunities Program, which provides a low-cost means to mature technologies through a wide range of sub-orbital flight opportunities.

Strategic Goal 2: AFRC operates aircraft platforms and supports technology development, research, and education. Flight tests on unique platforms such as the X-48, X-56, and G-III SCRAT provide knowledge we can use to reduce noise and emissions, and improve efficiency of, commercial aircraft. Flight tests also provide critical research data for advanced supersonic aircraft. AFRC is the focal point for the integration of unmanned aircraft systems (UAS) in the National Airspace System.

AFRC supports Earth science research through the operation of aircraft platforms that provide the capability to fly a wide range of science instruments and collect in situ data from low to high altitudes.

AFRC supports technology development through ground and flight research. The Center's capabilities have been used to advance electric propulsion, evaluate hyper-elastic materials, and assess the feasibility of towed launch concepts for reduced launch cost.

Armstrong provides primary support for the Agency University Affiliated Research Center Program and supports education initiatives through the unique partnership with the AERO Institute. The Airborne Astronomy Ambassadors on SOFIA and the Student Airborne Research Program on the DC-8 provide educators and students the unique ability to engage in hands on science activities.

Strategic Goal 3: AFRC has made it a priority to increase the diversity of the workforce and the overall inclusiveness of the work environment. The Center focuses on having quality people with the appropriate competencies in mission-critical activities.

Armstrong manages and ensures the strategic availability of a minimum critical suite of aeronautical test facilities, support aircraft, laboratories, and the western aeronautical test range necessary to meet the long-term aerospace testing requirements for the Nation.

Learn more about Armstrong Flight Research Center at http://www.nasa.gov/centers/dryden/.

Glenn Research Center (GRC)

Strategic Goal 1: Glenn Research Center's contributions to exploration beyond low Earth orbit include the development of critical subsystems for SLS, Orion, and leadership of the European Service Module international partnership. GRC projects in spacecraft fire safety, chemical and electric in-space propulsion and transportation stages, human research, and systems architecture studies are all advancing human exploration beyond low Earth orbit. GRC supports the Human Research Program by developing medical devices and exercise equipment that mitigate health risks for explorers. The Center is also vital to the Space Communications and Navigation program, leading spectrum management and communications architecture and technology development for future exploration missions. GRC allows use of wind tunnels, space simulation chambers, and large-scale environmental simulation test facilities to commercial partners. Reaching farther into the solar system poses increasing challenges in power, propulsion, and communications. The Center will help overcome these challenges by developing advanced in-space propulsion and power capabilities, including cryogenic propellant storage and transfer technologies and electric propulsion systems to enable travel to destinations outside the reach of chemical propulsion systems.

Strategic Goal 2: GRC develops revolutionary technologies and critical system capabilities to achieve

major improvements in fuel use, safety, reliability, and maintainability, while also realizing major reductions in environmental noise and emissions in all types of aircraft and rotorcraft. GRC's efforts have produced advanced technology that has been adopted by engine, aircraft, and spacecraft manufacturers. Furthermore, to facilitate technology infusion from the private sector into NASA's missions, GRC partners with small businesses in innovative research, which results in new technologies on aircraft such as the Boeing 787, as well as advanced optical reflectors, electrically-powered thrusters, and lightweight solar arrays on future spacecraft.

Our current focus is on developing propulsion technologies with the specific objectives of monitoring and reducing engine-specific fuel consumption, nitrogen oxide, carbon oxide emissions, and engine noise, as well as understanding their impact to the environment. Glenn also develops sensor and instrumentation technologies to enable improved Earth and environmental sensing and observation on-board aircraft. Working in support of NASA's Earth Science Technology Office, GRC develops networking and communication protocols to enhance the production, collection, and transmission of data.

Since 2011, NASA Glenn Education Leadership has assisted nationally recognized STEM education experts, researchers, other Federal agencies, and implementers to help frame future solicitations and support from the Department of Education and partners across the 50 states.

Strategic Goal 3: GRC fosters a highly skilled, diverse, and engaged workforce and develops integrated roadmaps for workforce, facilities, labs, information technology, Center operations, and services. We provide these services in a timely, safe, and cost-competitive manner to meet customer needs in an environment that ensures success through empowerment, diversity, and teamwork.

Learn more about Glenn Research Center at http://www.nasa.gov/centers/glenn/.

Goddard Space Flight Center (GSFC)

Strategic Goal 1: Goddard Space Flight Center both enables and conducts science research from space. GSFC research expands knowledge, national capability, and space-based opportunities through the execution of a preeminent program of scientific research in the areas of Earth science, planetary and lunar science, heliophysics, and astrophysics. The research uses measurements from space complemented by suborbital, ground-based, and laboratory measurements; numerical modeling; and theoretical investigations. GSFC directly supports the needs of the science community through collaborative development and operation of a broad spectrum of flight missions and field campaigns.

GSFC teams work with other NASA Centers, academia, and industry to conceptualize, design, build, test, integrate, and operate space, airborne, and ground-based missions, spacecraft, and state-of-the-art instruments. GSFC's in-house renowned space and Earth scientists help to focus the driving scientific requirements and then process, analyze, and utilize the mission-derived data from spacecraft to produce essential science products that advance critical knowledge needed about our place in the universe. The Center also has responsibility for the Wallops Flight Facility and the Agency's Independent Verification and Validation facility.

Strategic Goal 2: GSFC combines a comprehensive scientific program of research on Earth's natural systems and processes with a multidisciplinary engineering staff that develops and demonstrates new technologies and drives constant advances in scientific understanding to meet societal needs. Research from the Space Weather Program furthers our understanding of the Sun's effects on Earth,

provides situational awareness for national space assets, and advances scientific knowledge of the solar system as it relates to life and living on our planet.

GSFC designs, fabricates, tests, and operates remote-sensing satellites and airborne and ground-based instruments, and analyzes observational data from all three vantage points, providing a comprehensive picture of the current state of our environment and contributing to the development and refinement of models to predict the environment's future. These data are available to the world's scientists and universities, and we develop data assimilation approaches that optimize the use of space-based measurements to support human needs. The general public is provided an increasingly larger window into research outcomes and their benefit to society via GSFC-driven social media and public outreach efforts. Research conducted at Goddard's Institute for Space Studies emphasizes a broad study of global change, and prediction of atmospheric and climate changes in the 21st century.

Strategic Goal 3: GSFC provides the key workforce, infrastructure, and mission-enabling activities critical to achieving Agency objectives. The Center assembles and sustains its employee base with forward-looking leadership and management practices, a supportive work environment, and adaptive work systems and processes. GSFC teams develop and operate the space and ground network systems that enable communication for NASA's groundbreaking scientific, human and robotic, exploration missions, as well as providing and operating spaceflight tracking and data acquisition networks. GSFC teams close this flow of data and information through their development and maintenance of advanced information systems for the display, analysis, archiving, and distribution of Earth and space science data. GSFC staff is establishing and maintaining satellite servicing capabilities essential to extending the lives and improving the functionality of valuable observatories in orbit. GSFC's Wallops Research Range provides operational capabilities that enable launch and aircraft operations worldwide supporting NASA's science, technology, and educational programs, as well as supporting the mission needs of other Federal agencies, academia, and industry.

By leveraging its people, technical capabilities and infrastructure, GSFC is able to make advancements towards the strategic goals though its mission-validated capabilities to conceive and engineer new missions; acquire data through the space- and ground-based world-wide network systems it manages; the command, control, and simulation systems it builds and operates; and the science systems it fields to capture, process, and archive the science analysis products it extensively distributes. The positive impact of these results can be observed every day, from the satellite images seen in televised weather reports to the images of recovered victims made possible through the search and rescue capabilities GSFC enables.

Learn more about Goddard Space Flight Center at http://www.nasa.gov/centers/goddard/.

Jet Propulsion Laboratory (JPL)

Strategic Goal 1: Jet Propulsion Laboratory leads NASA's robotic exploration of space beyond Earth orbit. JPL's missions to all planets in the solar system provide the foundation of our understanding of the origin, evolution, and destiny of Earth itself. JPL contributes groundbreaking scientific investigations and enabling technologies for NASA's programs in astrophysics, Earth and planetary science, and heliophysics. Supporting these programs is JPL's end-to-end mission capability in which innovative ideas advance from the initial concept to spacecraft and instruments, to operation in flight, and to the generation of knowledge. The Center's capabilities in deep space robotics have enabled more than a decade of continuous presence on Mars by rovers, an initial step toward human exploration of the planet. Missions to asteroids and small bodies in the solar system employ JPL's expertise in low-

thrust propulsion, guidance, navigation, and proximity operations. And, JPL's Interplanetary Network is the communication hub for all deep space missions. JPL is especially active in the pursuit of habitable environments within and beyond the solar system, and manages the Mars and Exoplanet Exploration programs for the Agency.

Strategic Goal 2: JPL's broad expertise in instruments designed for observing many of the physical parameters relevant to understanding the Earth's interconnected processes, coupled with a rich scientific program of research and analysis of Earth's systems and a program that develops and demonstrates related new technologies, drive constant advances in our ability to create data products leading to actionable information for resource managers and decision makers. JPL's end-to-end expertise (observation, data analysis, visualization and mining, model validation) and robust collaboration network provides a comprehensive picture of the current state of the Earth's climate, and contributes robust datasets to the improvements of models to predict the climate's future. This data is made readily available to the world's scientists and universities and the general public. The effort of both our scientists and our media and outreach personnel helps inform the public of the research outcomes and their benefit to society. JPL's data and images are experienced by tens of millions of people each year. Tens of thousands of teachers and hundreds of thousands of students participate in our programs annually.

Strategic Goal 3: JPL workforce and infrastructure provide proven key end-to-end capabilities that are critical to achieving Agency objectives, especially for innovative robotic space missions. Some of the capabilities and infrastructure that JPL manages, such as the Deep Space Communications Network, are unique assets that enable NASA's deep space mission telecommunications and navigation. JPL proactively recruits and develops a diverse and dynamic workforce, which coupled with an innovative work environment, stand ready to meet the future needs of the Agency. With a very productive technology and scientific research staff, and the innovative use of ground-based, aircraft and small satellite demonstrations, JPL continues to advance the state of the art to enable the Agency to meet the challenges of the future. Through its management of NASA's Small Business Innovative Research and Small Business Technology Transfer programs, JPL actively enhances the national technology base by funding and guiding advanced technology development within innovative small businesses. JPL also excels at technology transfer to the commercial sector, as exemplified by over 50 commercial licenses over the past five years.

Learn more about the Jet Propulsion Laboratory at http://www.nasa.gov/centers/jpl/.

Johnson Space Center (JSC)

Strategic Goal 1: Johnson Space Center is a hub of NASA human spaceflight activity. As the nucleus of the Nation's astronaut corps, home to the International Space Station program and mission operations, and a host of future space developments, the Center plays a pivotal role in use of the International Space Station as a cornerstone of human exploration, enabling the emerging human spaceflight industry, and extending human exploration beyond low Earth orbit.

JSC provides technical expertise, ISS domain knowledge, and facility usage; serves as a key customer; and manages commercial cargo resupply and commercial crew efforts (co-led with Kennedy Space Center). JSC also provides leadership for the development of Orion, several Advanced Exploration Systems projects, Human Research Program, and technology development efforts.

The Center has curatorial responsibility for all NASA extraterrestrial materials. Our expertise in this area results in critical support of robotic planetary science missions, particularly of Mars, asteroids and

comets, and the Moon. We also integrate NASA Earth observation activities with ISS utilization for research and International Disaster Charter.

Strategic Goal 2: JSC emphasizes engagement in mutually beneficial partnerships to maximize economic and societal impact. Our technology initiatives are aligned to optimize investments and national benefit. Investments are leveraged to facilitate technology transfer and intellectual property utilization. JSC also provides STEM experiences for educators, students, and faculty by leveraging Human Space Flight missions and subject matter experts, with the goal to engage all generations to advance human space exploration. STEM impact is enhanced through strategic partnerships with other Government agencies and academia.

Strategic Goal 3: The Center's capabilities allow JSC to continue to be a leader in human spaceflight, as well as provide opportunities for other NASA programs to take advantage of JSC-unique expertise, test facilities, and labs located in Houston, Texas and the White Sands Test Facility in Las Cruces, New Mexico. JSC is committed to making NASA exploration missions safe and successful, starting with ISS and leading to a mission to Mars, by attracting and growing a highly skilled innovative and inclusive workforce; by pursuing advanced technical and business approaches; and by making smart decisions about the size of our infrastructure and the roles of our partners.

Learn more about Johnson Space Center at http://www.nasa.gov/centers/johnson/home/.

Kennedy Space Center (KSC)

Strategic Goal 1: Kennedy Space Center manages the Commercial Crew Program (CCP) that facilitates development of U.S. commercial crew space transportation to and from low Earth orbit and the ISS. This lets NASA continue crew rotations and execute science on the ISS, including some KSC plant research and biology experiments. KSC is developing ground systems and plans for Orion and SLS assembly and integrated test, for the 2014 Orion test flight, the SLS missions, and beyond. KSC is also developing or maturing crosscutting and innovative technologies, including RESOLVE, Ka-BOOM, and IGODU.

Strategic Goal 2: KSC optimizes Agency technology investments by leading ISRU technology development for multiple destinations, advancing research and technology through integrated testing in relevant environments, developing external payload carriers, and fostering innovative partnerships. KSC advances aeronautics research by developing innovative metal alloys to improve safety of spacecraft and aircraft. KSC collaborates with partners to advance STEM learning. Partners include K-12 schools, universities, the Florida Department of Energy, and youth and service organizations.

Strategic Goal 3: KSC's major transformation from a single customer to multi-customer launch complex is vital to the success of both NASA and commercial space industry. To support NASA and our partners' success, KSC ensures and provides launch services and access to space for NASA missions. KSC continually evaluates and aligns its highly valued people, and programmatic and institutional capabilities. KSC implements rigorous and innovative safety, IT, and communication services to ensure quality and reliability of products.

Learn more about Kennedy Space Center at http://www.nasa.gov/centers/kennedy/.

Langley Research Center (LaRC)

Strategic Goal 1: Langley researchers contribute to human exploration beyond low Earth orbit (LEO) by

supporting Orion and SLS. LaRC leads Agency-level systems architecture studies and uses systems analysis to identify technologies required to explore beyond LEO. LaRC also improves crew safety through leadership of the Orion Launch Abort System and development of heatshield and landing systems, including conducting key water-impact tests.

LaRC supports deep-space exploration through Advanced Exploration Systems projects in radiation protection; advanced sensor systems for automated hazard detection and avoidance during entry, descent, and landing (EDL); autonomous rendezvous and docking; and advanced composite structures. LaRC supports the Human Research Program by developing radiation transport and design codes and establishing computational frameworks to enable future biological countermeasure development. LaRC leverages its workforce, wind tunnels, and other experimental facilities to partner with commercial companies developing a new U.S. capability to access LEO and the ISS.

Human-scale Mars missions require more landed mass than ever before, and LaRC projects applying breakthroughs in lightweight materials and structures, nanotechnology, and hypersonic aerodynamic inflatable decelerators for EDL will be key to NASA's success. LaRC partners extensively with industry, academia, and other NASA Centers on technology demonstration missions in solar electric propulsion, cryogenic propellant storage and transfer, and low-density supersonic decelerators.

Strategic Goal 2: LaRC and its partners continue to advance aeronautics research by focusing on ways to reduce aircraft noise around airports, boosting aircraft fuel efficiency, and creating new ways of relieving air-travel congestion in flight and on the ground. For example, LaRC is participating in the Agency's Environmentally Responsible Aviation Project. This project is concentrating on aircraft concepts and technologies to reduce the impact of aviation on the environment over the next 30 years.

Researchers in Langley's Science Directorate help advance our understanding of Earth's atmosphere and climate. Langley's Atmospheric Science Data Center houses the world's most comprehensive collection of atmospheric data, about 50 times the total holdings of the Library of Congress, which serves 130,000 customers in 160 countries. A series of instruments developed by LaRC for NASA's Earth Observing System, known collectively as the Clouds and the Earth's Radiant Energy System mission, or CERES, is a world-renowned source of information about global climate. This is among several Earth observation projects that LaRC is leading.

Strategic Goal 3: LaRC has plans in place to attract a skilled workforce and provide it with the infrastructure and tools needed for success. This multi-year workforce transformation plan is strategically aligned with mission priorities and new business opportunities. The Vibrant Transformation to Advance LaRC, or ViTAL, is another key plan that lays out how Langley will demolish its old buildings and replace them with energy conserving state-of-the-art facilities and to improve other facilities. This effort could save $105 million in maintenance and utility costs and eliminate $141 million in deferred maintenance over the 20-year life of the plan. This plan is synchronized with the Comprehensive Digital Transformation plan and workforce strategies to ensure effective management of programs and operations to complete the mission safely and effectively.

Learn more about Langley Research Center at http://www.nasa.gov/centers/langley/.

Marshall Space Flight Center (MSFC)

Strategic Goal 1: Throughout its history, Marshall Space Flight Center has served as the space transportation design, development, and manufacturing leader for the Agency. Today, Marshall leverages

its expertise with large-scale, complex systems to develop the SLS, and the propulsion, structural, life support and engineering systems that open the space frontier. MSFC also serves as the 24/7 command post for ISS science and sustains the ISS life support systems. NASA engineers and scientists use MSFC test facilities to simulate space and ensure the success of JWST and other observatories. Marshall scientists study the Sun's dynamics to improve forecasts, use the Chandra Observatory and other instruments to study the universe, and expand our understanding of Heliophysics.

Strategic Goal 2: MSFC develops, tests, and manages instruments that study Earth to improve agriculture, urban planning, severe weather planning, and water resource management. The SERVIR program managed from MSFC uses NASA satellite data to help developing countries manage resources while the ISERV camera on the ISS captures images beneficial for disaster relief. MSFC manages competitions and explores technologies to stimulate the economy and excite students. Through partnerships and technology transfer, MSFC shares technologies and fosters collaboration.

Strategic Goal 3: Managers at MSFC continually pursue opportunities to improve affordability in all phases of program implementation and to reduce schedules. MSFC ensures sustainable exploration by investing in promising technologies and taking risks with high payoffs, such as developing composite tanks, additive manufacturing, digital design methods and advanced modeling with the goal to reduce development cycle time by half. Additionally, MSFC manages sustainable facilities, including green buildings, and enables technology demonstration missions and innovative centennial challenge competitions. Marshall promotes safety, embraces diverse viewpoints, and mentors young engineers and scientists who operate International Space Station experiments, test rocket engines, and study the universe.

Learn more about Marshall Space Flight Center at http://www.nasa.gov/centers/marshall/.

Stennis Space Center (SSC)

Strategic Goal 1: Stennis Space Center provides and manages the resources, facilities, and expertise to provide the Agency and aerospace industry with propulsion test capabilities spanning research, development, qualification, and acceptance testing to enable successful launch services required for the strategic objectives. Specific programs supported by SSC are the SLS, Launch Services Program, Commercial Resupply Service, and Commercial Crew Program.

Strategic Goal 2: SSC conducts Earth science research and develops innovative tools and techniques to enable others to use Earth observations when responding to environmental crises, establishing policies, or conducting business. SSC develops novel technologies that enable and encourage public participation in NASA science and pursuit of STEM careers by students. SSC manages the Agency's Gulf of Mexico Initiative and supports the Applied Sciences Program, OCO-2/3, and SWOT.

Strategic Goal 3: SSC aligns all Center-level activities with Agency-level directives and actions to ensure consistent approaches are implemented in pursuing the management and development of workforce, propulsion test technical capabilities (including facilities and infrastructure), Earth science research technical capabilities, information technologies, and development of effective management of all Center activities to support NASA's missions.

Learn more about Stennis Space Center at http://www.nasa.gov/centers/stennis/.

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Appendix E

Brief Guide

The following page is a "tear away," trifold brief guide to the 2014 NASA Strategic Plan. It includes:

- Vision and Mission Statements
- Core Values
- Strategic Goals
- Strategic Objectives
- Overarching Approach
- Links to Important Web Sites

Vision

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

Mission

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

Core Values

- Safety
- Integrity
- Teamwork
- Excellence

Overarching Approach

- **Invest** in next-generation technologies and approaches to spur innovation;
- **Inspire** students to be our future scientists, engineers, explorers, and educators through interactions with NASA's people, missions, research, and facilities;
- **Expand** partnerships with international, intergovernmental, academic, industrial, and entrepreneurial communities, recognizing their roles as important contributors of skill and creativity to our missions and for the propagation of our results;
- **Commit** to environmental stewardship through Earth observation and science, and the development and use of green technologies and capabilities in NASA missions and facilities; and
- **Safeguard** the public trust through transparency and accountability in our programmatic and financial management, procurement, and reporting practices.

More Information

» Full Strategic Plan, Performance Plan, and Budget: http://nasa.gov/news/budget/index.htm
» Agency Priority Goals: http://goals.performance.gov/agency/nasa
» Cross-Agency Priority Goals: http://goals.performance.gov/goals_2013

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www.nasa.gov

National Aeronautics and Space Administration

Strategic Plan 2014

www.nasa.gov

Strategic Goal 1

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

By empowering the NASA community 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.

Strategic Goal 2

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

By engaging our workforce and partners to…

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.

Strategic Goal 3

Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure

By working together to…

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.

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