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November 17, 2011

Statement of
The Honorable Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration

before the

Subcommittee on Science and Space
Committee on Commerce, Science and Transportation
U. S. Senate

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the outlook for NASA's human space flight program. This has been a remarkable year, as we have completed assembling and outfitting of the U.S. On-orbit Segment (USOS) of the International Space Station (ISS), allowing us to focus on full utilization of the Station's research capabilities; taken key steps in moving forward into the future of exploration beyond Low-Earth Orbit (LEO); celebrated the 50th anniversary of human spaceflight; and witnessed the successful conclusion of the historic Space Shuttle Program. We are also pleased with the progress our industry partners have made in developing an American capability to transport cargo and eventually astronauts to the ISS, and end the outsourcing of this work to foreign governments. More importantly, this will add a critical level of redundancy for transporting cargo and crew to the ISS. A robust transportation architecture is important to ensuring full utilization of this amazing research facility. Enabling commercial crew and cargo transportation systems in LEO allows NASA to focus on developing its own systems for sending astronauts on missions of exploration beyond LEO. This split between commercial and Government systems allows for a cost effective approach to promote a broad base for human exploration by the United States.

International Space Station

The ISS is the culmination of the efforts of the United States and its Canadian, European, Japanese, and Russian partners to work together to construct a highly complex and capable spacecraft with components built in many nations around the globe, launched from four different space centers, and assembled on orbit by astronauts conducting over 160 spacewalks. It represents an unparalleled capability for human space-based research. The STS-135 mission, flown by Space Shuttle Atlantis in July of this year, marked the conclusion of the successful Space Shuttle Program after 30 years of flight, as well as the completion of major assembly and outfitting activities on the ISS. The Station, including its large solar arrays, spans the area of a U.S. football field and end zones, and weighs over 860,000 pounds, without its variety of visiting vehicles. The complex has more livable room than a conventional five-bedroom house, and has two bathrooms, a fitness center, a 360-degree window, and, most importantly, state of the art scientific research facilities that can support a large variety of research disciplines. Examples include high-energy particle physics, Earth remote sensing and geophysics experiments, protein crystallization experiments, human physiology research (including bone and muscle research), radiation research, plant and cultivation experiments, combustion research, fluid research, materials science experiments, and

biological investigations. Since November 2, 2001, when the crew of Expedition 1 docked with the ISS, the Station has been visited by more than 200 people, and has been continuously crewed for over 11 years. With the docking of Soyuz 28S to the ISS on November 16, 2011, the Soyuz crew exchange capability is restored. The planned December 2011 docking of Soyuz 29S will restore the crew complement to six for a nominal six-month duration.

Beyond being a feat of unparalleled engineering and construction, as well as international collaboration, the ISS is a place to learn how to live and work in space over a long period of time. It is a place to conduct research and development (R&D) that cannot be pursued on Earth due to our gravitational field. The three major science laboratories aboard the ISS -- the U.S. *Destiny*, European *Columbus*, and Japanese *Kibo* facilities – as well as external test beds, enable astronauts to conduct a wide variety of experiments in the unique, microgravity and ultra-vacuum environment of LEO. It is important to note that the Station supports R&D across an array of disciplines, including biology and biotechnology, Earth science, space science, human research, physical and materials science, and technology development. This means that R&D conducted aboard Station holds the promise of new discoveries not only in areas directly related to NASA's exploration efforts, but in fields that have terrestrial applications, as well. The ISS will provide these opportunities to scientists and technologists through at least 2020.

In the NASA Authorization Act of 2005 (P.L. 109-155), Congress designated the U.S. segment of the ISS as a National Laboratory, and directed NASA to seek to increase the utilization of the ISS by other Federal entities and the private sector. To this end, on February 14, 2011, NASA issued a cooperative agreement notice, and on August 31, 2011, the Agency finalized a cooperative agreement with the Center for the Advancement of Science in Space (CASIS) to manage the portion of the ISS that operates as a U.S. National Laboratory. NASA has made solid strides in its effort to engage other organizations in the ISS program, and the Agency now has Memoranda of Understanding with five Federal agencies and Space Act Agreements with nine companies and universities.

While the ISS offers extraordinary opportunities for advancing science and technology to other U.S. Government agencies, non-profit research foundations, and private firms, it will also continue to meet NASA's mission objective to prepare for the next steps in human space exploration – steps which will take astronauts beyond LEO to destinations such as the asteroids, the Moon, and eventually, Mars. The ISS is NASA's only long-duration flight analog for future human deep space missions. It provides an invaluable laboratory for research with direct application to the exploration requirements that address human risks associated with deep space missions. It is the only space-based multinational research and technology test-bed available to identify and quantify risks to human health and performance, identify and validate potential risk mitigation techniques, and develop countermeasures for future human exploration.

In addition to the direct research benefits to be gained by utilizing the ISS as a National Laboratory, this innovative arrangement also supports NASA's effort to promote the development of a LEO space economy. National Lab partners can use the unique microgravity environment of space and the advanced research facilities aboard Station to enable investigations that may give them the edge in the global competition to develop valuable, high technology products and services. Furthermore, the demand for access to the ISS will support the providers of commercial crew and cargo systems. Both of these aspects of the U.S. segment of ISS as a National Laboratory will help establish and demonstrate the market for research in LEO beyond the requirements of NASA.

U.S. Commercial Cargo and Crew Transportation Services for the ISS

Commercial Orbital Transportation Services (COTS) and Commercial Resupply Services (CRS)

In the area of commercial cargo transportation, NASA has implemented a two-phased approach for developing and procuring services: Commercial Orbital Transportation Services (COTS) to develop and demonstrate commercial cargo transportation capabilities; and Commercial Resupply Services (CRS) to procure cargo resupply services to and from the ISS. NASA is pleased with the progress being made by Space Exploration Technologies, Inc. (SpaceX) and Orbital Sciences Corporation (Orbital) on both of these efforts.

We anticipate that these providers will begin transporting cargo to the ISS in 2012 -- a challenging endeavor that will mark a significant milestone for both companies. NASA and these providers have spent many years preparing for the full utilization phase of ISS; now is the time when we will begin to see the fruits of this planning and development. NASA is engaged in ISS utilization and with the help and dedication of these providers; the ISS will be more extensively utilized and positioned to demonstrate the benefits of space-based R&D more widely to the world.

Commercial Crew Development (CCDev)

NASA's investments have been aimed at stimulating efforts within the private sector to develop and demonstrate human spaceflight capabilities through the CCDev initiative. Since 2009, NASA has conducted two CCDev rounds, soliciting proposals from U.S. industry to further advance commercial crew space transportation system concepts, and mature the design and development of elements of the system, such as launch vehicles and spacecraft. In the first round of CCDev, NASA awarded five funded Space Act Agreements (SAAs) in February 2010, which concluded in the first quarter of 2011. Awardees and the amounts of the awards were: Blue Origin, $3.7 million; the Boeing Company, $18.0 million; Paragon Space Development Corporation, $1.4 million; Sierra Nevada Corporation, $20.0 million; and United Launch Alliance, $6.7 million. Under these SAAs, companies received funding contingent upon completion of specified development milestones, all of which were successfully accomplished by the CCDev industry partners.

During the second CCDev competition, known as CCDev2, NASA awarded four funded SAAs that are currently being executed with the following industry partners:

- Blue Origin's work involves risk-reduction activities related to its reusable biconic shaped Space Vehicle, which is to be launched first on an Atlas V launch vehicle, and then on Blue Origin's own Reusable Booster System. As of October 31, 2011, Blue Origin had successfully completed five of ten milestones and NASA had provided $11.2 million of the $22 million planned for this effort.

- The Boeing Company is maturing its concept for a capsule-based spacecraft that will be reusable for up to ten missions and be compatible with multiple launch vehicles. As of October 31, 2011, Boeing had successfully completed five of fifteen milestones and NASA had provided $52.5 million of the $112.9 million planned for this effort.

- Sierra Nevada Corporation (SNC) is maturing its Dream Chaser, a reusable, piloted lifting body, derived from NASA's HL-20 concept that will be launched on an Atlas V launch vehicle. As of October 31, 2011, SNC had successfully completed five of thirteen milestones and NASA had provided $30 million of the $105.6 million planned for this effort.

- SpaceX is maturing its flight-proven Falcon 9/Dragon transportation system focusing on developing an integrated, side-mounted Launch Abort System. Their crew transportation system is based on the existing Falcon 9 launch vehicle and Dragon spacecraft. As of October 31, 2011, SpaceX had successfully completed four of ten milestones and NASA had provided $40 million of the $75 million planned for this effort.

In addition to the four funded agreements mentioned above, NASA has also signed SAAs without funding with three companies: Alliant Techsystems, Inc. (ATK); United Launch Alliance (ULA); and Excalibur Almaz, Incorporated (EAI). The ATK agreement is to advance the company's Liberty launch vehicle concept. The ULA agreement is to accelerate the potential use of the Atlas V as part of a commercial crew transportation system. The EAI agreement is to further develop the company's concept for LEO crew transportation. As of October 31, 2011, ATK had successfully completed one of five milestones; ULA successfully completed two of five milestones; and EAI had completed one of five milestones.

Commercial Crew Program (CCP)

The CCP is a partnership between NASA and the private sector to incentivize companies to build and operate safe, reliable, and cost effective commercial human space transportation systems. In the near term, NASA plans to be a partner with U.S. industry, providing technical and financial assistance during the development phase. In the longer term, NASA plans to buy transportation services for U.S. and U.S.-designated astronauts to the ISS. We hope that these activities will stimulate the development of a new industry that will be available to all potential customers -- including the U.S. Government -- putting U.S. industry in a leadership role for this new market.

On September 19, 2011, NASA released a draft Request for Proposals (RFP) for Phase 1, entitled Commercial Crew Integrated Design Contract (CCIDC), inviting industry to comment on the process. The final CCIDC RFP will incorporate input from industry as appropriate and solicit proposals for a complete end-to-end crew transportation and rescue system design, including spacecraft, launch vehicles, launch services, ground and mission operations, and recovery. NASA plans to release the final RFP for this effort by the end of 2011.

NASA has been told consistently by a broad range of potential providers that private sector partners expect to be able to achieve the capability to provide commercial spaceflight services to the ISS within 3-5 years from initial development start. NASA's FY 2012 budget request of $850 million for CCP would provide that initial start in FY 2012 for the development of commercial crew transportation systems, which NASA believes would enable services to ISS to be possible in the 2016 timeframe. A reduction in funding from the President's request could significantly impact the program's schedule, risk posture, and acquisition strategy. NASA's *initial* analysis shows that a FY 2012 funding level of $500 million (consistent with the 2010 NASA Authorization Act) implemented with the current contract-based NASA acquisition strategy would delay initial capability to ISS to 2017, assuming additional funding is available in the outyears.

Preparing for the Next Giant Leap – Supporting Beyond-LEO Exploration

NASA is aggressively moving forward with our next generation human spaceflight system by developing the Orion Multi-Purpose Crew Vehicle (MPCV) and Space Launch System (SLS), which will take astronauts beyond LEO for the first time since the Apollo-17 lunar mission of December 1972. NASA's plans include an uncrewed system test flight of the Orion and SLS in 2017, and a crewed test flight in 2021.

In addition, we are planning to conduct Exploration Flight Test-1 (EFT-1), an uncrewed, two-orbit, high apogee, high-energy-entry, low-inclination test mission that is targeted for flight in early FY 2014. This early exploration flight test is critical to providing early data to influence design decisions and serving as a pathfinder to validate innovative new approaches to space systems development that will reduce the cost of exploration missions. The EFT-1 utilizes an early production variant of the Orion spacecraft that will be integrated on a Lockheed Martin-procured, commercially available heavy class launch vehicle. This launch vehicle will require performance capability to launch a mass of approximately 18 metric tons to provide the energy and guidance capability to achieve reentry conditions required to validate Orion's heat shield performance.

The EFT-1 spacecraft will make a water landing and will be recovered using the 21st Century Ground System (21CGS) recovery forces planned for future human exploration missions. The proposed flight test provides an opportunity to significantly inform critical design by operating the integrated spacecraft hardware and software in flight environments that cannot be duplicated by ground testing.

Orion Multi-Purpose Crew Vehicle (MPCV)

In May 2011, I approved the Orion-based reference vehicle design, outlined in NASA's January 2011 report to Congress, as the Agency's MPCV. The Orion, which was already being built to meet the requirements of a deep-space vehicle, maps well to the scope of the MPCV requirements outlined in the NASA Authorization Act of 2010. The Agency's current contractual partnership with Lockheed Martin Corporation will therefore be used for at least the development phase of the MPCV.

The MPCV will transport crew from the Earth's surface to destinations beyond LEO, eventually providing all services necessary to support a crew of up to four for up to 21-day missions. For very long beyond-LEO missions, such as exploration of Near Earth Asteroids (NEAs) or other planetary bodies, additional elements – a space habitation module for example – will be included to provide long-duration deep space habitation capability.

Mounted on top of the SLS for launch and ascent, the MPCV will be capable of performing abort maneuvers should an emergency arise, to safely separate from the launch vehicle and return the crew to the Earth's surface. MPCV will also be capable of performing in-space aborts if conditions require the immediate safe return of the crew. The vehicle will include the necessary propulsive acceleration capability to rendezvous with other mission elements and return the flight crew from the destination to the Earth's surface. In-space operations, such as rendezvous and docking and extravehicular activities, will be performed with the MPCV in conjunction with other mission elements.

The MPCV will be capable of efficient and timely evolution, allowing for an incremental or "block" development and mission capability approach. This will enable early progress to be made on the fabrication of key design aspects, depending on available funding, while utilizing early testing to buy down risks associated with subsequent block configurations. Each test cycle will also provide an opportunity to on-ramp or off-ramp capabilities as the design evolves.

Moving forward, work on the MPCV will focus only on the deep-space design. While the MPCV could be called upon to service the ISS as a contingency effort – a backup requirement established by the NASA Authorization Act of 2010 (P.L. 111-267) -- it should be well understood that utilizing the vehicle for routine ISS transportation would be a very inefficient and costly use of the MPCV deep-space capability. NASA is confident in the ability of our commercial and international partners to provide all currently foreseen support for the ISS. Therefore, there is no intention to conduct routine LEO missions with the MPCV.

Space Launch System (SLS)

On September 14, 2011, I selected the design of a new launch vehicle – the SLS – that will take the Agency's astronauts farther into space than ever before, create high-quality jobs here at home, and provide the cornerstone for America's future beyond LEO human space exploration efforts. This new heavy-lift rocket will be America's most powerful since the Saturn V rocket that carried Apollo astronauts to the Moon and will launch humans to places no one has gone before. SLS's early flights will be capable of lifting 70-100 metric tons before evolving to a lift capacity of 130 metric tons.

The new rocket will use a liquid hydrogen and liquid oxygen propulsion system. The vehicle's core stage will utilize existing Space Shuttle Main Engines (SSME RS-25D) for the initial capability (the first four or five missions, depending on manifest requirements). NASA is planning to develop an expendable version of the SSME (RS-25E) which would have lower manufacturing costs but still provide the engine performance needed, particularly specific impulse in a vacuum environment. NASA's use of the SSME inventory will reduce initial design costs and take advantage of an existing human-rated system. NASA plans to modify and use the existing SSME contract with Pratt & Whitney Rocketdyne to acquire engine servicing and testing for the initial launch system.

The upper stage of the SLS will also use a liquid hydrogen and liquid oxygen propulsion system that includes the Ares I upper stage engine, the J2X. NASA intends to modify the existing Ares I Upper Stage contract with Boeing to develop the SLS core stage and upper stage and will also utilize the existing J2X contract with Pratt Whitney Rocketdyne to continue developing the upper stage engine. The Ares I Upper Stage Production Contract is the only means to meet SLS milestone schedules and avoid substantial duplication of cost, and the Ares I Upper Stage has the same functionality as the SLS Core and Upper Stage elements. NASA also plans to modify and use the existing Ares Instrument Unit/Avionics contract.

While NASA plans to use five-segment solid rocket boosters for at most the first two initial capability flights of the SLS, there will be a competition to develop the follow-on boosters based on performance requirements. On October 7, 2011, the Agency released a Request for Information for Advanced Development of the follow-on systems boosters and received over 30 responses from the aerospace industry.

Beyond LEO Exploration with Orion MPCV and SLS

The primary purpose of the Orion MPCV and SLS heavy lift vehicle is to conduct crewed deep space missions of exploration beyond LEO. Together, they represent the foundational building blocks and key enablers for both our national and international human spaceflight exploration enterprise.

The Orion MPCV and SLS launcher will provide the United States with the flexibility to conduct missions to a variety of compelling destinations beyond LEO, including NEAs, the Moon, the moons of Mars, and Mars itself. The "horizon destination" for human space exploration is Mars, as it represents a compelling destination for both robotic and human space exploration missions. A human exploration mission to Mars will need vital technology, systems and operational development to succeed in this tremendously bold and challenging endeavor. NASA is working to develop new technologies to support human missions beyond LEO through its Space Technology and Advanced Exploration Systems (AES) programs.

Advancing Space Exploration Technologies

NASA recognizes that any future human exploration effort is largely dependent on developing breakthrough technologies that will enable us to safely go farther and faster into space and at a lower cost. By investing in high payoff, disruptive technology that industry does not have today, NASA matures the technologies required for future missions, while proving the capabilities and lowering the cost of government and commercial space activities.

NASA has been working with the National Research Council to develop Technology roadmaps for the Agency. Much like the Science decadal surveys, these roadmaps will help guide our investment strategy to ensure NASA is advancing the technology it needs for future human exploration. In a draft report released to the public late this summer, the National Research Council made a stark observation by noting that, "NASA's technology base is largely depleted, and few new, demonstrated technologies are available to help NASA execute its priorities in exploration and space science."

Internally, NASA has identified several critical technologies to advance human exploration. Within the Space Technology program Congress authorized, NASA is working toward a FY 2016 flight demonstration to test long-term storage and transfer capabilities for cryogenic fluids. Improved capabilities in this area, in combination with the SLS heavy-lift vehicle, will bring deep-space exploration closer to reality. In addition, Boeing and a team of engineers from four NASA Centers are working together to develop two large-scale, lightweight composite cryogenic propellant tanks for validation and qualification testing in FY 2013 that promise to achieve weight and cost savings as compared to traditional aluminum lithium tanks and may be used on future heavy-lift launch vehicles. Other significant investment includes acceleration of the in-space propulsion and space power generation and storage ground-based technology development efforts required to reduce risk for a future planned solar electric propulsion demonstration that will enable efficient deep-space transportation that is required for deep-space exploration.

Other technology work in development includes the following:

- At Goddard Space Flight Center (GSFC) in Maryland, a team is developing a laser-based, deep space communications system that will revolutionize the way we send and receive data, video and other information, using lasers to encode and transmit data at rates 10 to 100 times faster than today's systems which will be needed for future human and robotic space missions.

- At NASA's Jet Propulsion Laboratory (JPL), a team is developing a Deep Space Atomic Clock, which utilizes a key component from the Johns-Hopkins Applied Physics Laboratory, that will dramatically improve navigation and guidance in future deep space missions, and may lead to an improved Global Positioning System (GPS) in support of activities here on Earth.

- At JPL and the Langley Research Center, engineers are working to develop lightweight planetary entry systems that will enable large mass, high elevation and pinpoint landing capabilities required for Mars and other planetary destinations.

- At Johnson Space Center, a team is working to build on the Robonaut 2 demonstration on ISS and further NASA's development of next-generation tele-robotics systems.

Consistent with NASA's technology roadmaps, the Human Exploration and Operations Mission Directorate's (HEOMD) AES Program is pioneering new approaches for rapidly developing prototype systems, demonstrating key capabilities, and validating operational concepts for future human missions

beyond Earth orbit. AES activities are uniquely related to crew safety and mission operations in deep space, and are strongly coupled to future vehicle development. Early integration and testing of prototype systems will reduce risk and improve affordability of exploration mission elements. The prototype systems developed in the AES program will be demonstrated in ground-based test beds, field tests, underwater tests, and flight experiments on the ISS. Many AES projects will evolve into larger integrated systems and mission elements that will be tested on ISS before we venture beyond Earth orbit. The AES and the Space Technology Programs will work closely together to incorporate and integrate new technologies and innovations as they are matured to the point of infusion.

The AES Program is also working closely with NASA's Science Mission Directorate to pursue a joint program of robotic precursor activities that will acquire critical data on potential destinations for future human missions such as the Moon, NEAs, and Mars and its moons. This program builds upon the successful collaboration between science and exploration on the Lunar Reconnaissance Orbiter mission. Later this month, the Mars Science Laboratory will be launched. Onboard the rover will be a Radiation Assessment Detector to measure the radiation environment during the transit to and on the surface of Mars. These data will help researchers to understand how the Mars radiation environment may affect the health of future human explorers.

The development, testing, and evolution of an array of technologies for missions beyond LEO, including propulsion, logistics and resupply, life sciences and human systems, communications, and many other areas, enables what we call the Capability Driven Framework, and it's the basic approach to safely extending human presence to multiple destinations throughout the solar system in a robust, sustained and affordable manner.

In addition to developing building blocks for future missions, the AES and Space Technology programs are exploring innovative ways to drive a rapid pace of progress, streamline project management, and use NASA's resources workforce more effectively. By using small, focused projects to rapidly develop and test prototype systems in house, NASA hopes to greatly reduce lifecycle costs, and minimize the risk of incorporating new technologies into system designs.

A Capability Driven Framework Approach to the Human Space Exploration Architecture

NASA, in collaboration with our international, interagency, industry, and academic partners, continues to refine the analysis, planning, and communication that will be instrumental in defining an effective Capabilities Driven Framework as a long-term strategy for guiding NASA investments in capabilities, technologies, robotic precursors, testing and development, terrestrial analogue activities, and the partnerships that will enable them. NASA's ongoing and cross-cutting Human Architecture Team (HAT) continues the integrated planning, development, and analysis of the human spaceflight exploration and operations architecture, taking into consideration technology, science, and supporting infrastructure.

Leveraging the ISS as an important National research platform and test bed for exploration technologies and operational concepts and other potential missions in relatively close proximity to the Earth are actively being considered as part of the incremental capability build-up approach. These include potential satellite servicing and repair missions, assembly of large structures, or extended duration missions outside the radiation protection afforded by the Earth. The High-Earth Orbit and Geosynchronous Orbit regions provide another opportunity to test spacecraft systems at greater distances and in more challenging environments consistent with the NASA Authorization Act of 2010 (P.L. 111-267), which specifies that the architecture have "…the capability to conduct regular in-space operations, such as rendezvous, docking, and extra-vehicular activities, in conjunction with… other vehicles, in preparation for missions

beyond low-Earth orbit or servicing of [future observatory-class scientific spacecraft intended to be deployed in Earth-orbit], or other assets in cis-lunar space."

When looking beyond near-Earth space and LEO, several missions and target destinations are viable. These include Earth's closest solar system neighbors: the Earth-Moon or Sun-Earth Lagrange points and cis-lunar space, NEAs, the Moon, the moons of Mars, and Mars. Each destination provides unique exploration and operational opportunities. Lunar circumnavigation and flights to Earth-Moon or Earth-Sun Lagrange points hold near-term promise as compelling test locations for the SLS, Orion MPCV, and other key emerging systems. Lagrange points are gravitationally stable regions created by the interaction of the gravity fields of any two large masses; an object placed at a Lagrange point will tend to stay in place for a long time. The Earth-Moon L1 and L2 Lagrange points could therefore be excellent "gateways" for a multitude of exciting exploration missions. The NEAs provide the opportunity to send humans beyond the solar orbit of Earth while holding compelling science and planetary defense knowledge-building potential. In addition to possible scientific prospects, missions to NEAs would afford astronauts the experience applicable to deeper-space missions that would eventually contribute to establishing a permanent human presence beyond Earth. There are a few asteroids which could be visited by the SLS and Orion MPCV in the timeframe under consideration. Additional NEA survey data will be required to identify and refine the catalog of potential targets.

On a slightly longer timeline, the moons of Mars – Deimos and Phobos – present opportunities to blend both NEA and surface mission attributes in a hybrid mission that may be less risk- and resource-intensive than a full Mars surface exploration mission, but still be very much on the enabling path for such a mission. Mars, being the farthest and most challenging destination in the capability-driven plan, represents a long-term goal or horizon destination for human exploration and later longer duration surface habitation. Mars has a plethora of scientifically important and resource-rich targets from which to choose. Collectively, the NEAs, lunar, and Mars destinations also respond to the NASA Authorization Act of 2010, which states that Congress finds "…the extension of the human presence from low-Earth orbit to other regions of space beyond low-Earth orbit will enable missions to the surface of the Moon and missions to deep space destinations such as near-Earth asteroids and Mars."

NASA shares the belief of its partners that challenging and exciting exploration missions will be international in nature, so we are actively engaging with the international community, facilitating efforts to collaboratively set the stage for human exploration missions of the future through both the ISS partnership and in the International Space Exploration Coordination Group.

International Cooperation: The Global Exploration Roadmap (GER)

In September 2011, the initial version of the Global Exploration Roadmap (GER) was released by the International Space Exploration Coordination Group (ISECG) and its members. The GER is the culmination of work by 12 of the 14 ISECG space agencies over the past year to advance coordinated space exploration.

The GER starts with the ISS as a foundation, and examines options for expanding human presence into the solar system, with a human mission to explore the surface of Mars as the ultimate goal. The GER lays out a framework for continuing international discussions, including Common Goals and Objectives; two potential scenarios for human and robotic exploration over the next 25 years: "Asteroid Next" and "Moon Next"; and, Human Exploration Preparatory Activities. The exploration scenarios and preparatory activities are not binding on the participating agencies, but they may serve to inform agency decisions related to exploration activities.

Through the work of the ISECG and the GER, many of the world's space agencies have begun collaboratively working on long-range exploration mission scenarios. Agencies are looking for near-term opportunities to coordinate and cooperate that represent concrete steps toward enabling the future of human space exploration across the solar system.

Implementing the Future

In implementing NASA's missions, the Agency's Centers ensure that the future outlined here is brought into being. Three of NASA's Centers focused on human spaceflight goals are the Johnson Space Center, in Texas; the Kennedy Space Center, in Florida; and, the Marshall Space Flight Center, in Alabama. Without these Centers' highly skilled and dedicated workforce and state-of-the-art facilities, realizing the full potential of the human exploration of space would be impossible.

The Johnson Space Center (JSC) leads the development of the Orion MPCV, and the Program is working to make this vehicle affordable and able to meet budget and schedule requirements. As part of that effort, NASA is finalizing Orion's flight test strategy so that flight tests can focus on high risk items earlier in the development cycle when it costs less to change them. Orion has also streamlined NASA's insight and oversight model, using engineering for more in-line development work rather than only oversight. JSC has been working closely with other NASA centers on program-to-program integration to ensure safe and successful flight.

JSC continues to focus on operating, utilizing, and maintaining a safe ISS. The Center is working to enhance ISS capabilities for research and technology, allowing us to use Station as a test bed for deep space engineering demonstrations and building upon our international partnership.

The Kennedy Space Center (KSC) is focused on commercial partnerships to support safe, reliable, and cost effective access to LEO and the ISS, looking for creative ways to collaborate. Currently, KSC has approximately 80 partnership agreements signed or in discussion. A successful example is the historic agreement with Space Florida for use of Orbiter Processing Facility-3 (OPF-3) by Boeing to manufacture and test their CST-100 spacecraft.

KSC's Commercial Crew Program is developing a viable commercial space industry, which is will enable the U.S. to retain jobs and technical expertise, and the Center's 21st Century Ground Systems Program is going forward to build a true multi-user launch complex for our Nation. It is evolving from a Government-centric, government-owned and operated complex, to a true multiuse spaceport with Government and commercial operations utilizing key infrastructure for access to space.

The Marshall Space Flight Center (MSFC) is designing and developing the SLS. The plan for SLS starts where we are, with a talented workforce, robust hardware, and unique infrastructure either already in place or well into development, while providing competitive opportunities for advanced technologies that will be evaluated on both performance and return on investment. The SLS Program is a lean organization that has streamlined its interfaces, workflow, and decision-making processes.

MSFC is also responsible for hardware and payload operations for the ISS and such science missions as the Discovery and New Frontiers Programs and the Chandra X-ray Observatory. The Center continues to lead the way in propulsion, science and discovery, in part because of its exceptional team of renowned experts and many unique, specialized laboratories and facilities.

All three Centers are engaged in both the AES and Space Technology programs developing the essential technologies required for deep space exploration.

It is important to note that while JSC, KSC, and MSFC are represented here today, all of NASA's Centers play a role in the Agency's exploration efforts, whether in the form of providing valuable testing and other support facilities, or operating NASA's robotic science missions. The Agency relies on its personnel and infrastructure around the Nation to accomplish America's achievements in space.

Conclusion

NASA, with our commercial and international partners, has embarked on a new phase of human space exploration and development. In LEO, we see the culmination of the efforts of many nations to construct the ISS. From September 2000 to October 2010, 1,149 investigations were conducted aboard the Space Station, including U.S., International Partner, and National Laboratory Pathfinder investigations. This research involved 1,600 scientists and has already resulted in more than 310 scientific publications. The Station has now entered its operations and research phase, and this phase will continue through at least 2020. This research will benefit NASA's exploration goals, but also go beyond this by enabling other governmental and non-governmental entities to conduct wide-ranging experiments that we anticipate will result in a variety of terrestrial benefits.

All of this research will be supported by a new way of doing business: the use of commercially provided services rather than Government-owned vehicles to transport crew and cargo from Earth to LEO and back again. We are also working aggressively to bring the new domestic commercial cargo providers on board. The Commercial Crew Program has great promise, but also some significant challenges ahead. Human spaceflight is a very difficult endeavor, and our industry partners will have the responsibility for the full end-to-end system. Private enterprise and affordable commercial operations in LEO will enable a truly sustainable step in our expansion into space — a robust, vibrant, commercial enterprise with many providers and a wide range of private and public users will enable U.S. industry to support NASA and other Government and commercial users safely, reliably, and at a lower cost. NASA is proud to help in laying the groundwork for the emerging LEO space economy.

By investing in space technology research, NASA can be a significant part of the solution to our Nation's economic, national security and geopolitical challenges. NASA's Space Technology Program will support NASA's needs and also act as a catalyst for innovation throughout America's aerospace industries, and it will create new, high technology jobs and innovations in manufacturing that will guarantee American leadership in the new technology economy.

The commercial systems will enable NASA to focus its own development efforts on the Orion MPCV and SLS, which will send our astronauts on missions of exploration beyond LEO. These systems will be flexible enough to support many different mission scenarios, and will serve well in the decades to come. One of NASA's greatest challenges will be to reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. We must plan and implement an exploration enterprise with costs that are credible and affordable for the long term under constrained budget environments. We are committed to developing an affordable, sustainable, and realistic next-generation human spaceflight system that will enable human exploration, scientific discovery, broad commercial benefits, and inspirational missions that are in the best interests of the Nation. We are also committed to the development of the necessary technologies required to explore our universe. We need your continued support to provide the funding required for this effort.

Mr. Chairman, I would be happy to respond to any question you or the other Members of the Subcommittee may have.