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Statement of
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Administrator
National Aeronautics and Space Administration

before the

Subcommittee on Space and Aeronautics
Committee on Science
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here to present to you NASA's budget request for FY 2001. This is a great budget. It fully funds NASA's priorities in FY 2001: make investments in improving Space Shuttle safety; build the International Space Station; reduce the cost of access to space through a new Space Launch Initiative; invest in outstanding science and technology; and, revitalize the NASA workforce and facilities.

The FY 2001 request of $14.035 billion represents an increase of 3.2 percent over the FY 2000 enacted level and reflects future year increases that exceed the rate of inflation. If the Administration's vision for NASA is enacted by Congress, we will go from an FY 2000 appropriation of $13.6 billion up to $15.6 billion in 2005. That is an endorsement of our Strategic Plan of a balanced space and aeronautics program and a tremendous tribute to the NASA team. The percentage of our FY 2001 budget devoted to science and technology has increased from 31% in FY 1991 to 42%, and is planned to grow to 51% by FY 2005. It represents a strong commitment by this Administration to invest in science and technology, which is the Nation's foundation for future discoveries and economic prosperity.

Before I discuss NASA's exciting future and the new programs provided for in this budget, I would like to share with the Committee NASA's achievements, as well as our disappointments, since the last time I appeared before you. It is this history on which the FY 2001 budget is built, which prepares us for the future, and which provides the lessons and character to accomplish what was previously only imaginable.

We had a very exciting year in FY 1999, full of exciting missions and discoveries as we transitioned into the New Millennium. The achievements in FY 1999 extended from improvements in aeronautics applications to benefit the FAA and the airfaring public to the far

reaches of the universe, which addressed scientific objectives ranging from the environmental to the cosmological.

The list of accomplishments was impressive:

We started off the year with the launch of Deep Space One, a mission to test 12 revolutionary technologies including spacecraft autonomy and ion propulsion. The Submillimeter Wave Astronomy Satellite (SWAS), a small explorer mission, was launched to study the chemical composition of interstellar gas clouds. We launched Stardust on February 7, 1999 to rendezvous with comet Wild –2 in 2004, and bring back to Earth a sample of comet dust in 2006. In Earth Science, we launched Landsat-7, the continuation of the successful Landsat program and Terra, our flagship mission to study the Earth as a system. FUSE, the Far Ultraviolet Spectroscopic Explorer, was launched on June 24, 1999, to observe the universe in the ultraviolet and try to answer questions such as what conditions existed in the universe a few minutes after the Big Bang.

The first two International Space Station assembly missions were launched in November and December. In July, the Space Shuttle Columbia, commanded by the first female Shuttle commander, deployed the Chandra X-ray Observatory. The Hubble Space Telescope scientists calculated a value for how fast the universe is expanding, after eight years of painstaking measurement. Astronomers funded by NASA witnessed for the first time a distant planet passing in front of its star, providing direct and independent confirmation of the existence of extrasolar planets. Mars Global Surveyor provided the first global 3-dimensional map of Mars, and the Compton Gamma Ray Observatory enabled the first ever optical image of one of the most powerful explosions in the universe.

NASA and its industry partners developed new technology to allow planes to land safely in bad weather on parallel runways. The test version of the X-34 rocket plane, made its first captive-carry flight toward certification in preparation for testing new technologies and methods of operation needed to develop low-cost reusable space vehicles. We worked with the launch industry on the Space Transportation Architecture Studies, the fruits of which are reflected in this budget plan. Although safety has always been of foremost concern in NASA, we increased our focus on the need for a safe, healthy, and productive workforce and environment, and strengthened our resolve to reduce program costs as a result of focussing on improving safety. And, that philosophy is reflected throughout this budget.

At the end of 1999, NASA safely and smoothly transitioned to the Year 2000 with no significant problems. NASA's success was due to the hard work of hundreds of dedicated employees, contractors, and our international partners. During the transition period and the first few business weeks of 2000, we experienced only minor anomalies that were easily addressed. None of the anomalies had any significant impact on critical operations or functions. Computer hacking was at normal levels, and no Y2K-related attacks were detected. While we must remain vigilant as we move through "leap year day" on February 29, 2000, I am confident that this transition will be just as successful.

In 1999, we also experienced some severe disappointments and problems: in the Mars Surveyor Program, with the loss of the Mars Climate Orbiter, the Mars Polar Lander and the Deep Space - 2 probes and in the Space Shuttle Program with wiring problems affecting all of the orbiters, resulting in grounding of the entire fleet from August until December, as well as a hydrogen leak found in one of the Space Shuttle main engines. The TERRIERS and Wide Infrared Explorer missions failed. The X-33 composite hydrogen tank did not pass its qualification tests and the launch plans for the assembly of the International Space Station were delayed. We experienced deferrals in achieving a launch-ready position for the U.S. laboratory module and other components, although I am pleased to report these have now been overcome and we will be ready to launch. Our Russian partners also made good progress in readying the Service Module for launch, although their funding challenges continue to cause concern about their ability to fully meet their commitments.

1999 also was marked by continuing launch vehicle failures that directly and indirectly impacted NASA programs. The Russian Proton failures have had a significant impact on the readiness to launch the ISS Service Module. The Russians were not alone in experiencing launch failures, as the Japanese, Europeans, and the U.S. struggled as well to achieve safe and reliable access to space. And, just last week, a Japanese launch vehicle failed, taking with it our investment in the Astro-E X-ray spectroscopy mission.

There have been a number of independent reviews to examine these problems, search for the root causes, and recommend changes. NASA worked closely with the Department of Defense and others on the Broad Area Review. We chartered reviews of the Shuttle wiring problems, the WIRE and Terriers failures, and of course the Mars Surveyor Program failures. As a result of the Mars failures, I appointed a Mars Program Independent Assessment Team in December 1999 led by A. Thomas Young. That team has been charged to review and assess the entire Mars program architecture, management, content and recent failures. The team has complete authority to delve into any and every aspect of NASA's program management. Its report is due out in mid-March. Other reports will be issued in the next month by the Mars Climate Orbiter Review Team led by the Director of the Marshall Space Flight Center, Dr. Arthur Stephenson; the team set up to review the spacecraft development approach of better faster, cheaper headed by Tony Spear; and, by the team doing an independent assessment of the Shuttle problems. The Shuttle review team has been charged with reviewing all aspects of the Space Shuttle program including hardware maintenance and refurbishment requirements and practices with particular emphasis on aging airframe, structure and components. That team is led by the Director of the Ames Research Center, Dr. Harry McDonald.

I am confident that these teams will make recommendations that will help us improve our processes and make our operations safer and better. Upon receipt of the reports, we will share the results with the Congress and work with you and the Administration to ensure their timely implementation. We must continue to learn, not only from our successes, but also from our failures.

Mr. Chairman, in spite of our difficulties, I believe the report card on NASA's performance reflects well on the support of the Committee and on behalf of the American people. While we accomplished a great deal in 1999, I see an even brighter future ahead. That does not mean we

won't experience difficulties. We will. The ambitious programs we undertake are intolerant of human error and stress our human capabilities to detect and respond to anomalies.
Our strategy to achieve major improvements in safety, taking advantage of emergent technical tools, such as the Intelligent Synthesis Environment, includes improving our systems management approaches, and continuing to infuse the philosophy and practice of safety in all that we undertake. This budget provides funding for the research into and development of the technologies that will improve the probability of mission success. The additional funding requested for personnel and facilities, Shuttle safety investments, the next generations of launch vehicles, general aviation aircraft, Intelligent Systems, Bioastronautics, and nanotechnologies should all be understood as key players in improving Safety.

FY 2001 Budget

The FY 2001 budget represents a vote of confidence from the President that NASA is ready to tackle new challenges and opportunities in the New Millennium. This budget funds NASA's priorities and makes critical new investments to improve Space Shuttle safety, continuing to build the International Space Station, enabling a new generation of reusable launch vehicles that will improve the safety and reduce the cost of access to space through a new Space Launch Initiative, new science and technology initiatives to enhance our understanding of our planet, the solar system and the universe, as well as investments in aeronautics, education, our workforce and facilities.

Thanks to Administration investments, this budget includes a $1.5 billion increase for Space Shuttle safety improvements over six years. There are two elements to the increase in Shuttle safety funding. First, the FY 2001 budget includes a $300 million increase through FY 2005 for additional personnel at NASA's Human Space Flight Centers to ensure that the right skills and staffing levels are in place to operate the Space Shuttle safely and to launch and assemble the ISS. Over the past five years, we completed an exercise to streamline and downsize the NASA workforce. We told you that if we cut too far we would come back and tell you. After reviews by both internal and external, groups, we concluded that continuing on our current plan would indeed cut too far, in light of the increased activity planned over the next several years as we continue to build the ISS. This budget includes the necessary funding to stabilize and revitalize our workforce, particularly at the Human Space Flight Centers. The second element is a $1.5 billion increase in a safety allocation that, when combined with $600 million for upgrades in this year's budget, totals $2.1 billion from FY 2000 through FY 2005. This will allow us to address Space Shuttle safety improvements through hardware/software upgrades, personnel, facility, and other safety investments. This $2.1 billion will improve Space Shuttle safety by nearly a factor of two. The safety upgrades will be integrated into the Shuttle fleet by 2005 to get done in time to pay benefits, and all safety investments will be managed within the safety allocation budget.

Thanks to support from the Congress, the two highest priority safety upgrades have already been initiated: the electric auxiliary power unit (EAPU), and advanced health monitoring for the Space Shuttle main engines (SSME). We are studying a broad range of additional safety investments, including upgrades, personnel, facilities, and other safety investments, and the NASA Advisory Council will undertake a review of our comprehensive safety investment strategy, to ensure that these investments will generate the most effective safety improvements as quickly as possible.

This year will be a landmark year for the International Space Station. We have high expectations that the first crew will begin to live aboard the Station as the U.S. and our partners start to reap the benefits of long duration research in space. We anticipate that as planned research gets underway, opportunities for new unforeseen paths of study will arise. While we have a number of challenges in the ISS program, we are committed to moving forward and completing the ISS. Because of Russian Proton rocket failures, the launch of the Service Module (SM) has been delayed, and we are faced with adding a shuttle mission to service the station elements on orbit because they are operating longer than planned without the Service Module in place. We are working closely with the Russian Aviation and Space Agency to understand their plans for return to flight of the Proton launch vehicle and scheduled launch of the Russian Service Module. The Russians have reported that the Service Module is now scheduled to launch in a window between July 8-14, and the first Proton launch since last years failures was successful last Saturday. NASA is proceeding with preparations to launch the Interim Control Module in December of this year should Service Module delays continue. The U.S. is leading a 15-nation partnership in building a cutting edge on-orbit research facility. We will work through these current difficulties and will continue building the ISS. We continue to strongly support the ISS program as an important investment in America's long-term future in science and technology.

I am particularly pleased to report to the Committee that this budget reflects robust funding for initiation of a new Space Launch Initiative. Safe, cost effective space transportation remains the key enabler of a more aggressive civil space program and I believe the Space Launch Initiative puts us on the track to accomplish this. This initiative is a result of NASA's Integrated Space Transportation Plan that consolidated Space Shuttle Safety Upgrades, 2nd and 3rd Generation Reusable Launch vehicle technology programs, Alternate Access to Space Station and Aero-Space Base programs into a unified Agency strategy. It makes the critical investments that will enable major safety, reliability and affordability improvements for future generations of space transportation systems. The Space Launch Initiative makes an investment of $4.5 billion over five years for the 2nd generation RLV.

The Space Launch Initiative program is focused on initiating full scale development of a 2nd generation RLV architecture and supports a 2005 competition to meet NASA's launch needs through purchase of commercial launch services by 2010, with the specific goal of achieving commercial ownership and operation of any new RLVs as soon as 2010 if industry performs as promised. NASA's investments will focus on reducing technical, design and other programmatic risks through the use of large scale, long-life ground and flight tests and other risk reduction activities. We will also invest in reducing risk associated with systems that would be used for NASA-unique needs.

The Space Launch Initiative is the product of more than a year of study and interaction between NASA and industry. The focus of the study has been on developing an integrated space transportation plan to meet NASA's needs for human and cargo delivery while seeking synergy with the commercial space sector. In addition, the Initiative also includes procurement of near-term alternative access to the ISS for cargo transport needs on commercial vehicles.

This year we will undertake bold new science and technology initiatives in biotechnology, naotechnology, and information technology. Three key emerging, interrelated technologies will provide NASA with a new pathway to revolutionize our missions and the scientific and engineering systems that enable them: biotechnology, nanotechnology and information technology. Over the past decade there have been tremendous scientific breakthroughs in the understanding of these fundamental processes. We are now ready for our technology to move out and exploit what we are learning. We will develop and execute our missions with greater safety, performance and robustness while continuously decreasing design cycle time and life cycle cost.

The first tier of NASA's technology strategy is biotechnology -- the true revolutionary technology of the 21st century. Since the formation of the first cells on Earth, all living systems have developed an extraordinary capacity to adapt to rapidly changing conditions, build-in a high degree of resilience enabling them to overcome damage and evolve in response to new environments. In terms of size, memory, processing speed and energy consumption biological systems are up to a billion times better than the systems we build today. These are the characteristics NASA will build into its future missions and systems. NASA will apply the underlying principles of biological processes to all our missions. We will develop biologically-inspired materials that self-repair when damaged, structures that self-assemble to achieve near perfect final shapes. We will develop concepts for aircraft that change their shape in flight like birds to optimize performance or perform complex maneuvers in complete safety.

Nanotechnology provides the capability to manipulate matter at the atomic level. In the future we will measure the way we design and build our systems by the atom, not by the pound. Today we are developing material systems, at the molecular level, that are 100X stronger than steel at 1/6 the weight. We will also develop sensors and detectors capable of responding to a single photon of light or the stimulus from a single electron. Using nanotechnology we will build systems on a scale 1000X smaller than today -- at true molecular level. They will be based on concepts emerging from biology, quantum mechanics and chemistry, all of which have no current parallel.

NASA is also on a path to "revolutionize" the information technology revolution and apply it to our unique mission needs. Humans can process the equivalent of about a terabyte of data every second -- that is equivalent to about 24 hours of television – as we process the data from our multi-sensory systems – sight, sound, smell, touch. We do this because we do not simply compute, we think. This third tier of our technology strategy will blur the notion of computer hardware and software and systems built from chips and black boxes. Our future systems will look and operate more like living systems than machines. We will build them with distributed sensory systems - like a central nervous systems – to allow us to monitor and control every function. Our computer systems will more resemble the human brain, with the capacity to learn.

The safety, productivity and health of the human in space supported by these technology tools are the foundation of our vision to explore. To catalyze this human-technology interaction, we will base our designs on biological processes and principles proven over the existence of mankind to adapt to changing and dynamic environments. The development and deployment of

such technological tools will serve as extensions and expansions of human cognitive processes and blend inextricably with the human user.

The Bioastronautics Initiative will significantly improve long-term crew safety and health, and is the forcing function that focuses the research already underway to solving operational health and safety problems. Medical support systems will be developed by accelerating development and validation of countermeasures for the diagnosis, therapy, prevention and rehabilitation of crew on long duration missions aboard the ISS. Solutions to these space health problems find ready application to a multitude of health problems on Earth.

We are making new investments to enhance our Mars exploration strategy with funding to establish a Mars Communication Network, a system of communication satellites around Mars that will greatly increase the science return and overall success of future Mars missions. Eventually, this Network will enable researchers and the public to explore and experience Mars firsthand through live video links. The Administration has recognized the inherent risk in space exploration and given NASA a vote of confidence by providing a total of almost $350 million in additional funding for Mars. In combination with the Mars Communication Network, these funds will allow us to pursue a sustained presence at multiple locations in and around Mars and build incrementally to support aggressive future goals. If successful, this approach to Mars could become a model for future missions to other research targets. As the President stated in the State of the Union, we must "set great goals worthy of a great nation." We are doing just that. This budget also contains new funding for new Discovery Program micromissions to facilitate new low-cost solar system research opportunities, and restores Space Science funding for the Flight Validation Program (formerly the New Millennium Program) that will enable us to develop and test revolutionary technologies to enable future missions.

A new Space Science program I am particularly excited about is Living With a Star, a new initiative to understand the Sun's impact on the Earth and space environment. The FY 2001 budget includes funding to begin Living With a Star. The program will deploy some of the most creative and advanced technologies to construct a network of spacecraft aimed at helping us understand our star, the Sun, and how it influences the Earth. We can't talk about sending people to other planets without first understanding how astronauts would be affected by the Sun's radiation. How can we fully understand the Earth's climate system without understanding solar variability and its affect on the Earth's atmosphere? Using multiple spacecraft, these Solar Sentinels will be able to track Earth-directed coronal mass ejections and pave the way for future systems that can warn of impending danger to terrestrial power grids, our astronauts, and air passengers flying at high altitudes, and to the Defense and civil space assets. Given the importance of understanding and predicting solar variability to fundamental science, terrestrial climate, national defense, and technology, NASA has begun to develop collaborations with NSF, DOD agencies, FAA, and NOAA, and will pursue collaborations with the commercial space industry as well.

In Earth Science, we will continue to develop a full and comprehensive understanding of the total Earth system and the impacts of natural and human-induced changes on the global environment. Through recent technology efforts, we will shrink the size, cost, and development time for our missions planned for this decade. Following decades will see a web of sensors over

the Earth in a variety of orbits, including constellations of intelligent microsatellites that target resources or major events happening on the Earth's surface. While pursuing our core Earth Science objectives, we will also provide the tools to apply satellite imagery and technology to generate the next great advances in weather and climate prediction, improve agricultural productivity, and advance the growth of the U.S. commercial remote sensing industry. These applications have the potential to enhance our quality of life and stimulate the development of new commercial products and services based on NASA-developed technology.

This budget includes funding for new initiatives in Aeronautics. Over the five year period from FY 2001 through FY 2005, the new Small Aircraft Transportation System (SATS) Program is funded at $69 million. The budget also supports a funding increase of $100 million for noise and emissions research over the same five-year period, including the new Quiet Aircraft Technology (QAT) Program. SATS will develop vehicle and infrastructure technologies to reduce the accident rate of small aircraft to that of commercial transports, utilize the nation's under-used airspace and landing facilities at non-hub airports in all weather conditions, and increase capacity for efficient operations of commuter, regional and runway independent aircraft at hub airports. QAT will provide the technology to meet the NASA/FAA vision for a noise-constraint-free air transportation system that would contain the decibel contour within the airport boundaries, a 10 decibel reduction from 1997.

The FY 2001 budget makes necessary investments in NASA's workforce and the NASA institution by providing additional funding for stabilizing civil service personnel levels at NASA's Space Flight Centers and addressing pressing facility issues. This will help keep our highly skilled workforce safe and healthy by spreading the tremendous workload among more people. In addition, it will help NASA improve the safety and reliability of our unique assets by ensuring the right staffing levels are in place to improve the Space Shuttle and assemble the ISS. An increase of almost $600 million over five years will cover not only increased personnel salary and expense costs but also an FTE increase over the previous downsizing plans until 2004. The effect is to hold personnel levels steady at the FY 1999 level at OSF Centers. An increase of almost $200 million over five years is included for facilities revitalization in order to reverse a long-term trend of declining facility condition, which is impacting safety and productivity. We have completed a Core Capabilities Assessment that identified the physical and human assets required to accomplish the Mission Areas and Center of Excellence assignments identified in our Strategic Plan. With this as a basis, we can now make investments in facilities with the assurance that those in which we are investing are essential for success of our missions and the safety of our personnel.

One of the many ways in which NASA establishes our relevance to the American people is through our education program. I was proud to testify before the House Science Committee on April 28, 1999, about our program and accomplishments in K-12 science and mathematics education. But the NASA Education Program is comprehensive, addressing all levels of the education system from K-12 schools to colleges and universities. In all our education activities we strive to achieve education excellence by involving the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.

Included in the budget for FY 2001 is a request for $1 million to begin a coordinated, agency-wide internship program for undergraduate students. Through this program we anticipate providing a diverse group of 200 students a 10-week internship program at a NASA Field Center. This program is critical to complete a continuum of student programs that currently begin in high school and continue through graduate and post-graduate education. We have also listened to the Congress and increased our baseline funding for Space Grant in this budget. The funding level represents an increase of $5.6 million over our previous request and is maintained in the outyears. An additional $7.4 million is included for the Minority University Research Program to continue the Science, Engineering, Mathematics and Aeronautics Academy (SEMAA) Program through competitive selections and to continue partnerships with other institutions in support of math, science, and technology education at all levels of education for under represented groups.

While our budget for Academic Programs in FY 2001 is below the overall FY 2000 enacted level, it maintains our base level funding for our core programs but does not continue funding for Congressional earmarks.

The FY 2001 budget of $14.035 billion signifies a strong commitment by this Administration to science and technology and recognizes the critical role it plays in stimulating the economy and developing the jobs of tomorrow. Now I would like to discuss in detail each of the Strategic Enterprises and major program areas.

NASA's Enterprises

Human Exploration and Development of Space Enterprise

International Space Station

Compared to the FY 2000 budget, the FY 2001 budget request reflects an overall reduction in the budget and runout estimates through FY 2005 of about $1.2 billion. Roughly $0.8 billion of this reduction is due to the movement of funding for the Phase 2 production of the ISS Crew Return Vehicle (CRV) to the Science, Aeronautics and Technology budget account. The FY 2002-2005 funding estimates will reside in that account pending a decision in the next two years on whether to proceed with an X-38-based CRV design, in the context of broader decisions that NASA and the Administration will make regarding future space transportation architectures. There was also an approximate $0.4 billion reduction in other ISS funding over five years, in order to fund agency needs and other high priority activities such as the Bioastronautics initiative.

In 1998, we celebrated the birth of the ISS, as the first two elements were successfully launched and mated; the combined stack has now completed over 6,700 orbits. In 1999, flight hardware continued to be delivered to the Kennedy Space Center. We just successfully completed the most comprehensive systems integration test and evaluation at NASA since STS-1. It worked flawlessly. The Mission Sequence Test sequentially exercised all nominal crew and mission control interfaces planned for deployment of the U.S. laboratory, per the 5A flight plan, with actual hardware and software response. The test was performed as close to the in-flight configuration as possible. It included additional mission control to Station interfaces not performed during previous multi-element tests, allowing engineers to validate operational flight

plans and procedures. These tests – while critical to ensuring that the ISS will work in space as planned – have taken longer than planned resulting in slips last year. However, as a result, we can now confidently say that we will be ready to launch the American equipment. Also, last October, on-orbit assembly planning paused after Russia encountered two setbacks in its long history of over 250 Proton launches, 95 percent of which have been successful. While these launch delays are unfortunate, they illustrate both the importance of integrated testing and the need for redundant launch systems, as the ISS program has with the Shuttle and Proton.

Decisions made at the General Designers Review in Russia February 11th, place the Service Module on a path to launch this summer in a launch window of July 8-14. Should the Service Module experience further delays or mission failure, we will launch the ICM in December of this year. Should the Service Module be successfully launched this summer, we will reconfigure it to enable docking with the Service Module as early as 2001. I have clearly communicated to Mr. Koptev that this Program will move forward in 2000, regardless of whether the Service Module is ready for launch.

Relative to the Proton failure, its return to launch, and plans for launch of the Service Module (SM), RSA provided their plan and technical considerations at the General Designers Review. The failure was attributed to contamination and manufacturing non-compliances during 1992/93 time-frame. None of these engines are slated for future launch. However, several commercial parties have agreed to launch on inspected engines from later production sets. The plan for the Service Module is to launch it on engines upgraded to increase their resilience against these types of failures. The Service Module launch will follow two precursor flights using the same Proton modifications and upgraded engines, as well as other commercial Proton flights. NASA propulsion experts have reviewed these plans and are in agreement that the Russian approach provides a high degree of launch confidence. NASA has also asked the NASA Advisory Council (Stafford) Task Force on ISS Operational Readiness to review the findings of various Proton launch failure investigation teams with RSA's Advisory Expert Council and provide their views on the Service Module launch plan.

Delay in the SM launch also impacts Zarya in that its flight certification period must be extended. NASA's plans include a Space Shuttle mission to the on-orbit ISS this Spring to perform critical maintenance on some of Zarya's systems to re-certify it for flight through December 2000, consistent with ICM contingency planning. This approach requires splitting the presently planned mission following the Service Module launch, 2A.2, into two missions designated 2A.2a and 2A.2b. The 2A.2a mission would occur this Spring to provide the needed maintenance on Zarya. The 2A.2b mission will be similar to the currently manifested 2A.2 mission in that it will prepare the Service Module for the arrival of its first resident crew in late 2000. Shuttle Orbiter Atlantis will be used for both missions, minimizing mission unique costs and enabling a reduced turnaround time for the second flight. Since some Shuttle missions have been delayed due to the Service Module/Proton problem, the addition of 2A.2a would not increase the annual Space Shuttle flight rate, nor materially affect our budget.

Program momentum is being maintained as the Kennedy Space Center (KSC) is taking delivery of new flight hardware with each passing month. Last year I told you of the on-going transition from development work into operations. This trend has accelerated in earnest with many

elements for flights through 12A having been delivered to KSC including truss segments, attitude control system, communications system, the first solar arrays, thermal radiators, integrated electronics, and the U.S. Laboratory, "Destiny."

We have significantly reduced the amount of risk as elements have moved through the first set of integrated testing. This summer we will move into the second major set of integrated testing activity. This activity will verify ISS flight hardware to each other and to the orbiters. Also included in the test will be the mobile transporter, a movable base of the Station's Canadian mechanical arm that allows it to travel along the Station truss.

Progress on U.S. items has not been without challenges. Just last Fall we determined the likely cause for a component failure in the ISS DC to DC Converter Unit (DDCU), the U.S. pacing component for flights 3A-5A. We are now working delivery of alternate parts to maintain our schedules.

As the program transitions into the assembly and operations phase, manufacturing activities are declining. Over 86 percent of the U.S. ISS development contract is complete, with the majority of flight hardware scheduled to be delivered to the launch site this year. With these changes, it is in the best interest of the government to concentrate resources on assembly planning, operations and utilization readiness, and on the on-orbit assembly of the ISS. As such, NASA restructured the Prime contract to focus resources on the work remaining in the most efficient manner. The restructure provides the government and Boeing flexibility in directing the work force at a time when fast responses to unanticipated problems are desirable. The restructure also provides incentive for Boeing to improve performance through a revised award fee system for the remaining work.

Relative to operations, the communications systems between Mission Control Center (MCC)-Houston, MCC-Moscow, and the ISS have been successfully demonstrated and avoided Y2K related issues. The U.S. led international control teams have been vigorously exercised as they worked anomaly resolution, avoidance maneuvers, an ISS reboost and the first docking with the ISS.

NASA continues to evaluate program progress and take contingency steps to mitigate risk in case any partners have problems meeting their commitments. NASA is making good progress toward completing these steps. A key element in this plan is the development of the U.S. Propulsion Module. The Preliminary Design Review process for the Propulsion Module will be completed next month, leading to a scheduled 2003 launch.

A second set of contingency plan activities is the purchase of unique Russian goods and services. As ISS development, assembly and operations have progressed, NASA has identified goods and services that would allow the implementation of the next steps of NASA's Contingency Plan and provide improved crew training and operational capabilities. The goods and services NASA intends to purchase are:

- Outside the scope of what Russia has agreed to provide as part of its commitment to the ISS

- Uniquely available from Russia, and would be much more costly and significantly delayed, if purchased from U.S. or other sources, and
- Needed to ensure timely availability of U.S. contingency capabilities

Russia has a good record of on-schedule and on-budget delivery of items purchased, and NASA is confident in the timely delivery of these needed items. I believe that the provision of these goods and services will reduce risk to our crew and to the overall ISS program. Protecting the ultimate safety of our ISS crew and the investment of the American people is paramount in our decision to embark on this transaction. An operating plan change request was sent on February 11.

In the U.S., development of Crew Return Vehicle (CRV) operational technologies through the X-38 program is progressing well with testing of two 83% scale atmospheric flight vehicles, construction of a full scale space reentry vehicle, and testing of a full operational scale 7500 sq. ft. parafoil, the largest in the world. The first test flight of the full-scale parafoil was successfully completed in January 2000 with flawless deployment dynamics and a safe touchdown – a major project milestone. In a future operating plan, we plan to request an additional $21 million to FY 2000 for CRV Phase I development to assure success of critical validation tests and design. We are proceeding with an FY 2002 competition down-select to 2 contractors to get ready for a production decision. We will work with the Aerospace Safety Advisory Panel (ASAP) to make sure we have the safest design.

While NASA works aggressively toward deployment of a U.S. crew return capability, we have decided to move funding for the CRV production phase into the Science, Aeronautics and Technology funding line. Production funding will remain in this line while we work toward validation of the X-38/CRV approach as the safest way to provide the crew return function, and evaluate the potential of Crew Transfer Vehicle (CTV) concepts as an alternative approach. Until the arrival of the CRV, the Russian Soyuz will be the only means of crew rescue. The CRV was planned to be available in May 2004 (based on the June 1, 1999 Revision E assembly sequence), but X-38 program delays and a cut in FY 2000 appropriations to the CRV project has delayed availability by 12 to 18 months. Given the delays in assembly since the Rev. E assembly sequence was released, and the impact of those delays on six-person readiness, most of the 12 to 18 month slip in CRV delivery should be accommodated in the new assembly schedule. If six-person capability is achieved prior to availability of a U.S. crew return capability, the launch of a six-person crew could be deferred a few months, or additional Soyuz crew return services could be purchased to fill the gap.

The contributions of our other International Partners will become more prominent as assembly progresses throughout this year. Two of the three Italian Multi-Purpose Logistics Modules (MPLM) and the Canadian Space Station Remote Manipulator System (SSRMS) have been delivered to KSC and are in preparation for launch. The third MPLM is in assembly in Turin. In late 2001, initial deliveries of the Japanese Experimental Module (JEM) begin to arrive in the U.S. The European Columbus Orbital Facility is in production and is on schedule for delivery in early 2004.

Economic Development of Space

While much of the early effort regarding the economic development of space was focused on the ISS due to its enormous potential in scientific and business applications, we have also reached out into other space opportunities. We believe that the key to increasing and accelerating space commercialization, not just maximizing what is currently available or achievable, is to bring in new players – investors, customers, suppliers, and users – and make it easy for them to include space as part of their business strategies and operations. We solicited and incorporated inputs from all sectors of the economy as we worked on our approach for enabling the economic development of space.

Beginning in 1998, NASA committed to set aside at least 30% of the ISS payload capacity for commercial development. During 1999, we put in place the necessary management systems and processes with which to conduct a vigorous economic development program for the ISS. Process improvements made in the past year included: single point of entry process for all entrepreneurial offers; policies to protect private intellectual property and proprietary data; an ISS demonstration pricing policy to stimulate commercial investment and government/industry partnership; and a soon-to-be published price list for using ISS resources such as research racks,crew time, power, and other resources. This integrated and inclusive approach has resulted in over 50 entrepreneurial offers from private companies wanting to use part of the ISS and related infrastructure for non-government businesses. Most offers involve private investment and non-government use of space assets.

We are also working on the development of a Non Government Organization (NGO) for ISS utilization management. This has the potential to greatly enhance the scientific and commercial uses of the ISS, while at the same time freeing up precious NASA resources to concentrate on pushing the boundaries of science and technology.

Near term commercialization opportunities include NASA TV and its related multi-media infrastructure; commercial habitation module; reimbursable space shuttle flights; remote sensing, multiple use research centers; and solar power platform for communications and surveillance. With the help of the Administration and Congress, we have an exciting start in our initiative for the economic development of space. The pending launch of the ISS laboratory module, and the start of the permanent human presence in space should take us to yet another level in our quest to open up space to increasingly more people and applications. Our next step is the inclusion of and coordination with our international partners to further expand the commercial opportunities and reach of our assets.

All recent policies, reports, and procedures can be found at http://commercial.nasa.gov/.

Space Shuttle

The FY 2001 Space Shuttle budget is $3.165 billion, a 6.2 percent increase over the FY 2000 budget. The Space Shuttle continues to prove that it is the safest and most versatile launch vehicle ever built. The team has proven again that safety, not schedule, dictates launch readiness. I salute them.

The Space Shuttle manifest currently reflects nine missions scheduled to fly during FY01—seven ISS assembly flights, the second half of the Hubble Space Telescope's third servicing mission, and a research flight. This is a significant increase over the four missions that were conducted in both FY1998 and FY1999, and a further increase over the six missions currently manifested for flight in FY2000. The FY 2001 budget of $3.165 billion will enable the system to successfully meet its goals of: 1) fly safely; 2) meet the flight manifest serving diverse customers; 3) improve the system; and, 4) improve supportability. This year, and in the near-term, the manifest is dominated by ISS assembly.

We must continue to ensure the Space Shuttle's viability as a safe, effective transportation system and scientific platform. The Space Shuttle will need to be capable of supporting the critical human space transportation requirements for the assembly and operations of the International Space Station and through at least a significant portion of the 10 years of the completed Space Station's life. To accomplish this, we must continue to invest in the system's safety and supportability until a replacement vehicle is available. We have found that investing in upgrades provides, not only a safer vehicle, but one that is more reliable and one that is easier to maintain.

I appreciate the additional $25 million that the Congress provided last year to invest in several high priority safety upgrades and start the process. In addition, last year we reprioritized the existing budget within Human Space Flight to bring the total FY 2000 budget for high priority safety upgrades to $87M. The Administration has provided additional funding to continue the initiatives that started in FY 2000, as well as additional high priority safety upgrades that are being funded in FY2001. The Space Shuttle program is initiating two high priority safety upgrades and have recommended additional investments for study.

I have directed that safety upgrades be developed and implemented into the Orbiter fleet no later than 2005 to realize the benefits of these high priority safety upgrades to the fullest before we transition to a Space Shuttle replacement. I am happy to be able to report that work on these upgrades in currently underway. Because safety and reliability benefits can be realized from investing in the Space Shuttle, additional investment candidates have been identified for the Orbiter and propulsion elements of the vehicle. Examples include the Block III Space Shuttle Main Engine (SSME), the Solid Rocket Booster (SRB) Advanced Thrust Vector Control (TVC), and the Electric APU or Solid Propellant Gas Generator (SPGG). These candidates will be studied, along with other upgrades, personnel, facility or other safety investments, to validate priorities and cost in FY 2000 prior to decisions whether to initiate their implementation or development in FY 2001 as part of the Shuttle safety allocation.

Additional studies are being conducted in several areas such as the Space Shuttle's Thermal Protection System (TPS) lower surface tile upgrades, propulsion system, and hazard protection during processing. Completion of these studies is vital to successfully supporting our safety efforts and will be complemented by outside reviews.

The Administration's budget proposes to transfer the funding that the FY 2000 appropriation bill set aside to partially pay for another dedicated research mission and instead directs it into safety investments by hiring additional civil service personnel at the Human Space Flight Centers, and

accelerating the development of the Space Shuttle safety upgrades. These are very high priorities for this agency. I am also a firm believer in the value of providing sufficient research opportunities to the science community impacted by the delays in the Space Station's assembly. I agree with Congress on the merits of doing so. That is why we have plans to fly a research mission (STS-107) in early FY2001, and use increased Shuttle middeck locker opportunities during Shuttle assembly flights. Over the next five years, we plan to increase the number of investigators in Life and Microgravity research to enable us to take advantage of every flight opportunity and we must continue to focus limited resources on getting ISS built and its research hardware developed as soon as possible.

OSF Workforce

As the Office of Space Flight (OSF) builds the International Space Station and supports the infrastructure and upgrades to the Space Shuttle program as well as its Expendable Launch Vehicle (ELV) commitments over the next 5 years the workload will increase steadily. Internal and external workforce assessments have convinced OSF management that OSF civil service FTE targets needed to be adjusted. As mentioned earlier, from internal reviews, such as the Core Capabilities Study, to external evaluations by the ASAP and the Space Shuttle Independent Assessment (McDonald) Team, it became apparent that the OSF workforce required immediate revitalization. Five years of buyouts and downsizing have led to serious skill imbalances and an overtaxed core workforce. As more people leave, the workload and stress remaining increase, with a corresponding increase in the potential for impacts to operational capacity and safety. OSF Centers will begin to accelerate hiring in FY 2000, in order to address immediate critical skill shortfalls. After the initial hiring of 500 new personnel across the four Space Flight Centers in FY 2000, OSF workforce trends will begin a one-for-one replacement process and will allow OSF Center's to attain a steady state in civil service employment by FY 2001. We will continue to monitor OSF Center hires and attrition, ensuring that workforce skill balances are achieved and maintained.

NASA will be working with OMB in the coming months, to conduct a personnel review with an eye towards the future. This review will assess management tools and innovative approaches for personnel management that might best equip NASA to evolve and adapt our civil service workforce in the future. This will be particularly important as we continue our transition from operations to a focus on advancing the frontier with cutting edge research and development in science and technology.

Expendable Launch Vehicle Mission Support

NASA's Expendable Launch Vehicle (ELV) team coordinated the launch of ten ELV missions during the past year. The team supported launches from Cape Canaveral Air Station, including the Mars Polar Lander in January, Stardust spacecraft in February and the Far Ultraviolet Spectroscopic Explorer (FUSE) spacecraft in June. The NASA ELV team also supports launches from Vandenberg Air Force Base in California making it a bi-coastal team. The team supported the successful launch of ARGOS in February, the Wide-Field Infrared Explorer (WIRE) spacecraft in March, Landsat 7 in April, the TERRIERS satellite in May, the Quick Scatterometer (QuikSCAT) mission in June, and the Terra and AcrimSat spacecrafts in December.

There are two launch services competitions in work this year. The NASA Launch Services (NLS) acquisition providing launch services for future NASA missions will be completed. These contracts provide for awards to multiple suppliers with vehicles that have a demonstrated flight history. Also, the Next Generation Launch Services (NGLS) acquisition will be initiated. NGLS will enable competition for the emerging launch services companies with little or no flight history to offer launch services to NASA. Last year I met with the CEOs of entrepreneurial startup companies and we have taken a number of steps to ensure that we can create an opportunity for them to compete with the major launch companies. The FY 2001 budget provides funding to support NASA's intention to award as many as five *indefinite delivery/indefinite quantity* launch service contracts to provide launch opportunities for university, science and technology payloads.

Space Operations (SOMO)

A new era in space communications began in January 1999, with the implementation of the Consolidated Space Operations Contract (CSOC). A major objective of the CSOC is to reduce NASA's space operations costs while continuing to deliver high quality services. Operations performance has continued to be of high quality in this first full year of the SCOC contract. With respect to savings, in the FY 1998 budget to Congress, NASA reduced its budget in anticipation of CSOC savings and we do not expect to see any significant additional savings in the first few years of the contract.

Consistent with Congressional direction, NASA provided a CSOC commercialization plan in November. The plan addresses the purchase of space communications services from the private sector as well as the sale of available capacity from our existing NASA capabilities. As an example of this commercialization effort, CSOC is obtaining the use of commercial facilities to supplement the current NASA polar ground network. Additionally, all wide area network telecommunications are now being provided through commercial arrangements. We will be conducting a vigorous effort in FY 2000 to increase the use of emerging commercial capabilities to meet our space communications needs.

HEDS Technology/Commercialization Initiative

The Human Exploration and Development of Space (HEDS) Technology/Commercialization Initiative (HTCI) will support studies, technology developments and demonstrations that advance safe, affordable and effective future programs and projects of human exploration and discovery, while advancing the commercial development of space. The HTCI will pursue technologies and infrastructures for the future human exploration of space that also support commercial space development by making high-leverage investments that will enable progress toward innovative systems concepts and breakthrough technologies.

Life and Microgravity Science and Applications

The Office of Life and Microgravity Sciences and Applications (OLMSA) is a partner in NASA's Human Exploration and Development of Space (HEDS) Enterprise. OLMSA conducts ground and space based investigations to gain new knowledge to advance the health and safety of the astronauts in space. This interdisciplinary research will also increase the fundamental knowledge of biological, physical, and chemical processes; enable the development of space for human enterprise; and create new products and services. This knowledge and new technologies

will be transferred to the private and government sectors as broadly as possible within the United States.

The FY2001 budget request of $302.4 million for OLMSA is 10% higher than FY 2000 and will support a research base attracting new investigators (for a total of 986), as well as expanding cooperation with other agencies. This program will take advantage of the opportunities presented by the deployment of the Destiny laboratory to the International Space Station (ISS) and other opportunities to access space. Early in the assembly phase of the ISS, research will concentrate on investigations taking advantage of the Human Research Facility (HRF) and the EXPRESS racks. This research will focus on identifying and improving the spacecraft environment, habitability and crew health. To help maintain NASA's research communities during the ISS build-up, NASA plans to fly a research mission (STS-107) in early FY2001, and use increased Shuttle middeck locker opportunities during Shuttle assembly flights.

A new effort for OLMSA this year is the Bioastronautics Initiative, which will significantly improve crew safety and health aboard the ISS, and further strengthens research already underway to focus on the health, safety, and performance of humans in space. This initiative will accelerate research and development of solutions for diagnosis, therapy, prevention, and rehabilitation of crew on long duration missions aboard the ISS.

OLMSA has embarked on a focused program to develop advanced technologies that are critical for long-duration space flights to monitor and enhance human health, safety and performance. OLMSA is fostering this research in biologically inspired technology through dedicated NASA Research Announcements (NRAs). These fields of research have great potential for application to health care issues here on Earth. I have also established a formal collaboration with the National Cancer Institute (NCI) in the area of biologically inspired technology. This is part of the Bioastronautics initiative and is being led by the NASA Chief Scientist.

A major portion of the Bioastronautics Initiative will support the National Space Biomedical Research Institute (NSBRI). It is a consortium of 12 U.S. medical research academic institutions led by Baylor College of Medicine. These institutions and others will use the knowledge gained by working with NASA to improve health maintenance and care for patients on Earth. NASA is currently evaluating options for and benefits of integrating facilities and capabilities where astronauts, medical professionals, scientists, engineers, and operational specialists could interact as a team in accomplishing this Bioastronautics Initiative.

OLMSA research and development activities have also provided benefits in other areas such as improvements for the visually impaired which have been advanced by the development of an optical detector by the NASA Space Vacuum Epitaxy Commercial Space Center. Growth of three-dimensional active heart tissue in the NASA bioreactor has also been accomplished. Successful engineering of heart tissue could eventually be used to repair damaged heart tissue inside the body, test new drugs on heart diseases, and study general heart development and function.

Space Science Enterprise
The FY 2001 Space Science budget of $2.4 billion represents an increase of 10 percent over the FY 2000 enacted level. The Space Science Enterprise is the arm of NASA that looks up, out, and back in time . . . at planets, stars, galaxies and other phenomena that populate our Universe. Despite the vastness and complexity of the Universe, the ultimate goal of all Space Science missions and research can be narrowed down to pursuing answers to three fundamental questions: How did the Universe begin and evolve? How did we get here? Are we alone?

Mission by mission and scientific discovery by scientific discovery, we are getting closer to the answers we seek. In recent years, space science discoveries have rewritten textbooks, challenged long-standing scientific beliefs, and inspired a sense of awe in the inhabitants of planet earth as we contemplate our place in this amazing cosmos.

Though there were both ups and downs for NASA's Space Science Enterprise this year, overall there was a wealth of compelling science delivered by this program.

Losing Mars Climate Orbiter and Mars Polar Lander back-to-back was a blow not only for the Space Science Enterprise, but also for NASA as a whole. However, as has been the case at various times throughout this Agency's 40-year history, we are going to learn what we can from these losses, change our approach where it is prudent to do so, and move on. Right now we have an expert team studying these failures and our entire Mars program architecture. This is a very important study for NASA, and we look forward to having their analyses and recommendations. The report will be released on March 15, and I will withhold comment until them.

One of the most exciting Space Science events of the past year was the launch of the long-awaited Chandra X-ray Observatory (CXO), the third of NASA's four Great Observatories. In July, the Space Shuttle Columbia, commanded by Colonel Eileen Collins, carried the CXO to space and sent it on its way to a highly elliptical orbit, where it is studying the wonders of the Universe in the X-ray part of the spectrum. As you have already seen, the images from Chandra taken during its short time in space are phenomenal and are a wonderful complement to the dazzling images and important scientific discoveries that the Hubble Space Telescope (HST) has delivered in the ultraviolet, visible, and near infrared wavelengths.

I am pleased to report that following the successful mission of STS-103 in December, the Hubble Space Telescope is back and better than ever. Thanks to new gyroscopes, a new computer, and a host of other upgrades, HST is more powerful and robust than at any other time in its almost-ten-year history. In addition to the thousands of breathtaking images that the telescope delivered last year, one result was a long-awaited, scientific coup: after eight years of painstaking measurement, Hubble scientists found a value for how fast the universe is expanding. This rate of expansion, called the Hubble Constant, is essential to determining the age and size of the Universe, which scientists now believe to be about 12 billion years. Measuring the Hubble Constant was one of the three major goals for the telescope when it was launched in 1990.

In planetary news, the Mars Global Surveyor spacecraft has given us the first global, three-dimensional map of the Martian surface. This incredible database means that we now know the topography of Mars better than many continental regions of Earth. This mapping mission has

revealed many new insights about Mars' varying topography including an impact basin deep enough to swallow Mount Everest, mysterious magnetic lines on the ancient surface reminiscent of plate tectonics on Earth, and weather patterns raging across the North Pole. This new global map of Mars is changing our fundamental understanding of the red planet and will likely influence scientific research of Mars for years to come. The increasingly detailed high-resolution map represents 250 million elevation measurements gathered in 1998 and 1999.

The Cassini spacecraft, currently on a journey to Saturn, completed a highly accurate swing-by of Earth in August. This fly-by was necessary to give Cassini a boost in speed, sending it toward a rendezvous with Saturn and its moon Titan in 2004.

Astronomers, racing the clock, managed to take the first-ever, optical images of one of the most powerful explosions in the Universe -- a gamma ray burst -- just as it was occurring on January 23, 1999. Such bursts occur with no warning and typically last just for a few seconds.

We also had some exciting news about our own star, the Sun. NASA-sponsored scientists have discovered that an S-shaped structure often appears on the Sun in advance of a violent eruption, called a coronal mass ejection, which is as powerful as billions of nuclear explosions. Early warnings of approaching solar storms will prove useful to power companies, the satellite communications industry and organizations that operate spacecraft, including NASA.

I think most of us, on a day-to-day basis, take the Sun for granted. We know it is always there . . . big and yellow and warm. Kind of like a friend we are always happy to see. But, I want to remind you that the same Sun is also a huge, violent ball of energy. The Sun gives off about a million tons of matter every second -- and that's just on an average day. Occasionally, the Sun has explosions that we call coronal mass ejections, the largest of which can have the energy of 1 billion megatons of TNT and eject 10 billion tons of solar gas. Even though by the time this solar matter reaches the Earth's magnetic field it is diluted by its 93-million-mile journey, its effects can still be dramatic and far-reaching. Solar disturbances can affect civilian and military space systems, human space flight, electric power grids, GPS signals, high-frequency radio communications, long-range radar, microelectronics and humans in high-altitude aircraft, and terrestrial climate.

Recognizing the critical role that solar events can have on Earth, the FY 2001 budget includes an exciting new initiative. As I mentioned earlier in my testimony, this new initiative is called "Living with a Star," and it will undertake the most comprehensive study of the Sun and its interaction with the Earth to date. This is a major initiative that will take the talents of many, many people – people at NASA, in other government agencies, academia, and the private sector. Working together, I know we will reach the ultimate goal of this program, which is to help astronomers understand and predict storms and other solar phenomena that can have a direct and often critical impact on Earth and its citizens.

This budget includes an increase of 17% for continued aggressive programs in Solar System Exploration that will enhance the science return and overall success of future mission to Mars and other key research targets. This is a vote of confidence from the Administration on behalf of the American public that we will fix what is wrong, develop a more robust program, and

continue to explore the red planet. The budget supports a Mars Communication Network and other potential sustained presence concepts that will enable us to build incrementally towards aggressive future goals at multiple locations in and around Mars. We also received additional outyear funding that will enable us to apply such research capabilities to other future solar system targets.

The budget request also features funding for a new branch of an existing program. Called "Discovery Micromissions," this series of missions to various Solar System targets will be similar to our Small Explorers program, enabling regular small, low cost missions throughout the solar system and creating new opportunities for university-based research.

The FY01 budget request provides strong support for a robust technology base, as evidenced by funding for the Intelligent Systems Initiative. Although this funding will allow the agency to pursue a broad range of information technology investments, we will place highest priority on investments to enable robotic networks that support new approaches to our Solar System exploration programs. In a related field, NASA has increased the budget for nanotechnology. This investment in microminiaturization and related technologies is crucial for future exploration and allows us to participate in the new interagency nanotechnology initiative. And finally, this budget request provides for Astrobiology instrumentation and technology research and for a restructured Flight Validation Program through FY 2005.

The President's proposed budget supports a robust and scientifically diverse Space Science program with nine planned launches this calendar year. It allows us to continue studying the Universe we live in and develop the technologies necessary to expand our presence in it. Profound scientific discoveries and glimpses of new phenomena occurring in the Universe have long been hallmarks of this great program. This budget request ensures that the Space Science Enterprise will continue to bring value and wonder to the American public.

Earth Science Enterprise

The President's budget for Earth Science in FY 2001 is $1,405.8 million, down $37.6 million from $1,443.4 million in FY 2000. This budget reflects a decrease in funds for observing systems and an increase in research and technology as we pass the peak of development of the Earth Observing System (EOS). FY 2001 continues formulation of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Program (NPP), a cooperative program between DOD, NASA and NOAA that will be launched in 2005. NPP will simultaneously continue the Terra and Aqua mission research measurements as well as demonstrate new and innovative sensors for the NPOESS.

From our birth as the Nation's civilian space agency, NASA has used the vantagepoint of space to view the Earth in order to understand how it functions as a dynamic system of land, oceans, ice, atmosphere, and life. We give people a window on the world to understand how it changes, and what the impacts of those changes might be on human civilization.

The year 1999 marked a milestone in humanity's quest to understand our home planet. We began deployment of the EOS series of satellites, the first attempt to examine all major interactions among the key components of the Earth system. Deployment of the EOS began with

the launch of Landsat 7, the cornerstone of the world's space-based land remote sensing efforts, with wide application in agriculture, forestry and regional planning in addition to its scientific value. Terra, the flagship satellite of the EOS , was successfully launched in December and the activation and checkout of its instruments are proceeding. In April, NASA launched the QuikSCAT satellite to resume global measurement of winds at the ocean surface to improve short-term weather prediction and tracking of major hurricanes and tropical storms globally. Also in December, we launched AcrimSat, an instrument that extends our measurement of variability in the output of the Sun.

FY 1999 was a year of substantial scientific accomplishment in our understanding of the major elements that comprise the Earth system using satellites launched in prior years, along with a variety of aircraft campaigns and ground-based research. Using data from the NASA/Japan Tropical Rainfall Measuring Mission (TRMM), the Earth Science Enterprise (ESE) reduced the uncertainty in measuring rainfall over the tropics by one half, thus improving short-term weather prediction and availability of fresh water globally. Over the ice caps, NASA and other researchers determined the thinning and thickening rates for the Greenland ice sheet. We conducted an international field experiment in the Amazon to help understand the role of vegetation on Earth in removing carbon dioxide from the atmosphere.

This year promises to be equally exciting, as we begin to see the first results from the Terra mission. NineEarth science missions are planned for launch this calendar year, including three deferred from 1999 to assure mission success. Among these nine missions are several important complements to the EOS . The Shuttle Radar Topography Mission is mapping the topography of nearly all the inhabited portions of the Earth's land surface. The QuikTOMS mission will continue our fulfillment of our Congressional mandate for ozone monitoring. Also included is the first of our Earth System Science Pathfinders (ESSP). These are small, rapidly developed missions to explore little understood Earth system processes. The first Earth-oriented New Millennium Program mission is scheduled to fly this calendar year, and will demonstrate new and lower cost land imaging technologies.

Within the President's FY 2001 budget request for Earth Science, the largest activity is the continued deployment of the EOS ($447.1 million). This calendar year will see the launch of the Aqua satellite, the second of the three major components of EOS (along with Terra in 1999 and Chem in 2002). Aqua will provide highly accurate atmospheric temperature and humidity measurements essential for climate change research. Other EOS components in FY 2001 are ICEsat, which will measure the topography of the world's major ice sheets, and the SeaWinds instrument which will continue the ocean winds measurements currently taken by QuikSCAT. FY 2001 EOS funds will also continue development of Chem and 3 smaller satellites (Jason, SAGE III, and SORCE).

This budget also includes $120.4 million for Earth Probes, a series of small, rapidly developed missions such as the ESSP that explore unfamiliar Earth system processes. FY 2001 will see the launch of the Gravity Recovery and Climate Experiment (GRACE) which will provide a precise mapping of the Earth's geoid, thus substantially improving the accuracy of our satellite measurements of sea level. The Triana mission, currently being reviewed by the National Academy of Sciences, will, if approved, detect sunrise-to-sunset changes in ozone, aerosols,

clouds and surface ultraviolet radiation as well as provide warning of space weather events. Development will continue on two new ESSP missions, PICASSO and Cloudsat, which will make three-dimensional measurements of aerosols and clouds in the atmosphere.

Implementation of the Earth Observing System Data and Information System (EOSDIS) will continue and is funded at $252.0 million in FY 2001. Problems encountered in 1999 have been overcome, and EOSDIS is meeting its requirements for operation of Terra and management of the already extensive set of Earth remote sensing data collected from existing satellites.

Within a nearly level budget, the ESE is increasing its investment in research and advanced technology development by $63.9 million over last year to $533.3 million in FY 2001. The ESE has updated its research strategy for the next decade, highlighting specific questions about forces of change acting on the Earth system, and how the Earth responds.

This budget also funds a series of partnerships that may turn our scientific results into practical applications. Topic areas of these partnerships include fire hazard prediction and water availability in the West, farming and forestry in the upper Midwest and the South, as well as urban and regional planning in the Northeast. The standard of success for applications and commercial partnerships is that they become self-sustaining entities based on the quality and utility of the applications products we help them demonstrate. In keeping with NASA's continued commitment to meet research needs, to the extent possible, through scientific data purchases, the Commercial Remote Sensing Program expects to identify new commercial sources of Earth Science data.

FY 2001 promises to be a year of substantial payoff from prior investments in the EOS program, as well as a year of new opportunities from small missions and from partnerships that demonstrate new uses of Earth remote sensing data across the Nation.

Aero-Space Technology Enterprise

The Office of Aero-Space Technology is submitting a FY 2001 budget of $1.193B, which represents a $68M increase over FY 2000. We have restructured this budget to reflect our priorities and to maximize the benefit arising from synergy between aeronautics and space transportation technologies. The increase represents expanded investments in existing programs (Aviation Safety, Flight Research, and Information Technology) and new programs (Space Launch Initiative, Small Aircraft Transportation System, and Quiet Aircraft Technology). These increased investments and new initiatives reflect our priority objectives in safety, aviation systems capacity, noise reduction, next-generation design tools, experimental aircraft and access to space. These investments also support out collaborative effort with the FAA and DOD to achieve the national aviation goals described in the National Science and Technology Council's "National Research and Development Plan for Aviation Safety, Security, Efficiency and Environmental Compatibility."

Aero-Space Technology Programs

The Enterprise is making great progress in accomplishing all three of its major goals, which we refer to as "Pillars for Success"—Global Civil Aviation, Revolutionary Technology Leaps, and Access to Space.

Pillar One, Global Civil Aviation. Over the years, NASA has embraced safety as its number one core value, articulating an unwavering commitment to safety for the public, astronauts and pilots, and the NASA workforce, as well as for high value equipment and property. Although flying is the safest of all the major modes of transportation, the predicted tripling of air traffic over the next 20 years will render even today's low rate of less than two accidents per million flights unacceptable. Therefore, as part of our commitment to the public, we have taken dramatic steps, through joint FAA and NASA research, to assure unquestioned safety for both travelers and crew on our Nation's commercial airlines. The goal of NASA's Aviation Safety Program is to reduce the aircraft accident rate by a factor of five within 10 years, and by a factor of 10 within 25 years.

Of the many technologies now under development, two may have profound impacts on aviation safety. The first is Synthetic Vision, which will turn every flight into a clear daylight flight and alert the crew to any safety hazard. This system will greatly reduce the single most critical factor impairing the safety of worldwide aviation operations—controlled flight into terrain (CFIT). The second is Flight Data Analysis Tools, which will be used by airlines and governments to identify and fix problems before they cause incidents or accidents. The Agency is also collaborating with the Canadian Atmospheric Environmental Services and the Federal Aviation Administration (FAA) in researching the formation of ice on aircraft wings. In the area of weather prediction and adaptation, NASA researchers continued their work on the Advanced Vortex Sensing System (AVOSS)—a key to both improving the safety of flight and reducing the impact of the growing demand for air travel. New features included improvements in wake prediction, observational weather systems, and real-time weather forecasting.

With regard to environmental issues, NASA's collaborative initiative with Pratt & Whitney demonstrated that the company's low-emission combustor can reduce nitrogen oxide (NOx) levels by half during landing and take-off cycles. It also showed comparable reductions in cruise NOx emissions, carbon monoxide, and unburned hydrocarbons. NASA has also been effectively addressing noise pollution, through development of a new aircraft noise impact model that help reduce noise by optimizing aircraft approach trajectories. The new Quiet Aircraft Technology program will extend this research by developing technologies for engine and airframe noise source reduction and advanced operations to reduce community noise impact.

Another important development is NASA's increasing cooperation with the U.S. Air Force, exemplified by the creation of a new Air Force–NASA Partnership Council for Aeronautics. The Council is initially focusing on six areas, one of which is classified. The five non-classified areas are: Aging Aircraft, Propulsion, Concurrent Airspace Operation of Uninhabited Air Vehicles, Simulation-Based Acquisition / Intelligent Synthesis Environment, and Advanced Vehicles.

Pillar Two, Revolutionary Technology Leaps. Progress continued during FY 1999 in NASA's general aviation initiatives. Researchers completed assembly and initial performance and operability testing on both a new advanced internal combustion engine and a new small gas turbine engine, both of which will be demonstrated on experimental aircraft at the Summer 2000 Oshkosh Fly-In in Wisconsin. Also, in the context of NASA's Advanced General Aviation Transport Experiment (AGATE) program, researchers made final selections of systems deemed

most suitable for future integration into an experimental general aviation aircraft. Selected systems include both improved structural materials and an Intuitive Pilot Interface, which provides pilots with a graphic depiction of a desired flight path—or "Highway in the Sky"—taking into account weather, traffic, terrain and any airspace issues, without the use of voice communications. The new Small Aircraft Transportation System (SATS) program will apply this research in a focused demonstration of how increased use of safer, small aircraft could improve air system crowding. This new initiative has the potential in the long-term to change the way people in outlying communities view air travel.

Remotely piloted aircraft (RPA) have also been a focus of NASA research. In July 1999, the Environmental Research Aircraft and Sensor Technology (ERAST) project conducted a flight demonstration at Edwards Air Force Base involving the Altus vehicle, which is capable of performing science missions of greater than 4 hours above 55,000 feet in areas such as the polar regions. The first low-altitude flight of the Helios RPA was conducted in September 1999—the first step on the way to eventual flight at an altitude of 100,000 feet in FY 2001.

Pillar Three, Access to Space. I am very excited about our new Space Launch Initiative and I believe that no effort will be as important to the future of this Enterprise and this agency as this one. In recent years, NASA has made significant progress in transitioning routine space operations to the private sector so that taxpayer resources can be concentrated on high-leverage science research and technology development functions. However, commercially competitive, privately owned, low cost, safe, Earth-to-orbit launch for human space flight remains the most critical, fundamental step this agency can take to enable more aggressive civil space exploration and to stimulate new space commerce. If successful, the Space Launch Initiative will mark a dramatic maturing of our space program, with the potential to revolutionize NASA's and the industry's roles and responsibilities. The Initiative more than doubles FY 2000 funding and supports our goal of conducting a competition in 2005 to meet NASA's human space flight needs through commercial launch service procurements by 2010 if industry is capable of delivering on its promises.. To achieve this goal, the Space Launch Initiative will pursue a three-pronged strategy: 1) technical risk reduction activities to support full-scale development decisions for at least two commercially competitive reusable launch vehicles prior to the 2005 competition, 2) hardware development to meet NASA-unique needs such as crew transport and cargo return on commercial launch vehicles that cannot economically meet these requirements alone, and 3) launch service procurements to provide alternative access for select Space Station needs in the near-term. In addition to these activities, the Space Launch Initiative also incorporates ongoing NASA space transportation technology programs.

Among the most important of these ongoing programs are NASA's X-vehicle demonstrator programs. The X-33 program made considerable progress in FY 1999 by beginning testing of the world's first aerospike engine at the Stennis Space Center. Engine testing is on track to be completed this summer. A significant challenge also arose, involving a structural failure of the X-33's unique, composite material liquid hydrogen fuel tank after successful completion of a rigorous testing sequence. We are dealing with cutting-edge technology with large composite designs, which have never been tested before. An independent investigation team will release a report on the incident in mid-February. In NASA's X-34 program, progress was evident throughout FY 1999, with delivery of the first flight vehicle and captive carry tests by the

companion L-1011 vehicle successfully carried out. Stennis Space Center also conducted hot fire testing of the X-34's innovative Fastrac engine. In addition, the wing was installed on the second X-34 test vehicle, which will be used during the X-34's first powered flights.

Research involving highly innovative space transportation propulsion systems took a step forward with the ground testing of a pair of hydrogen-fueled Rocket Based Combined Cycle (RBCC) flowpath models. The transition from air-augmented rocket to ramjet operating mode was demonstrated in a unique new facility that allows continuous variation of the simulated mach number. Beyond this, NASA's Propulsive Small Expendable Deployer System (PROSEDs) experiment is exploring the potential role of electrodynamic tethers as a means of propulsion in space, without the use of propellants. A Critical Design Review of the project was carried out in early September 1999, and the experiment is scheduled for launch in August 2000. In addition to the Space Launch Initiative, NASA's FY 2001 budget request includes $1.2 billion over five years, an increase of approximately $200 million, for a base level of space transportation research that supports 2nd and 3rd generation RLV technologies.

Commercial Technology Programs

Since its inception in 1958, NASA has been charged with ensuring that the technology it develops is transferred to the U.S. industrial community, thereby improving the Nation's competitive position in the world market. The FY 2001 budget request of $135.0M continues this important aspect of our mission. The Agency's commercialization effort encompasses all technologies created at NASA centers by civil servants, as well as innovations produced by NASA contractors. The technology commercialization program involves the following components: conducting a continuous inventory of newly developed NASA technologies, maintaining an internet-based database of this inventory, assessing the commercial value of each technology, establishing R&D partnerships with industry for dual use of the technology, disseminating knowledge of these NASA technology opportunities to the private sector, and supporting an efficient system for licensing NASA technologies to private companies. Included in the amount requested for NASA commercialization efforts is $100.0M to carry out the provisions of the Small Business Innovation Research (SBIR) Act, which requires that 2.5% of NASA's total extramural R&D spending be set aside for small business research grants. An additional set-aside, involving 0.15% of NASA's total extramural R&D spending, applies to the Small Business Technology Transfer (STTR) Program. The NASA SBIR program has clearly contributed to the U.S. economy, fostering the establishment and growth of over 1,100 small, high technology businesses.

Conclusion

Mr. Chairman, I am enthusiastic and pleased with the budget I am presenting to the Committee. It gives us the stability to: continue vital safety investments in our Space Shuttles, start a Space Launch Initiative that will revolutionize our approach to meeting human space flight launch needs, continue construction of the ISS, and to do the cutting-edge research in science and technology that will make the missions of tomorrow a reality. While there will continue to be challenges with our ISS partnership, we will push forward and complete the ISS. We are on the brink of having a state-of-the art laboratory in space that will provide unprecedented

opportunities for long-term space research and provide the foundation for opening the space frontier in low-Earth orbit and beyond.

With a healthy launch industry, NASA would be able to focus its sights beyond Earth orbit. We will revolutionize our understanding of the universe and send rovers back to Mars while we look outward to Europa and try to uncover the mysteries locked beneath the icy surface of the Jovian moon that contains water and perhaps life. We will continue to develop the technology which will ultimately enable us to discover earth-size planets around other stars. We will continue to study our own planet Earth to try and understand the Earth system as a whole. We will push leap-frog technology which will not only make the missions we haven't yet dreamed of a reality, but will also provide the technology push for continued economic prosperity and the exciting jobs of tomorrow