I. Top Priority: Restore Science ‘Firewall’

For many years, Congress and the Administration protected the science portfolio and missions of NASA from inevitable cost overruns in large human programs, such as the International Space Station and the Shuttle program, through a budgetary firewall. This separation within the budget ensured that NASA’s science portfolio was not raided by programs related to the human exploration mission of NASA. This ensured that NASA held onto both its human space exploration mission as well as its science mission. Last year, this protection was dropped and it has resulted and will continue to result in numerous programs being cut or slated for cancellation in the science program due to large budgetary pressures from the Space Station, the Shuttle program, and other large proposed missions.

This virtual firewall should be restored in order to achieve NASA’s science mission and the nation’s need for space-based observations.

II. Reinforce Need for Continued Planning in Partnership with the National Academies

The outstanding accomplishments of the science enterprises over the past decade or more have been accomplished by a careful multi-step process that matches highest priority science goals to technological and budgetary realities. This is accomplished by means of a constructive interaction between the National Academies, NASA advisory committees, the NASA centers, Congress, and the public. Even though there have been setbacks, the overall program has been a stunning success with missions such as Chandra, Eos, Galileo, GRACE, HST, JASON, Mars Rovers, SOHO, TRMM, UARS, and WMAP. This record establishes that the science community, in partnership with NASA, has developed a successful strategy for defining a program in which outstanding science, excitement, and public inspiration are achieved. Recently, quick decision-making, independent of the careful planning process that has served science so well, has been utilized, leading to several delays or cancellations of highly rated programs.

In planning the Vision for Space Exploration, NASA should continue to use its successful broad-based planning process with respect to its science mission, and avoid making irreversible decisions regarding well-planned science programs.

III. Authorize Critical Science Programs to Reinvigorate NASA’s Science Mission

The core capabilities of NASA’s science mission can be divided into three parts: Solar System Exploration, Investigation of the Universe, and the Exploration of the Earth-Sun System.
Solar System Exploration

NASA must continue the robust program for the exploration of Mars and other planets through continued support for several critical, ongoing missions such as the Mars Exploration Rovers, the Mars Reconnaissance Orbiter, and other major non-human Mars initiatives. The Mars program has captured the minds and imaginations of the public and NASA is only at the beginning of true scientific understanding of this planet.

Despite the continued success of the Mars rovers, the Cassini-Huygens probe, and other important scientific missions, there are no planned major robotic explorations of the outer solar system, other than the Pluto probe, now that the Jupiter Icy Moons Orbiter has been postponed/canceled.

NASA currently has an ideal mix of engineering and science expertise, which are innovative to the max and competitive to the max. It is essential that NASA not lose this capability by postponing major discoveries on some of the least explored planets in our solar system. A two or three year gap in funding for these types of missions may result in a five year or decade long gap in research findings due to the long timelines needed to get from concept to flight to discovery.

*Given the tremendous scientific and engineering successes of these programs and the long gestation period for each one of these missions (i.e. developments for Cassini began back in the mid 90’s), it is imperative that NASA continue to propose, vet (through the Roadmap process), and fund robotic Solar System Exploration missions.*

Investigation of the Universe, Its Nature, and Its Beginnings

In addition to Solar System Exploration, the other major portion of NASA’s space research portfolio consists of the missions, instruments, and programs to study fundamental questions about the universe, including how and when it began and what the nearby stars and galaxies are like. Programs in this element of NASA’s science mission help answer some of the biggest questions humans have had since the beginning of time, captivate the imagination of the next generation of astronomers and scientists, and are the primary support mechanism for the nation’s cadre of astronomers.

The Hubble Space Telescope is an excellent example of how past programs and instruments dedicated to science have produced some of the greatest results and discoveries in NASA’s history.

The future of this portion of NASA’s science mission is most in jeopardy due to the large shift in focus to a purely human exploration mission. Critical, highly endorsed programs funded in the Universe theme, such as the Space Interferometry Mission, the Explorer program, and the Beyond Einstein program are all facing severe budget constraints. These constraints may ultimately halt decades of discovery to come. Moreover, many of these missions are ones used by individual university-based astronomers to explore key questions of understanding.
NASA must invest in these types of ongoing missions now unless it isolates the astronomy community completely.

Exploring and Understanding the Earth-Sun System

Earth-Sun System Science activities include those which look at Earth and those that research solar weather and other major space environment questions. Earth related research provides critical information for weather and atmosphere concerns. Solar weather and sun earth connections research is important for scientific understanding as well as eventual human travel through space.

The future of Earth-observing missions continues to be questioned given the large funding needs of the new Moon-Mars Vision. The already existing environmental decision support systems rely on NASA support and if we intend to continue to study the Earth system, and the effects of changes on our planet, this portion of NASA’s science research portfolio can not be sacrificed. The international Global Observing System of Systems initiative supported by the current administration requires NASA satellite observations of our planet. These observations are critical for the wise evolution of our social, economic, and environmental infrastructures in the face of environmental changes. In addition, predictive capabilities for space weather will be needed for the Moon-Mars Vision to be successful. The success of expansive, already funded programs like Living with a Star depend on numerous data inputs from a multitude of sources that are currently slated for cancellation.

NASA continues to apply heavy cuts to the Earth-Sun Systems division in order to help pay for the new exploration vision. Future and existing, tremendously successful missions such as Voyager, TRMM, LANDSAT are slated for cancellation despite decades of scientific output. With countless, successful and highly rated missions canceled, these cuts will have a devastating impact at universities nationwide, where much of the science analysis is carried out. They would also amount to a going out of business plan for many of NASA’s Earth-Sun Science activities and research areas. These enormous cuts silence about $3 billion of investment in flight missions (in FY06 alone) and will decimate an active research community. The bulk of the funding being cut goes mostly to the research community for direct scientific return.

NASA must give high priority to its Earth-Sun science research activities now or it will risk losing critical teams of scientific talent, which are needed to answer some of the biggest questions regarding the Earth and its future as well as regarding overarching concerns in future space exploration.

IV. Authorize an Increased Investment in Core Aeronautics Research and Development Programs

The funding reductions, combined with significant expected reductions in workforce and research infrastructure, make the United States dominance in aeronautical research and products almost certainly unsustainable. For over 30 years, the U.S. has enjoyed a favorable balance of trade in aeronautics; in 2003, this was $27 billion. However, the U.S. has no domestic regional jet manufacturers (the fastest growing segment in civil aviation), and the European Union has
explicitly stated its objective of becoming the world’s leading supplier of aeronautics goods and services. The EU has increased funding in aeronautics by a factor of 20 over the last 10 years, at the same time as NASA aeronautics funding for research has declined by more than half over the past decade. Aeronautics declines a further 6 percent in the President’s FY06 Budget, and the agency’s proposed five-year outlook for aeronautics shows research funding declining an additional 20 percent.

Every aircraft flying today has benefited from NASA basic research and development. Technological advances in aeronautics over the past 40 years have enabled a ten-fold improvement in aviation safety, a doubling of fuel efficiency with reductions in emissions per operation, reduction in noise generation and a 50 percent reduction in cost to travelers. Aeronautics research funds are usually dispersed to researchers through a wide array of government agencies; however, NASA is the only federal agency supporting research on civilian aircraft. NASA fundamental research and its screening of high-risk concepts are vital to industrial competitiveness and innovation. Academic partners, vital to NASA basic research, are also responsible for cultivating the next generation of NASA scientists and engineers. Aeronautics research and technology has, for decades, contributed significantly to our economy in jobs and taxes, and has proven itself in every war since WWII to be a crucial, if not decisive, element.

Aeronautics research and development programs should be balanced with long-term and short-term goals. Technology demonstration programs should not be performed to the exclusion of fundamental science and engineering programs – there needs to be solid, long-term research in aeronautics. This is especially the case in NASA’s Vehicle Systems Program, the hardest hit area within the NASA budget. Current re-focusing of Vehicle Systems toward four technology demonstration programs comes at the expense of more fundamental research and core technology development.

*NASA should invest in core long-term research programs in order to perform world-class aeronautics research and development and train the next generation of scientists and engineers necessary to keep NASA and the U.S. aeronautics industry competitive and innovative.*

**V. Restore Investment in Critical Enabling Information Technology to Support all Facets of the NASA Mission**

The overall level of funding from NASA in the areas of software practices and critical IT has declined by 75% in the past two years. This is despite growing evidence of both need and opportunity for software and IT services. From a historical perspective, the *need* is evidenced by a record of major mission failures attributable to software problems. For example there were numerous software related problems experienced by the Mars Rovers Opportunity and Sojourner. Looking forward, the requirements for software capability and assurance are even more important due to the need for greater autonomy in the planned Exploration missions, as well as the growing sophistication of the science missions. The evidence of *opportunity* for progress in the areas of software practices and critical IT is reflected in the recent accomplishments in the NASA research community and in the broader, cross-cutting activities conducted by the National Coordination Office for Information Technology, Research and
Development (NITRD). These successful activities have seized specifically on the opportunity available for progress, both in technology/tool development and in mechanisms for validation and transition into practice.

Failure to address these issues now will result in greater risks with respect to cost, schedule, capability, and potential for major mission failures. The current state of practice of software engineering in commercial and aerospace industry is not advancing at a rate sufficient to address emerging NASA requirements. We cannot afford to wait for a software-induced mission failure to motivate appropriate action in this area.

VI. Authorize Programs for Education and Training of the Next Generation of NASA’s Workforce and U.S. Scientists

NASA science programs play an extremely important role at universities nationwide where both undergraduate and graduate students are exposed to high-tech programs in flight hardware, advanced data analysis, information technology, and modeling. NASA activities carried out at universities have a double payoff – the first as NASA acquires instruments and software used in its missions, and the second as students are trained to enter the technological workforce later on. The student training in NASA programs provides an important input into future S&T workforce development that is sorely needed by our nation.

Compounding this problem is the chilling effect caused by NASA management practices as the agency redirects funding to support the Exploration mission. Many university efforts were abruptly terminated, leaving graduate students, faculty, and project staff without support in mid-semester. Even in cases where they were able to obtain alternate funding (which in the normal cycle requires six to nine months), both they and their institutions became less willing to take the financial risk of accepting further NASA support. The effect is that NASA-related university programs are either down-sized or redirected to other scientific and technical areas. This damages the long-term S&T capacity of NASA and more generally our National capability to address S&T challenges and opportunities. It also means that NASA and its contractors will find it more challenging to hire a capable and informed technical workforce.

Critical workforce education and training programs need to be supported through NASA funding if the U.S. is going to continue to possess the world’s best cadre of engineers and scientists. NASA research management practices for university contracts should be revised to promote stable and predictable funding, even as NASA mission priorities evolve.