The Civil Space Sector

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The information presented in this paper is based on research done by the author. Although it was prepared for the Commission in conjunction with its deliberations, the opinions expressed in this paper are those of the author alone and do not represent those of the Commission or any of the Commissioners.

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I. Introduction

Since the enactment of the National Aeronautics and Space Act of 1958, our nation has had a policy that separates space exploration and commercial activities from "activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States". However, to fully utilize the scientific and engineering resources of the United States and to avoid unnecessary duplication of effort, facilities, and equipment, the policy also provides for sharing "with national defense of discoveries that have military value or significance." In light of the guidance given to this Commission to study national security space management and organization, this paper addresses the sharing of information and cooperative efforts between national security space organizations and:

(1) The civilian agencies exercising control over space activities sponsored by the United States

(2) The federal departments and agencies exercising policy and regulatory control over international space issues and the space activities of U.S. commercial companies.

II. Civil Space Agencies Organizations

A. Civil Space Agencies

The National Aeronautics and Space Administration (NASA) is a Federal research and engineering agency that accomplishes most of its space, aeronautics, science, and technology programs through nine Field Centers and the Jet Propulsion Laboratory, which is a Federally Funded Research and Development Center. In fiscal year 2000 (FY00), NASA's budget was approximately $13.58 billion and it maintained a civil service workforce of approximately 17,970. In recent years NASA has carried out its missions with a shrinking workforce and budget. The Agency has successfully reduced its workforce from a high of nearly 25,000 in FY91 to 17,970 in FY00. NASA's share of Federal spending has declined from a high of 4.4% of the Federal Budget in 1966, at the height of the Apollo program, to about 0.7% today.

NASA continues to make significant scientific and engineering advances with fewer resources. In the face of declining budgets, NASA has made changes in program emphasis during the last few years. The Agency has reoriented its budgets consistent with its strategic planning and its missions, which are to:

- Advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe
- Advance human exploration, use, and development of space
- Research, develop, verify, and transfer advanced aeronautics and space technologies

NASA's resources have been allocated to its mission-related top priorities: safe operation of the Space Shuttle, development and operation of the International Space Station and maintenance of a strong program of science and technology development.

The *National Oceanic and Atmospheric Administration* (NOAA), located within the *Department of Commerce*, provides satellite observations of the global environment by operating a national system of satellites to explore, map, and chart the oceans and their resources and to describe, monitor, and predict conditions in the atmosphere, ocean and environment. NOAA's *National Environmental Satellite, Data, and Information Service* (NESDIS) acquires and manages the Nation's operational environmental satellites, provides data and information services, and conducts related research in order to provide and ensure timely access to global environmental data from satellites and other sources to promote, protect, and enhance the Nation's economy, security, environment, and quality of life.

B. Policy and Regulatory Department and Agencies

The *Bureau of Oceans and International Environmental and Scientific Affairs* is the Department of State's focal point for foreign policy formulation and implementation in global environment, science, and technology issues. The Bureau's *Space and Advanced Technology* (SAT) staff handles international space issues and multilateral science and advance technology questions. Its objectives are to ensure that U.S. space policies and multilateral science activities support U.S. foreign policy

objectives and enhance the competitiveness of the U.S. aerospace industry. The SAT staff has primary responsibility for providing U.S. representation on the United Nations Committee on the Peaceful Uses of Outer Space, the NATO Science Committee, and the OECD committee on Scientific and Technological Policy. SAT also maintains the U.S. Registry of Space Objects and reviews export license requests for space technology. The State Department's *Office of Defense Trade Controls* (DTC) controls the export and temporary import of defense articles and services by taking final action on license applications and other requests for approval for defense trade exports and retransfers, and handling matters related to defense trade compliance, enforcement and reporting. DTC oversees the U.S. Munitions List that includes scientific and research satellites.

The *Federal Communications Commission* (FCC) is an independent U.S. Government agency that is charged with establishing policies to govern interstate and international communications by television, radio, wire, satellite and cable. The *International Bureau* was established in 1994 to handle all FCC international telecommunications and satellite programs and policies. The Bureau represents the commission in international conferences involving telecommunications matters such as rates, standards, and development issues. Its other primary functions include international safety and distress, space and earth stations, cable landing licenses, bilateral discussions and interaction with other international organizations.

The *National Telecommunications and Information Service* (NTIA) is an agency of the *Department of Commerce* (DOC) and is the Executive Branch's principal agency responsible for domestic and international telecommunications and information policy issues. The *Office of International Affairs* (OIA) advocates Executive Branch policy perspectives in bilateral and multilateral consultations with foreign governments, in international regulatory conferences, and in other forums dealing with Global Information Infrastructure issues. Specific oversight responsibilities include (in cooperation with the State Department and with the FCC), the COMSAT Corporation's activities in the International Telecommunications Satellite Organization (INTELSAT) and the International Mobile Satellite Organization (INMARSAT). OIA also monitors other developments in the satellite industry.

The *Office of Space Commercialization* is the principal office within the DOC for the coordination of space-related issues, programs, and initiatives. The office conducts activities in three primary areas:

(1) Policy development

(2) Market analysis

(3) Outreach and education

In fulfilling these roles and functions, the *Office of Space Commercialization* focuses its efforts on a select group of commercial space industry sectors, including satellite navigation and imaging, space transportation, satellite communications and emerging space business activities.

The DOC's *Bureau of Export Administration* seeks to advance U.S. national security, foreign policy, and economic interests by regulating exports of critical goods and technologies that could be used to damage those interests. It seeks to:

(1) Enforce compliance with export control regulations.

(2) Cooperate with like-minded nations to obtain global support for this effort.

(3) Assist nations that are key exporters or transit points for sensitive goods and technologies to strengthen their own transit and export controls.

(4) Monitor the U.S. defense industrial base to ensure it remains strong.

The *Department of Transportation* (DOT) is the lead agency within the Federal government for regulatory guidance pertaining to commercial space transportation activities. Within the *Federal Aviation Administration* (FAA), the *Office of the Associate Administrator for Commercial Space Transportation* (AST) is the newest and only space-related line of business. AST is given responsibility to:

(1) Regulate the commercial space transportation industry as necessary to ensure compliance with international obligations of the U.S. and to protect the public health and safety, safety of property, and national security and foreign policy interest of the United States.

(2) Encourage, facilitate, and promote commercial space launches by the private sector.

(3) Recommend appropriate changes in Federal statutes, treaties, regulations, policies, plans, and procedures.

(4) Facilitate the strengthening and expansion of the U.S. space transportation infrastructure.

In fulfilling its responsibilities, AST issues Launch Operator Licenses for commercial launches of orbital and sub-orbital rockets.

III. Civil/National Security Cooperative Efforts

A. Current Activities

NASA participates extensively in cooperative efforts with other U.S. Government agencies. A number of these activities are coordinated through the President's Office of Science and Technology Policy and the National Science and Technology Council.

NASA collaborates with the Department of Defense (DOD) on a variety of space launch and operations activities and in developing future Human Exploration and Development of Space capabilities. NASA, U.S. Air Force Space Command, and the National Reconnaissance Office coordinate a variety of technology development and planning activities through a Partnership Council. NASA and DOD also collaborate on future communications and data systems architectures for space operations through the National Security Space Senior Steering Group. Through the Interagency Global Positioning System (GPS) Executive Board, NASA participates with DOD and other civilian agencies to assure that the GPS meets overall space research needs. Interagency activities such as these ensure maximum compatibility among the Agencies' spacecraft, instruments, and ground systems.

Interagency planning and coordination occurs at all levels. NASA scientists and engineers collaborate directly with their DOD colleagues through professional conferences, workshops, meetings, teleconferences, joint projects, working groups, and personnel exchanges. At the program management level, NASA program officials meet with appropriate officials

from DOD to coordinate programs and technology development work. At the Enterprise and Agency level, NASA is a member of numerous committees that facilitate joint planning. These groups range from working groups to senior-level management committees. To further enhance collaboration, NASA, DOD agencies and the services have assigned liaison staff to their partner agencies. NASA also participates in interagency planning meetings. At the highest level, NASA is an active participant in Administration interagency planning groups such as the National Science and Technology Committee and its Subcommittees. The primary mechanism used to formally document cooperative activities and interagency commitments with the DOD is the Memoranda of Agreement.

The following programs/projects illustrate the level of ongoing interagency cooperation between the civil space agencies and the DOD to meet mutual science, technology, and national security goals and objectives:

Shuttle Radar Topography Mission (SRTM)—An international project spearheaded by the National Imagery and Mapping Agency (NIMA) and NASA. SRTM's objective was to obtain the most complete high-resolution digital topographic database of the Earth. The radar system flew onboard Space Shuttle Endeavour and gathered topographic data over approximately 80% of the land surface of the Earth, creating the first-ever near-global data set of land elevations. The processed SRTM radar data can be tailored to meet the needs of the military, civil, and scientific user communities.

National Polar-Orbiting Operational Environmental Satellite System (NPOESS)—On May 5, 1994, the President directed convergence of the Department of Commerce/National Oceanic and Atmospheric Administration's Polar-orbiting Operational Environmental Satellite (POES) program and the Department of Defense's Defense Meteorological Satellite Program (DMSP). These two programs will become the National Polar-orbiting Operational Environmental Satellite System (NPOESS). In addition, the National Aeronautics and Space Administration, through its Earth Observing System efforts, offers new remote sensing and spacecraft technologies that could potentially improve the capabilities of the operational system. The President also directed the three agencies to establish an Integrated Program Office to manage this converged system. The Integrated Program Office (IPO) provides for the planning, development, management, acquisition, and operation of the Nation's single polar-orbiting operational environmental satellite system to satisfy

both civil and national security requirements for remotely sensed meteorological, oceanographic, climatic and space environmental data. The IPO is a tri-agency office reporting through the NOAA to an Executive Committee comprised of Under Secretary/Administrator level officials of the Departments of Commerce, Defense and the National Aeronautics and Space Administration.

Shuttle Potential and Return Electron Experiment (SPREE)—A satellite experiment designed to monitor the Space Shuttle's electrical potential throughout its flight, SPREE monitored the electrical charging of the space shuttle while the Tethered Satellite System was operating. When SPREE detected electrical charges building up on the shuttle, a low-energy particle beam was fired into space to discharge the Orbiter and bring it back toward equilibrium with its environment. The data collected on this mission demonstrated that a large spacecraft could be operated to safely handle charging up to fairly high levels with no adverse effects to crew or equipment and was a valuable addition to the understanding of the space environment and its effect on Air Force space systems.

B. Roadmap for Ongoing Cooperative Efforts

The following series of NASA Strategic Enterprise tables chart a course toward achieving the Agency's goals in the near-term (2000-2005). They include the current cooperative efforts between NASA, the military services and DOD agencies that demonstrate interagency collaboration and the civil space contribution to national security (NASA goals, objectives and plans relevant to national security interests are shaded, along with the formal agreements that support those goals and objectives).

1. Space Science Enterprise

The Space Science Enterprise seeks to chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planetary bodies, and life. The Enterprise asks basic questions that have eternally perplexed human beings, such as: How did the universe begin and evolve? How did we get here? Where are we going? Are we alone? The Space Science Enterprise develops space observatories and directs robotic spacecraft into the solar system and beyond to investigate the nature of the universe.

Space Science Enterprise		
Goals	***Objectives***	***2000-2005 Plans***
Science: Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life	Understand our changing Sun and its effects throughout the solar system	Study the dynamics of the Sun's atmosphere and interior, research the interactions between the solar wind and Earth's magnetosphere, and view solar coronal mass ejections in 3-D
	Chart our destiny in the solar system	Obtain images of the Earth's magnetosphere during geomagnetic storms, search for evidence of water on Mars, and characterize the number and orbits of Near Earth Objects
	Understand the structure of the universe, from its earliest beginnings to its ultimate fate	Measure fine details of microwave background
	Explore the ultimate limits of gravity and energy in the universe	Observe structure of collapsed objects, and determine origins of gamma-ray bursts
	Learn how galaxies, stars, and planets form, interact, and evolve	Observe in infrared the earliest stages of stellar birth, determine composition of material between stars, and learn about early formation of galaxies and of stars in the galaxy
	Look for signs of life in other planetary systems	Analyze dust in other planetary systems, and obtain precise distances and velocities for 40 million nearby stars
	Understand the formation and evolution of the solar system and the Earth within it	Investigate Saturn, its rings, and moon Titan. Analyze the structure and composition of comets, understand the history of Mars, and return dust and solar wind samples
	Probe the evolution of life on Earth, and determine if life exists elsewhere in the solar system	Conduct laboratory and field research on the origin of life on Earth (Astrobiology Initiative), and search for water on Mars
Agreement(s) 1. MOA between BMDO and NASA GSFC for the BMDO active plasma experiment North Star 1. APEX is a US/Russian cooperative program to study the characteristics and effects of artificial plasma clouds in space.		
Support Human Space Flight: Use robotic science missions as forerunners to human exploration beyond Low-Earth Orbit	Investigate the composition, evolution, and resources of Mars, the Moon, and small bodies	Explore the surface and atmosphere of Mars, survey the structure and composition of asteroids, and investigate the composition and structure of comets. Analyze the dynamics of the Sun's atmosphere and interior and obtain 3-D images of solar coronal mass ejections.
	Develop the knowledge to improve reliability of space weather forecasting	

Table 1 —DOD/NASA Joint Programs that
Support Space Science/National Security Goals and Objectives

Space Science Enterprise (cont.)		
Goals	***Objectives***	***2000-2005 Plans***
Technology: Develop new technologies to enable innovative and less expensive flight missions	Acquire new technical approaches and capabilities	Develop technologies such as radiation-survivable miniaturized spacecraft avionics, advanced non-solar power sources, precision optics, planetary sampling mechanisms, bioassay technology, and sample return systems Test two independent spacecraft flying as an optical interferometer, and demonstrate flying three subminiature spacecraft as a single system
	Validate new technologies in space	
	Apply and transfer technology	
Agreement(s) 1. Reimbursable Interagency Agreement, dated 22 May 1997, between NASA (GRC) and DARPA for Thermophotovoltaic and photovoltaic systems and technology development. NASA GRC and DARPA wish to conduct research, technology development and testing efforts in photovoltaic (PV) and thermophotovoltaic (TPV) energy conversion technology for the purpose of meeting NASA and DOD needs for remote power systems. 2. MOA, dated 9 January 1998, between NASA and DOD to establish an Alliance for increased cooperation, improvements in efficiency, and the mutual benefits resulting from coordinated planning, acquisition, improvement, maintenance, operation and utilization of space environmental simulation facilities. 3. MOA between BMDO and NASA to define the relationships between NASA and BMDO and the terms and conditions for fabrication, delivery, launch and post-flight operations and data collection of NASA provided payload hardware and software for 5 experiments to be integrated with the Electronics Test Bed Data Handling systems, which is being designed and fabricated by the USAF AFRL. 4. MOU between NASA GSFC and the National Reconnaissance Office, dated Nov 1999, for Advanced Mirror System Demonstrator in support of the Next Generation Space Telescope mission; MOU with the Jet Propulsion Laboratory for inflatable and deployable structures; and participation in the "gossamer" R&D initiative.		
Education and Public Outreach: Share the excitement and knowledge generated by scientific discovery and improve science education	Share the excitement of space science discoveries with the public	Integrate education and enhanced public understanding of science into our missions and research programs, establish strong and lasting partnerships between the space science and education communities, and provide ready access to the products of space science education and outreach programs
	Enhance the quality of science, mathematics, and technology education, particularly at the pre-college level	
	Help create our 21st century scientific and technical workforce	

Table 1 (cont.)—DOD/NASA Joint Programs that
Support Space Science/National Security Goals and Objectives

2. Earth Science Enterprise (ESE)

The Earth Science Enterprise aims to understand the Earth and its response to natural and human-induced changes in order to improve prediction of climate, weather, and natural hazards, and help us to be responsible stewards of our planet for future generations. The Enterprise investigates Earth as an interacting system of atmosphere, oceans, land masses, and living beings affected by the Sun and other external

phenomena. It inquires into the nature of the forces acting on and within the Earth asking: Can we anticipate the Earth's response? How is the Earth changing? What are the consequences for life on Earth?

Earth Science Enterprise		
Goals	***Objectives***	***2000-2005 Plans***
Science: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth	Discern and describe how the Earth is changing	Establish a benchmark for global rainfall Estimate uptake of atmospheric CO2 from global measurements of the terrestrial biosphere Provide precise global measurements of atmospheric temperature and humidity Make global measurements of cloud properties to determine Earth's response to solar radiation Measure global ocean winds and topography to improve accuracy and length of weather prediction and drive models of ocean impacts on climate change Produce 3-D maps of the entire inhabited surface of the Earth to determine Earth's response to solar radiation Measure global ocean winds and topography to improve accuracy and length of weather prediction and drive models of ocean impacts on climate change Produce 3-D maps of the entire inhabited surface of the Earth
	Identify and measure the primary causes of change in the Earth system	
	Determine how the Earth system responds to natural and human-induced changes	
	Identify the consequences of change in the Earth system for human civilization	
	Enable the prediction of future changes in the Earth system	
Agreement(s) 1. MOU, dated 29 Jan 1995, between NIMA and NASA GSFC for the loan and use of digital terrain elevation data. 2. MOU, dated 7 Aug 1996, between NASA and NIMA for a cooperative flight of the shuttle radar topography mission (SRTM). The concept for SRTM has been developed in conjunction with scientists and engineers from NASA, NIMA and other DOD agencies. The primary objective of SRTM is to measure the topographic surface of the Earth. 3. MOA, dated 25 May 1995, between DOD, DOC and NASA for the National Polar-Orbiting Operational Environmental Satellite System (NPOESS). Purpose: Formal agreement between the agencies to implement the President's directive to establish the NPOESS. 4. MOA between NASA, USSPACECOM and NOAA, dated 17 April 1997, concerning support of the GOES and POES satellite programs.		

Table 2 —DOD/NASA Joint Programs that
Support Earth Science/National Security Goals and Objectives

Earth Science Enterprise (cont.)		
Goals	***Objectives***	***2000-2005 Plans***
Applications: Expand and accelerate the realization of economic and societal benefits from Earth science, information, and technology	Demonstrate scientific and technical capabilities to enable the development of practical tools for public and private sector decision-makers	Demonstrate applications of geospatial data to areas such as: agriculture, forestry, and urban and transportation planning Expand use of commercial systems in collecting Earth system science data Collaborate with educators to develop new curricula support materials using Earth science data and discoveries
	Stimulate public interest in and understanding of Earth system science and encourage young scholars to consider careers in science and technology	
Technology: Develop and adopt advanced technologies to enable mission success and serve national priorities	Develop advanced technologies to reduce the cost and expand the capability for scientific Earth observation	Implement satellite formation flying to improve science return, and New Millennium Program to validate revolutionary technologies in space Explore new instrument concepts for next decade missions Employ high-performance computing to address Earth system modeling challenges Collaborate with operational agencies in mission planning, development, and operations
	Develop advanced information technologies for processing, archiving, accessing, visualizing, and communicating Earth science data	
	Partner with other agencies to develop and implement better methods for using remotely sensed observations in Earth system monitoring and prediction	
Agreement(s) 1. MOU between NASA LaRC and the Air Force Research Laboratory, Wright Laboratory dated 22 Sep 1994, to develop systems for remote sensing applications that operate from ground, air, or space based platforms. 2. MOA between NASA SSC and NAVOCEASNO to provide the basis for joint projects between NASA SSC and NAVOCEANO for the mutual benefit of their respective missions in earth and ocean observation. 3. MOA between NASA GSFC and USSPACECOM, dated 17 March 1995, that establishes principles for exchanging information associated with RFI to NASA space systems in order to resolve such problems quickly and efficiently. As such, this agreement lays out the framework for timely reporting and analysis of RFI between NASA and the DOD.		

Table 2 (cont.)—DOD/NASA Joint Programs that
Support Earth Science/National Security Goals and Objectives

3. Biological and Physical Research Enterprise (BPR)

The Biological and Physical Research Enterprise conducts basic and applied research to support human exploration of space and to take advantage of the space environment as a laboratory. The Enterprise asks

questions that are basic to our future, such as: How can human existence expand beyond the home planet to achieve maximum benefits from space? How do fundamental laws of nature shape the evolution of life?

Biological and Physical Research Enterprise		
Goals	***Objectives***	***2000-2005 Plans***
Enable Exploration: Conduct research to enable safe and productive human habitation of space	Conduct research to ensure the health, safety, and performance of humans living and working in space	Identify mechanisms of health risk and potential physiological and psychological problems to humans living and working in space, and begin developing and testing countermeasures
	Conduct physical science research on planetary environments to ensure safe and effective missions of exploration	Conduct research in analog test beds and on orbit to enhance medical care for human space flight
	Conduct research on biological and physical processes to enable future missions of exploration	Test and validate technologies that can reduce the overall mass of human support systems by a factor of 2 (compared to 1990's levels)
		Begin developing interdisciplinary knowledge (e.g., biology, physics, materials) to support safe, effective, and affordable human/robotic exploration
Agreement(s) 1. MOA between NASA HQs (Code U) and the U.S. Air Force Surgeon General to define areas within aerospace medicine of mutual interest and to initiate cooperative action as agreed upon.		
Science: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology	Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community Develop strategies to maximize scientific research output on the International Space Station and other space research platforms	Conduct scientific, and engineering research and enable commercial research activities on the ISS to enrich health, safety, and the quality of life on Earth Establish dynamic research partnerships with the scientific community to open new fields of research in chemical, biological, and physical processes, including— • Gravity effects on cellular genomics and mechanisms • Structure of biological materials • Safe and efficient combustion processes • Atomic physics investigations probing relativity and new forms of matter Working with the HEDS Enterprise, identify important science objectives for 100-day class human missions

Table 3 —DOD/NASA Joint Programs that Support
Biological and Physical Research/National Security Goals and Objectives

Biological and Physical Research Enterprise (cont.)		
Goals	***Objectives***	***2000-2005 Plans***
Commerce: Enable and promote commercial research in space	Assure that NASA policies facilitate industry involvement in space research Systematically provide basic research knowledge to industry Provide technical support for companies to begin space research Foster commercial research endeavors with the International Space Station and other assets	Provide periodic reports on potential applications of space knowledge and possibilities for industry partnerships Review and make recommendations for changes to NASA commercial policies Advocate policy, legislative, and engineering actions to facilitate privately funded commercial space development Create new approaches to collaborative partnerships with the private sector for the development of future BPR Enterprise capabilities
Outreach: Use space research opportunities to improve academic achievement and the quality of life	Engage and involve the public in research in space Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets	Expand public and K-12 educational access to mission research information Work with colleges and universities in the conduct of biological and physical space research

Table 3 (cont.)—DOD/NASA Joint Programs that Support
Biological and Physical Research/National Security Goals and Objectives

4. Human Exploration and Development of Space Enterprise (HEDS)

The Human Exploration and Development of Space Enterprise seeks to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space. HEDS asks questions to improve human possibilities both on Earth and in space. How do we design systems to make possible safe and efficient human exploration and commercial development of space? What are the resources of the solar system? Where are they? Are they accessible for human use? How can we ensure that humans can be productive in and beyond Earth orbit? HEDS is building the International Space Station to provide a continuously operating research platform and to prepare the way for robotic and human exploration even farther into space.

Human Exploration and Development of Space Enterprise		
Goals	***Objectives***	***2000-2005 Plans***
Explore the Space Frontier	Invest in the development of high-leverage technologies to enable safe, effective, and affordable human/ robotic exploration	Obtain key data for human mission design decisions from collaboration with robotic science missions
	Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit	Identify and evaluate candidate approaches for 100- to 1000-day human missions capable of a 5- to 10- fold cost reduction*–while increasing safety and effectiveness
	Enable human exploration through collaborative robotic missions	Develop and validate competing technologies for human missions beyond Low-Earth Orbit (LEO) in cooperation with other Agencies, international partners and U.S. industry
	Define innovative human exploration mission approaches	
	Develop exploration/commercial capabilities through private sector and international partnerships	
Agreement(s) 1. MOA between NASA and USSPACECOM, dated 24 March 1994, that established as formal interface for the purpose of providing mutual support in the exchange of surveillance information on all objects of interest in space. Includes launch information, spacecraft health and status, and notification/ database information.		
Enable Humans to Live and Work Permanently in Space	Provide and make use of safe, affordable, and improved access to space	Complete transition of the Space Shuttle to Space Flight Operations Contract (SFOC) and undertake needed upgrades
	Operate the International Space Station to advance science, exploration, engineering, and commerce	Complete ISS development and pursue creation of a non-Governmental Organization (NGO) to simplify processes for and costs of access to space
	Ensure the health, safety, and performance of humans living and working in space.	Conduct exploration and engineering research–and enable scientific and commercial research–activities on the ISS to enrich health, safety, and the quality of life on Earth
	Meet sustained space operations needs while reducing costs	
Agreement(s) 1. Agreement (dated 12 Nov 1982) between the DOD and NASA for Joint Investigation of Aircraft or Space System Mishaps. Purpose: Establishes guidelines for the DOD and NASA to investigate jointly, aircraft or space systems mishaps that occur under their joint programs or operations. 2. MOA between NASA JSC and USSPACECOM, dated 24 March 1994, for space control, operations relationship, space shuttle program support and International space station program support. The MOA establishes the agreement in principle for exchanging information associated with potential and actual hostile space events supporting the Space Shuttle flight operations and developing a framework for future ISS operations support, including threat and warning, trajectory services and Computation of Miss Between Orbits. 3. Interagency Agreement between the Department of the Air Force, Air Force Systems Command, Armstrong Laboratory and NASA LaRC, dated 16 Mar 1992, to enhance critical human systems related research and technology areas of mutual interest.		

Table 4 —DOD/NASA Joint Programs that Support
Human Exploration and Development of Space/National Security Goals and Objectives

Human Exploration and Development of Space Enterprise (cont.)		
Goals	***Objectives***	***2000-2005 Plans***
Enable the commerical Development of Space	Improve the accessibility of space to meet the needs of commercial research and development	Formulate and advocate policy, and legislative and engineering actions, to facilitate privately funded commercial space development Identify jointly with industry the commercial potential of concepts for 100-day class missions and establish cooperative R&D to develop candidate technologies Create new approaches to collaborative partnerships with the private sector for the development of future HEDS Enterprise capabilities
	Foster commercial endeavors with the International Space Station and other assets	
	Develop new capabilities for human space flight and commercial applications through partnerships with the private sector	
Share the Experience and Benefits of Discovery	Engage and involve the public in the excitement and the benefits of—and in setting the goals for—the exploration and development of space	Expand public access to HEDS mission information (especially from ISS) by working with industry to create media projects and public engagement initiatives
	Provide significantly more value to significantly more people through exploration and space development efforts	Work with colleges and universities in the conduct of HEDS research and technology for future exploration
	Advance the scientific, technological and academic achievement of the Nation by sharing our knowledge, capabilities, and assets	
Agreement(s) 1. Partially reimbursable interagency agreement, dated 20 June 1999, between Naval Air Warfare Center, China Lake and NASA MSFC for Hypersonic Weapon Technology thermal protection system testing.		

Table 4 (cont.)—DOD/NASA Joint Programs that Support
Human Exploration and Development of Space/National Security Goals and Objectives

5. Aerospace Technology Enterprise (AST)

The Aerospace Technology Enterprise works to maintain U.S. preeminence in aerospace research and technology. The Enterprise aims to radically improve air travel, making it safer, faster, and quieter as well as more affordable, accessible, and environmentally sound. The Enterprise is

also working to develop more affordable, reliable, and safe access to space; improve the way in which air and space vehicles are designed and built; and ensure new aerospace technologies are available to benefit the public.

Aerospace Technology Enterprise		
Goals	***Objectives***	***2000-2005 Plans***
Advance Space Transportation: Create a safe, affordable highway through the air and into space	*Mission Safety–Radically improve the safety and reliability of space launch systems*	*Develop processes and technology improvements for safer crewed launches*
	Mission Affordability–Create an affordable highway to space	*Complete technology risk reduction to enable U.S. industry to significantly reduce the cost of launches to Low-Earth Orbit*
	Mission Reach–Extend our reach in space with faster travel	*Develop advanced space transportation concepts, and initiate enabling technology programs*
Agreement(s) 1. DOD Instruction dated March 26, 1985 to update and approve the continuance of an interagency missile, gun, and space propulsion coordinating committee known as the Joint Army, Navy, NASA, Air Force Interagency Propulsion Committee. Functions: Promotes and facilitates exchange of technical information among the Military Departments and NASA; to develop standards; and to effect coordination of research, exploratory development, and advanced technology development programs in the areas of missile, gun, and space propulsion. 2. Interagency Agreement, dated 23 Feb 1993, between DOD and NASA for access to and use of the GPS Precise Positioning Service. Purpose: Establishes the policies and procedures whereby NASA is provided access to and use of the Precise Positioning Service of the GPS. 3. MOA between NASA GSFC and the U.S. Army Space and Strategic Defense Command, dated 17 March 1994, to set forth an agreement for the operation and maintenance of a USASSDC owned 50K rail launcher deployed to Wallops Flight Facility.		
Commercialize Technology: Extend the commercial application of NASA technology for economic benefit and improved quality of life	*Commercialization–Facilitate the greatest practical utilization of NASA know-how and physical assets by U.S. Industry*	*Increase the number and quality of technology partnerships with U.S. industry, and facilitate increased private sector access to NASA technical expertise and facilities*
Pioneer Technology Innovation: Enable a revolution in aerospace systems	*Engineering Innovation–Enable rapid, high-confidence, and cost efficient design of revolutionary systems*	*Develop advanced engineering tools, processes and collaborative teaming environments*
	Technology Innovation–Enable fundamentally new aerospace system capabilities and missions	Pioneer basic research in revolutionary technologies, such as nanotechnology, information technology, and biotechnology

Aerospace Technology Enterprise (cont.)		
Goals	***Objectives***	***2000-2005 Plans***
Agreements 1. Agreement between the Air Force Flight Dynamics Laboratory and NASA Ames Research Center (ARC), dated Apr 1975, to cooperate in areas of mutual interest regarding computational fluid dynamics. 2. MOU between Dept of the Air Force, Arnold Engineering Development Center and NASA Ames Research Center (ARC), dated 12 Oct 1990, to enhance the aeronautical and space research and development capabilities of both parties 3. MOU between Dept of the Air Force, Wright Laboratory and NASA Ames Research Center (ARC), dated 10 Jan 1992, to enhance the aeronautical and space research and technology of both parties. 4. MOA between the Air Force Cost Analysis Agency, Air Force Space and Missile Systems Center and NASA Marshall Space Flight Center (MSFC), dated 7 Jul 1994, to share costing data for space programs. 5. MOU between Dept of the Air Force, Phillips Laboratory and NASA GSFC, dated 7 Jan 1995, to facilitate the open exchange of information, ideas, and technology in areas of mutual interest related to satellite control and autonomy. 6. MOU between U.S. Army Missile Command, U.S. Army Test and Evaluation Command, U.S. Army Space and Strategic Defense Command and NASA MSFC, dated 10 May 1995 to form the Hypervelocity Technology Alliance and share information regarding technical capabilities and objectives with other Alliance members in the area of hypervelocity impact and aerophysics, design, test, and analysis. 7. MOU between Dept of the Air Force, Phillips Laboratory and NASA LaRC, dated 28 Jun 1995, to share in the demonstration and validation of space system technologies. The technology areas of interest include spacecraft systems or subsystems hardware or software, spacecraft ground support equipment, mission unique equipment, innovative payload technologies and remotely operated vehicles. 8. MOA between the Department of Defense, Air Force Space Technology Center and NASA GSFC, dated 17 Jul 1996, to development and test of a long-life single stage cryogenic refrigerator for space applications 9. Interagency Agreement between Dept of the Air Force, Wright Laboratory and NASA LaRC, dated 22 Feb 1997, to enhance aeronautical and space research and technology of both parties. 10. MOA between U.S. Army Special Operations Command and NASA HQ (Code M), dated 22 August 1997, defining the roles and responsibilities of the parties for conducting a long term demonstration and evaluation utilizing NASA's Tracking and Data Relay Satellite System via the Portable TDRSS Communication hardware and software device. 11. Interagency Agreement between the Department of the Air Force, Air Force Material Command, Phillips Laboratory and NASA Langley Research Center (LaRC), dated 23 Sep 1997, for cooperative development of Advanced Technology Insertion Module/Improved Space Computer Program/Signal Processor with Ada Compiler all Enhanced for Space Program. 12. Reimbursable Interagency Agreement between NASA GRC and the Air Force Research Lab, dated 13 Mar 1998, to conduct research and testing efforts on spacecraft materials for the purpose of assessing the effects of simulated space exposure. 13. Reimbursable Interagency Agreement between NASA Glenn Research Center (GRC) and the Air Force Research Lab, dated 17 April 1998, to conduct research, technology development, space flight and ground demonstration efforts in flywheel energy systems for aerospace applications. 14. MOU between the Space and Missile Systems Center, Air Force Research Laboratory and NASA, dated 19 Mar 1999, for the purpose of spacecraft battery testing and verification. 15. MOA between the Department of the Army Communication and Intelligence Systems Support and NASA GSFC, dated 15 April 1999, to conduct a demonstration and evaluation utilizing NASA's Tracking and Data Relay Satellite Systems (TDRSS) via portable TDRSS Multiple Access communication hardware and software devices.		

Table 5—DOD/NASA Joint Programs that
Support Aerospace Technology/National Security Goals and Objectives

IV. Future Opportunities for Collaboration

As the abouve descriptions incidcate, there are a large number of ongoing collaborative efforts between the civil space agencies' and the military services, DOD agencies and the NRO, in support of national security. If this trend continues, then opportunities exist for future collaboration between NASA, NOAA and the DOD on programs of mutual benefit to both the civil and national security space sectors. The specific examples shown on the following page indicate how the U.S. civil space agencies might support the development of the critical capabilities required to achieve US Space Command's vision for 2020.

Critical Capability		NASA Contribution
Recoverable, Rapid Transport to, through and from space		Pathfinder Program—demonstrating advanced space transportation technologies through the use of flight experiments and experimental vehicles (X-34, X-37). Satellite Servicing and Repair—NASA successfully serviced the Hubble Space Telescope 3 separate times, and completed the Solar Maximum Repair Mission in 1984. On-orbit Refueling—NASA flight tested the Orbiter Refueling System (ORS) in 1984 and successfully demonstrated that on-orbit refueling of satellites from the Space Shuttle was possible.
Detect and Report Threats/ Attacks		Artificial Intelligence—NASA's Intelligent System Initiative is focused on providing for advancements in Automated Reasoning, Intelligent Use of Data, Human-Centered Computing, and Revolutionary Computing. Forecast Space Weather—some NASA space science missions (Wind, Polar, SOHO, etc.) are conducted as part of the International Solar-Terrestrial Physics program. ISTP's mission is to obtain coordinated, simultaneous investigations of the Sun-Earth space environment over an extended period of time.

Education Training Modeling and Simulation		Intelligent Synthesis Environment (ISE)—ISE combines leading-edge technologies effectively to build or assemble a widely distributed, integrated collaborative virtual environment for synthesizing missions as well as for designing, testing, and prototyping aerospace systems. ISE tools and capabilities will be used to develop Hyperactive Learning Systems to enhance education and training.
Global Partnerships		International Space Station—the largest and most complex scientific cooperative project in history. Led by the United States, it draws upon the scientific and technological resources of 16 nations. NASA's experience with international partnerships could serve as a model for establishing joint space security agreements with our allies.

Table 6—Collaboration Opportunities

Using the NASA Strategic Plan and the US Space Command Long Range Plan as guides, the following roadmap links areas for cooperative efforts that could support reaching the goals and objectives of each agency. Where possible, it also identifies the NASA program or project that most appropriately satisfies joint requirements. The roadmap uses an outline structure to identify areas for cooperation from 2001 through 2010. The NASA outline starts at the Strategic Enterprise level and ends at the "plans" level. The Space Command outline starts at the key objectives level and terminates 2 layers down with key capabilities. The linkage for potential cooperation will be shown at the NASA "plans" level and the USSPACECOM "key capabilities" level, and lists only those NASA plans with potential national security implications.

NASA STRATEGIC PLAN

Space Science Enterprise

- **Goal:** Science—chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life
  - **Objective(s):** Chart our destiny in the solar system
    - **Plans:**
      Characterize the number and orbits of Near Earth Objects

      Obtain images of the Earth's magnetosphere during geomagnetic storms

      Expand understanding of space weather using solar, radiation belt, and ionospheric mappers

USSPACECOM LONG RANGE PLAN

Control of Space Operational Concept

- **Specified Objective:** Protection—includes active and passive defensive measure to minimize threats (natural and man-made) to space systems
  - **Key Task(s):** (1) Detect and report all threats and attacks to key US and allied space systems. (2) Identify, locate and classify the source of threats or attacks
    - **Key Capabilities:**
      Detect and report threats to owner/operators in near real-time

      Identify/locate/classify source threat source with high confidence (seconds)

Space Science Enterprise (cont)

- **Goal:** Support human space flight—use robotic science missions as forerunners to human exploration beyond Low-Earth Orbit
  - **Objective(s):** Develop the knowledge to improve reliability of space weather forecasting
    - *** Plans:**
      Analyze the dynamics of the Sun's atmosphere and interior and obtain 3-D images of solar coronal mass ejections.

      Refine our predictive understanding of solar activity by investigating the dynamics of the solar atmosphere and interior and globally monitoring the Sun system

- **Goal:** Technology—develop new technologies to enable innovative and less expensive flight missions
  - **Objective(s):** Acquire new technical approaches and capabilities
    - *** Plans:**
      Develop technologies such as radiation-survivable miniaturized spacecraft avionics, advanced non-solar power sources, precision optics, and sample return systems.

Control of Space Operational Concept (cont)

- **Specified Objective:** Protection
  - **Key Task(s):** (1) Detect and report all threats and attacks to key US and allied space systems. (2) Identify, locate and classify the source of threats or attacks
    - *** Key Capabilities:**
      Identify/locate/classify source threat source with high confidence (seconds)

      Detect and report threats to owner/operators in near real-time
- **Specified Objective:** *Assured Access*—the on-demand use of space lines of communication to enable unimpeded operations in and through space.
  - **Key Task(s):** Operating on-orbit assets (command and control)
    - *** Key Capability:**
      Space weather forecasting to support global traffic control
- **Specified Objective:** *Assured Access*
  - **Key Task(s):** Transport mission assets to, through and from space
    - *** Key Capability:**
      On demand satellite deployment
  - **Key Task(s):** Service and recovery of selected on-orbit assets
    - *** Key Capability:**
      Recoverable, rapid response transport to, through and from space

Earth Science Enterprise

- **Goal:** Technology—develop and adopt advanced technologies to enable mission success and serve national priorities

  - **Objective(s):** Develop advanced information technologies for processing, archiving, accessing, visualizing, and communicating Earth science data

    * **Plans:**
      Employ distributed computing and data mining techniques for Earth system modeling

      Employ high-performance computing to address Earth system modeling challenges

      Develop and implement autonomous satellite control

      Develop high data rate communications and onboard data processing and storage

Global Engagement Operational Concept

- **Specified Objective:** Integrated Focused Surveillance—provides on-demand, continual surveillance of high-interest targets-to support missile defense and force application for all commanders

  - **Key Task(s):** Dissemination of near real-time support for time sensitive operations

    * **Key Capability:**
      Battle management

  - **Key Task(s):** Monitoring, cataloging, assessing—to establish historical references for near real-time comparative analysis

    * **Key Capability:**
      Target set detection/surveillance/ monitoring/ tracking

  - **Key Task(s):** Detecting, cueing and fusing—for the detection of specific events, cross cueing of multiple systems across all mediums, near real-time fusion of data into information

    * **Key Capability:**
      Real-time target identification and characterization

Human Exploration and Development of Space Enterprise

- **Goal:** Enable humans to live and work permanently in space
  - **Objective(s):**

    Provide and make use of safe, affordable, and improved access to space

    Meet sustained space operations needs while reducing costs

    Operate the International Space Station to advance science, exploration, engineering, and commerce

    * **Plans:**
      Complete transition of the Space Shuttle to Space Flight Operations Contract (SFOC) and undertake needed upgrades

      Complete ISS development and pursue creation of a non-Governmental Organization (NGO) to simplify processes for and costs of access to space

      Strengthen partnerships with industry to ensure ISS access and pursue Shuttle upgrades until a credible replacement is available

Control of Space Operational Concept

- **Specified Objective:** Assured Access
  - **Key Task(s):**

    Transport mission assets to, through and from space

    On-orbit asset operations—provide worldwide TT&C for on-orbit satellites

    Service and recovery of selected on-orbit assets

    * **Key Capability:**
      On-demand satellite deployment

      Launch to sustain required constellations for peacetime (100%)

      Recoverable, rapid response transport to, through and from space

Aerospace Technology Enterprise

- **Goal:** Advance Space Transportation: Create a safe, affordable highway through the air and into space
  - **Objective(s):**

    Mission Safety–Radically improve the safety and reliability of space launch systems

    Mission Affordability–Create an affordable highway to space

    Mission Reach–Extend our reach in space with faster travel

Control of Space Operational Concept

- **Specified Objective:** Assured Access
  - **Key Task(s):**

    Transport mission assets to, through and from space

    On-orbit asset operations—provide worldwide TT&C for on-orbit satellites

    Service and recovery of selected on-orbit assets

Aerospace Technology Enterprise (cont)

* **Plans:**
  Develop processes and technology improvements for safer crewed launches

  Complete technology risk reduction to enable U.S. industry to significantly reduce the cost of launches to Low-Earth Orbit

  Develop advanced space transportation concepts, and initiate enabling technology programs

  Reduce the payload cost to Low-Earth Orbit by a factor of 10 and the cost of inter-orbital transfer by a factor of 10

Control of Space Operational Concept (cont)

* **Key Capability:**
  Recoverable, rapid response transport to, through and from space

  On-demand satellite deployment

  Launch to sustain required constellations for peacetime (100%)

- **Goal:** Pioneer Technology Innovation: Enable a revolution in aerospace systems
  - **Objective(s):**
    Engineering Innovation–Enable rapid, high-confidence, and cost efficient design of revolutionary systems
    * **Plans:**
      Develop advanced engineering tools, processes and collaborative teaming environments

      Demonstrate advanced, full life cycle design and simulation tools, processes and virtual environments in critical NASA engineering applications

- **Specified Objective:** Assured Access
  - **Key Task(s):**
    On-orbit asset operations—provide worldwide TT&C for on-orbit satellites
    * **Key Capability:**
      On-demand satellite operations execution and integrated satellite operations mission planning

Full Force Integration Operational Concept

- **Specified Objective(s):**

  Educating the Force

  Training the Force

  Incorporating Space in Field and Command-Post Exercises

  Modeling and Simulation