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U.S. Space Programs: Civilian, Military, and Commercial

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CONTENTS

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SUMMARY

The 106th Congress is addressing a broad range of civilian, military, and commercial space issues.

The National Aeronautics and Space Administration (NASA) conducts the most visible space activities. NASA's International Space Station (ISS) program is the most controversial because it is over budget, behind schedule, and relies on Russia for some hardware and services. Nevertheless, it has survived 21 termination attempts in NASA funding bills since 1991. Other NASA issues are whether NASA is adequately managing its flight programs, ensuring the safe operation of the space shuttle, developing new launch vehicles, and facilitating space commercialization. Concerns about NASA's budget have been somewhat ameliorated in the FY2001 budget request. NASA received $13.6 billion for FY2000. The request for FY2001 is $14 billion, and is projected to rise to $15.6 billion by FY2005.

The Department of Defense (DOD) has a less visible but equally substantial space program. Tracking the DOD space budget is extremely difficult since space is not identified as a separate line item in the budget. DOD sometimes releases only partial information (omitting funding for classified programs) or will suddenly release without explanation new figures for prior years that are quite different from what was previously reported. However, in July 1999, OMB reported that DOD's total space budget was $12.359 billion for FY1998 and $13.207 billion for FY1999. For FY2000, $13.026 billion was requested; final appropriations figures are not yet available. Nor is the FY2001 request.

Civilian and military satellites provide data useful for environmental objectives. NASA's Earth Observing System has been controversial for several years because of its cost and other issues. A probe proposed by Vice President Gore called Triana to transmit images of the Earth to the Internet is the current focus of controversy, however. Proponents insist that it will provide important scientific data. Critics argue that it was not subjected to proper peer review.

The appropriate role of the government in facilitating commercial space businesses is an ongoing debate. For many years, the focus has been on commercial space launch services, but remote sensing satellites also pose complex questions.

Space launch vehicles are similar to ballistic missiles and concerns exist about the potential transfer of certain space technologies to countries intending to build missiles as well. U.S. linkage between space cooperation and adherence to the Missile Technology Control Regime was a significant factor in reaching agreement on cooperative and commercial space activities with Russia, and creates a complex relationship with China.

International cooperation and competition in space are being affected by the world economic situation and the post-Cold War political climate. President Clinton's decision to merge NASA's space station program with Russia's is symbolic of the dramatic changes, and the risks.

MOST RECENT DEVELOPMENTS

On June 12, the House Appropriations Committee reported the FY2001 VA-HUD-IA appropriations bill (H.R. 4635, H. Rept. 106-674), which includes NASA. The committee cut NASA's FY2001 request of $14 billion by $322 million. That would give the agency $113 million more than in FY2000. It also directed NASA to terminate all joint aeronautics and space related research programs with the Air Force.

The House passed the FY2001 Department of Defense (DOD) appropriations bill (H.R. 4576, H. Rept. 106-644) on June 7; the Senate has begun debate on its version (S. 2593, S. Rept. 106-298). The House passed the FY2001 DOD authorization bill (H.R. 4205) on May 18; the Senate has begun debate on its version (S. 2549, S. Rept. 106-292). Among space-related issues, the Senate authorization and appropriation bills add funding for the space-based laser (SBL) program and Army space control technologies, and the Senate authorization bill adds funding for the Kinetic Energy antisatellite (KEAsat) program. The House authorization bill funds the requested levels for those programs (zero in the case of KEAsat). The House appropriations bill reduces funding for the SBL program and funds space control and KEAsat at the requested levels. The House passed the FY2001 intelligence authorization bill (H.R. 4392) on May 23. The Senate Intelligence Committee reported its version of the bill (S. 2507, S. Rept. 106-279) on May 4. The House and Senate Intelligence Committees expressed concern about inadequate funding for utilizing data produced by intelligence satellites, especially under the Future Imagery Architecture soon to be implemented.

*(**See also:** CRS Issue Brief IB93017, Space Stations; CRS Report RL30493, NASA's FY2001 Budget Request ...; CRS Report RS20252, NASA's Triana Spacecraft; and CRS Issue Brief IB93062, Space Launch Vehicles...)*

BACKGROUND AND ANALYSIS

U.S. Government Civilian Space Programs

National Aeronautics and Space Administration (NASA)

The establishment of the National Aeronautics and Space Administration (NASA) in the National Aeronautics and Space Act of 1958 (P.L. 85-568, the "NASA Act"), symbolized the entrance of the United States into the space age. The Soviet Union had successfully orbited the first artificial satellite, Sputnik 1, on October 4, 1957, lending the U.S. space program a new urgency. The first U.S. satellite, Explorer 1 (developed and launched by the Army), was orbited on January 31, 1958 after several failures of the Naval Research Laboratory's Vanguard rocket. President Eisenhower's desire to separate military and civilian space activities led to the "NASA Act" and the creation of the civilian NASA on October 1, 1958, with the Department of Defense (DOD) retaining control over military space programs.

Human Spaceflight. The Soviets achieved another space "first" on April 12, 1961, when Yuri Gagarin became the first human to orbit Earth. The United States responded by launching Alan Shepard into space on May 5 (though he made only a suborbital flight; the

first American to orbit the earth was John Glenn in February 1962). Following Shepard's flight, President Kennedy announced that the United States intended to put a man on the Moon within a decade, a goal accomplished on July 20, 1969 when Neil Armstrong and Buzz Aldrin walked on the Moon (a total of six 2-man crews walked on the Moon through 1972). Apollo was followed by the Skylab space station (to which 3 crews were sent in 1973-1974) and the 1975 Apollo-Soyuz Test Project in which a U.S. Apollo spacecraft with 3 astronauts and a Soviet Soyuz spacecraft with 2 cosmonauts docked for 2 days of joint experiments.

In 1972, President Nixon approved NASA's space shuttle program to develop a reusable spacecraft for taking crews and cargo into Earth orbit. The first shuttle flight occurred in 1981 and the system was declared operational in 1982. The *Challenger* tragedy in January 1986 suspended shuttle operations for 32 months, but all the missions since the shuttle returned to flight in 1988 have been successful. NASA remains concerned about shuttle safety, however, and in the FY2001 budget request is asking for funds to hire more people at the NASA centers that work on the shuttle program (see CRS Issue Brief 93062).

In 1984, President Reagan directed NASA to build a permanently occupied space station "within a decade." In 1988, Europe, Canada and Japan agreed to be partners with the United States in building the space station. Redesigned and rescheduled repeatedly, President Clinton called for yet another redesign in 1993 and later that year merged NASA's space station program with Russia's. That program, the International Space Station (ISS), is the one currently being built. The first two segments of ISS were launched at the end of 1998 and docked together by a space shuttle crew. ISS now awaits the launch of the third segment, Russia's Zvezda Service Module. That schedule is uncertain because of funding difficulties in Russia, the delay in U.S. shuttle launches, and software problems. Questions about Russia's financial ability to fulfill its obligations to the ISS program and substantial cost overruns on NASA's part of the program make ISS an issue of continuing controversy. Twenty-one attempts since 1991 to terminate the program in NASA funding bills and three attempts in broader legislation have failed (see CRS Issue Brief IB93017).

Space Science and Applications. NASA has launched many spacecraft for space science and applications. Robotic probes served as pathfinders to the Moon for astronauts, and have visited all the planets in the solar system except Pluto. Many space science spacecraft are now in development or operating. As discussed further under the section on "**Current NASA Issues**" below, in 1999, NASA lost two Mars missions, one of which involved three separate spacecraft, so a total of four spacecraft were lost. First was the Mars Climate Orbiter (MCO) that failed in September 1999 because NASA used metric units while its contractor, Lockheed Martin, used English units for calculating and sending navigation commands to MCO. Consequently, the probe was off course as it attempted to go into Mars' orbit. MCO carried replacement instruments to compensate for another failed NASA probe, Mars Observer, with which NASA had lost contact just before it reached Mars in 1993. MCO's sister spacecraft, Mars Polar Lander (MPL), and two "Deep Space 2" probes carried with it were lost in December 1999. An investigation team could not determine for certain what caused the failures, but believes that MPL was lost due to a software design problem. MCO and MPL were carried as a single line item in the NASA budget with a total cost of $328.5 million. MCO and MPL were part of NASA's Mars Surveyor program in which two spacecraft were to be sent to Mars every 26 months (when Earth and Mars are aligned properly). They reflected NASA's "faster, better, cheaper" (FBC) approach to scientific spacecraft, replacing large, complex spacecraft that can acquire more information, but take

longer and cost more to build. The last two of that type are Galileo, which arrived at Jupiter in 1995 and continues to return data, and Cassini, now enroute to Saturn. The FBC approach is now being scrutinized, however, and NASA is restructuring its Mars exploration program.

Earth-orbiting observatories have studied the universe since the 1960s, creating new fields of astronomy since space-borne telescopes can intercept wavelengths (such as x-rays and gamma rays) that cannot penetrate Earth's atmosphere. In the 1980s, NASA embarked upon building four "Great Observatories" for studies in different parts of the electromagnetic spectrum. Three have been launched: Hubble Space Telescope, launched April 1990 (for the visible wavelengths); Compton Gamma Ray Observatory, launched April 1991, deorbited June 2000; and Chandra X-Ray Observatory, launched July 1999. The fourth, Space Infrared Telescope Facility (SIRTF), was reduced in size because of budgetary issues, but NASA still calls it a "great observatory." SIRTF is scheduled for launch in 2001.

The 1960s witnessed the development of communications and meteorological satellites by NASA, and in the 1970s, land and ocean remote sensing satellites. NASA's role in this aspect of space utilization, called space applications, traditionally is for R&D, not operations, however. Once the technology is proven, operational responsibility is transferred to other government agencies or the private sector. NASA continues to perform research in many of these areas, and the Landsat land remote sensing program was returned to NASA after a decade of trying to privatize it. NASA's major environmental satellite research program today is the Earth Observing System, a series of satellites to be launched over 15-20 years to provide data to help understand global climate change (see **Environment**). Controversy also has erupted over another Earth science program, Triana (see **Environment**).

Other Civilian Government Agencies

Beginning in the 1960s, other agencies became involved in space. At that time, operation of weather satellites was transferred to what is now the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. The Landsat land remote sensing satellite system was transferred to NOAA in 1979. (Later, NOAA oversaw private sector operation of the system, but in 1992, Congress moved the program back into the government; see below). The Department of Commerce also is involved in space issues due to its role in trade policy and export of items on the Commerce Control List, and has an Office of Space Commercialization mandated to facilitate commercial space businesses. In 1983, the Department of Transportation (DOT) was given responsibility for facilitating and regulating commercial launch services companies. This function is performed through the Federal Aviation Administration. DOT and DOD co-chair a group that oversees use of DOD's Global Positioning System of navigation satellites. DOT represents civilian users and has programs to augment the system's utility to the civilian community. Other government agencies involved in space include the Department of Energy, which historically has developed nuclear power sources for satellites; the Departments of Agriculture and Interior (particularly the U.S. Geological Survey) that use satellite data for crop forecasting and map making, for example; and the Department of State, which develops international space policy and determines whether to grant export licenses for items on the Munitions List (including some types of spacecraft and launch vehicles). The Office of the U.S. Trade Representative, the Office of Science and Technology Policy, the National Security Council, and other White House offices also are involved. President Clinton released a comprehensive space policy on

September 19, 1996, covering all government space activities including those in support of commercial objectives.

Commercial Space Programs

Civilian communications satellites have been chiefly a private sector activity since passage of the 1962 Communications Satellite Act (P.L. 87-624). Attempts to commercialize other aspects of space activities have yielded mixed success. Congress has passed several laws to facilitate the commercialization of space launch services for putting satellites into orbit (the 1984 Commercial Space Launch Act, the 1988 Commercial Space Launch Act Amendments, the 1990 Launch Services Purchase Act, and the 1998 Commercial Space Act). The development of a U.S. commercial launch services industry has been largely successful. DOD and NASA continue to play a strong role in developing new launch vehicles, though private companies also are developing their own. The most controversial issues are the relative roles of the government versus the private sector in developing new systems, ensuring that U.S. companies can compete with foreign launch services companies, and trade and missile proliferation issues involved in exporting satellites to other countries for launch. These issues are discussed in CRS Issue Brief IB93062.

Congress also sought to facilitate commercialization of land remote sensing satellites by privatizing the government's Landsat program through the 1984 Land Remote Sensing Commercialization Act (P.L. 98-365). Such satellites provide imagery of the Earth that can be used for land-use planning, environmental studies, mineral exploration, and many other uses. After a tumultuous 8 years that saw the effort to privatize Landsat fail, Congress repealed that Act and replaced it with the Land Remote Sensing Policy Act of 1992 (P.L. 102-555), bringing Landsat back under government sponsorship. The Act also promoted development of new systems by the private sector. Coupled with a 1994 Clinton Administration policy, these actions led several U.S. companies to initiate programs to build remote sensing satellites and offer imagery on a commercial basis. Those companies must obtain an operating license from NOAA for such systems. (The first successful launch of a commercial imaging satellite, Space Imaging's Ikonos 2, was achieved in September 1999).

Controversy over the fact that the imagery has military as well as civilian uses continues to complicate this commercial space effort, however. Though not as precise as military reconnaissance satellites, some of the private sector systems under development can produce imagery with 1 meter resolution (the ability to "see" an object or feature of a certain size). NASA's Landsat 7 offers 15 meter resolution. France, Russia, and India offer commercial satellite imagery with 10-meter, 2-meter, and 6-meter resolution respectively. Tensions between the government and the private sector in implementing the 1994 Clinton policy to ensure that national security is not harmed by commercial imagery sales prompted an interagency review. One major issue is when the government can exercise "shutter control," forcing companies to discontinue obtaining or distributing imagery of certain parts of the world in times of crisis. Shutter control is part of the 1994 policy, but the companies want greater guidance on when it could be exercised. Another issue is the government's role in controlling to whom the imagery is sold and which countries may invest in the U.S.-owned systems. U.S. companies want time limits on how long the government can take to decide whether particular sales or investments will be permitted so they can make wise business decisions. Under the 1992 Landsat Act, the Commerce Department has 120 days to accept or reject license applications. However, Clinton Administration policy requires that it consult

with other agencies, including the Departments of State and Defense. There are no time limits for those departments.

Special issues have arisen regarding Israel. On October 7, 1994, Senator Bingaman and 63 other Senators sent a letter to the Secretary of Commerce expressing concern that data from Eyeglass (one of the U.S. systems, built by Orbital Sciences Corporation and subsequently renamed Orbview) that could be used against Israel would be made available to Saudi Arabia, which is providing partial financing for the system and would be the location of a ground station. Eyeglass officials subsequently agreed not to take images of Israel, but the issue of access to high quality data is still controversial. The FY1997 DOD authorization bill (P.L. 104-201) included language prohibiting the collection and release, or U.S. government declassification, of satellite imagery of Israel unless such imagery is no more detailed or precise than what is available from commercial sources.

Potential availability of commercial imagery also has a positive side for the military, since the U.S. military and intelligence communities could reduce costs by acquiring imagery commercially instead of building their own systems for some purposes. The House and Senate Intelligence Committees have strongly encouraged the National Imagery and Mapping Agency (NIMA) to purchase commercial imagery to augment classified imagery. NIMA has announced several contracts with commercial imagery providers.

Other potential commercial space activities are microgravity materials processing (making products such as purer pharmaceuticals by utilizing the microgravity conditions in space), space tourism, and space facilities such as Spacehab's modules that fly inside the space shuttle's cargo bay for scientific experiments or carrying cargo.

Representative Rohrabacher is a strong proponent of the potential of space as a commercial venue and introduced legislation (H.R. 3898) on March 9, 2000, that would exempt products manufactured in space or services provided in or from space from certain federal taxes. The exemption would not apply to services provided by telecommunications or weather or other earth observation satellites, or services for transporting property to or from space. The exemption would begin to be phased out in 2026.

Military Space Programs

The creation of NASA was a deliberate step by President Eisenhower to separate military and civilian space activities. Among other things, he wanted to stress that the United States was interested in the peaceful uses of space, but recognized that space had military applications as well. The 1958 National Aeronautics and Space Act specified that military space activities be conducted by the Department of Defense (DOD). The Air Force is DOD's executive agent for most space programs. The intelligence community (coordinated by the Director of Central Intelligence) makes significant use of space-based intelligence collection capabilities, and participates in managing satellite reconnaissance programs through the National Reconnaissance Office (NRO), an agency within DOD. NRO builds and operates intelligence collection satellites, and collects and processes the resulting data. The data are provided to users such as the National Security Agency (NSA) and the National Imagery and Mapping Agency (NIMA). How to organize DOD and the intelligence community to work together effectively on space matters has been an issue for several years. The FY2000 DOD authorization act (P.L. 106-65) establishes a Commission to Assess U.S. National Security

Space Management and Organization to report within six months of its first meeting (expected in June 2000). The panel's membership was announced in May 2000; it will be chaired by former Defense Secretary Rumsfeld. One issue it will address is whether a Space Force should be created separate from the other military services. Also, the FY2000 intelligence authorization act (P.L.106-120) establishes a National Commission on the Review of the National Reconnaissance Office to report in one year.

DOD and the intelligence community rely increasingly on satellites for reconnaissance, surveillance, early warning, weather forecasts, navigation, and communications. During the Persian Gulf War, space-based sensors furnished commanders and staff at all levels with detailed information, often in near real-time, and satellites were crucial for communications between the National Command Authority in the United States and Central Command in the Persian Gulf, and within Central Command. GPS navigation satellites helped U.S. and allied land, sea, and air forces pinpoint their own locations as well as enemy targets. Support from space displayed great improvement over what was available during the last major conflict, Vietnam. Hence, the Persian Gulf War is dubbed by some the first "space war."

The separation between military and civilian space programs remains, but the functions performed by satellites and the vehicles that launch them are not easily divided. Both sectors use communications, navigation, weather, and remote sensing/reconnaissance satellites, which may operate at different frequencies or have different capabilities, but have similar technology. The same launch vehicles can be used to launch any type of military, civilian, or commercial satellite. DOD uses some civilian satellites and vice verse.

DOD develops space launch vehicles, too. The Delta, Atlas, and Titan launch vehicles were all initially developed by DOD, while NASA developed Scout and Saturn (both no longer produced), and the space shuttle. All except the shuttle are "expendable launch vehicles" (ELVs) that can only be used once (the shuttle is reusable). An August 1994 White House policy gave DOD responsibility for maintaining and upgrading the ELV fleet (through the Evolved Expendable Launch Vehicle program), while NASA maintains the shuttle and develops new reusable technology (see CRS Issue Brief IB93062).

After the Cold War ended, DOD and congressional interest in space weapons, both those to attack other satellites (antisatellite, or ASAT, weapons) and weapons based in space to attack ballistic missiles, declined initially, but since the 104th Congress, funding has been added for these projects (see below). Using satellites to attack ballistic missiles has been controversial since President Reagan's 1983 announcement that he would initiate a Strategic Defense Initiative to study the viability of building a ballistic missile defense (BMD) system to protect the United States and its allies. In May 1993, DOD changed the name of the Strategic Defense Initiative Organization to the Ballistic Missile Defense Organization (BMDO)reflecting decreased emphasis on "national missile defense" (NMD) to defend against a Soviet attack and increased interest in "theater missile defense" (TMD) for regional conflicts. In recent years, however, a renewed commitment to NMD has been made (see CRS Issue Brief IB10034). Whether BMD weapons ultimately are based in space or on the ground, a BMD system undoubtedly would require satellites for early warning, communications, and other traditional support functions served by spacecraft.

Interagency Coordination

Several different mechanisms have been tried since 1958 to coordinate interagency space policy. Dissatisfied with the Reagan Administration's approach of using a Senior Interagency Group (SIG/Space) under the National Security Council, in the FY1989 NASA authorization act (P.L. 100-685) Congress re-created the National Space Council. The original council, which included aeronautics, was created in the 1958 Space Act but was abolished by President Nixon in 1973. The FY1989 law required the council to be chaired by the Vice President, but did not stipulate what agencies were members. President Clinton decided to merge the Space Council functions into a National Science and Technology Council, administered through the Office of Science and Technology Policy. It oversees civil and commercial space policy; military space activities are overseen by the National Security Council. The Space Council still exists in law, but it is not staffed or funded.

International Cooperation and Competition

Virtually every country in the world uses satellites for communications and obtaining weather data, but the usual measure of whether a country is a member of the "space-faring" club is its ability to launch satellites. By this criterion, seven countries (Russia, the United States, China, Japan, India, Israel, and Ukraine) and the European Space Agency (ESA) are members. These countries, including many of the individual members of ESA, present opportunities for cooperation in space, as well as competition. The 14 members of ESA are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. (North Korea claims to have successfully launched a satellite in August 1998. The United States concluded it was a failed satellite launch attempt. Others think it was a ballistic missile test.)

The NASA Act specifically states that NASA will conduct international space activities, and most NASA space programs today have an international component. One of the major cooperative projects today is the space station (see CRS Issue Brief IB93017). European countries, both individually and through ESA, Canada, and Japan have participated in many cooperative space programs with NASA. Most of these countries also compete with U.S. companies in space activities. As noted earlier, one area of current concern is competition in launch services for placing satellites into orbit. Other competitors include France, Russia, and India in remote sensing, Europe in communications satellite technology, and Europe and Japan in microgravity materials processing research.

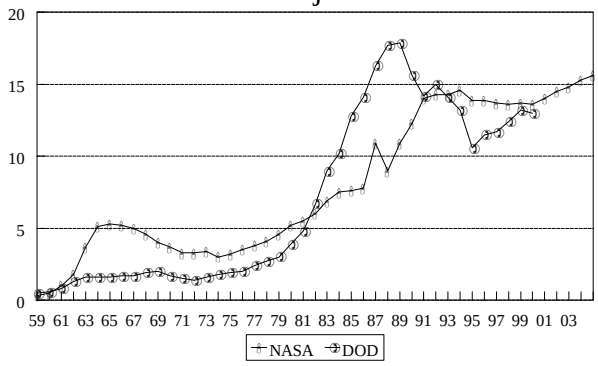
Cooperation and competition between the United States and the former Soviet Union attracted much attention. A joint commission on economic and technological cooperation, headed by Vice President Gore and the Russian prime minister, was created in 1993 and meets semi-annually. Competition with the Soviet Union was measured less in economic terms than in prestige and national defense. The prestige competition may finally have ebbed, and the reduction in military tensions has muted concerns about military satellites. Thus, the main area of competition in the future may be on the economic front.

NASA and DOD Space Budgets

The majority of U.S. government space funding goes to NASA and DOD. The accompanying table shows NASA and DOD space funding, but must be used cautiously. Tracking the DOD space budget is difficult since space is not specifically identified as a line item in the DOD budget. OMB and GAO provided CRS with DOD space funding figures through FY1995 including funding for both unclassified and classified DOD space programs. However, in 1996, the Director of Central Intelligence decided for the first time to classify the NRO funding figure so total figures for DOD space spending were not available for more than a year. In the summer of 1997, the Administration finally released a number for the total DOD FY1996 space budget, $11.5 billion, but at the same time revised numbers downward for FY1992-1995 without explanation. This table shows the data as provided in the FY1997 Aeronautics and Space Report of the President (published in 1998), with additional data from OMB for DOD's budget for FY1998, FY1999, and the FY2000 request. Final figures for FY2000 are not yet available, nor is the FY2001 request. NASA received $13.6 billion for FY2000; its FY2001 request is $14 billion. NASA's out-year projections as shown in the chart are from the FY2001 budget request. All NASA figures include aeronautics funding, approximately $1-1.3 billion a year in recent years.

NASA/DOD Space Funding

In Billions of Unadjusted Dollars



Does not include Transition Quarter. See text for other notes.

Space Program Issues

NASA's Current Challenges

NASA has faced many challenges in recent years. During the early 1990s, high profile problems (a 5-month delay in shuttle launches because of hydrogen leaks, the Hubble Space Telescope originally not performing as planned, and the loss of the Mars Observer spacecraft) created a perception that the agency was not managing programs adequately. During the mid-1990s, NASA repaired its image, and even though in 1999 NASA began encountering problems similar to those in the early 1990s, as well as delays in the space station program and significant problems with developing new launch vehicles, it has escaped the intense unfavorable media scrutiny of earlier years although Congress has focused on some of the problems. In particular, the loss of the two Mars missions discussed earlier have been sparked congressional interested, as well as internal NASA studies.

The 1999 Mars failures have raised concerns in general about NASA's "faster, better, cheaper" (FBC) approach to building spacecraft. Three reports requested by NASA were

released in March 2000 that looked at the Mars failures and/or at the FBC paradigm in general. Colloquially they are called the Stephenson Report, the Spear Report, and the Young Report and are available at [http://www.nasa.gov/newsinfo/publicreports.html]. A fourth report was prepared by the National Research Council at the request of Congress prior to the Mars failures. NRC issue a prepublication version of the report on March 14 (*Assessment of Mission Size Trade-Offs for Earth and Space Science Missions*). The Stephenson report is the final report of a team headed by Arthur Stephenson, director of NASA's Marshall Spaceflight Center, that investigated the first Mars failure (Mars Climate Orbiter). An initial Stephenson report had focused on technical issues, while the final report, released March 13, focused on project management. It found flaws in the implementation of FBC and recommended a modification to the FBC concept, termed "Mission Success First," to ensure proper processes are in place to ensure that missions succeed. The same day, NASA released a report that had been requested by NASA Administrator Goldin assessing FBC in general. It was prepared by Tony Spear who had worked on the successful Mars Pathfinder program that landed a small rover on Mars in 1997. The Spear report identified improvements needed to implement FBC missions successfully. A week later, the team organized to investigate the Mars Polar Lander and Deep Space 2 failures and recommend potential changes to NASA's Mars exploration program released its 3-volume report that looked not only at the Mars failures, but at three other projects that were conducted under the FBC rubric and were successful. This team was headed by Tom Young, a retired Lockheed Martin official (Lockheed Martin built both Mars Climate Orbiter and Mars Polar Lander).The Young Report noted that in the missions that failed, there was a lack of training, inexperienced project managers, understaffing, inadequate testing, and poor communications between NASA and its contractors, including the Jet Propulsion Laboratory (JPL) that executes NASA's planetary exploration program. JPL is a Federally Funded Research and Development Center (FFRDC) operated by the California Institute of Technology. The Young Report also cited lack of sufficient funding as a contributing factor to the spacecraft losses, concluding that the project was underfunded by 30%. The Spear and Young reports noted the lack of a precise definition of what FBC means, with different individuals holding sharply differing viewpoints. None of the NASA reports recommended abandoning FBC. Instead they all made recommendations on improving its implementation. Similarly, the NRC report concluded that the FBC philosophy is sound but inherently creates additional risk. It concluded that not all scientific missions can be accomplished under tight budget and size constraints, and a range of small, medium, and large spacecraft are needed. NRC recommended that"desired scientific outcomes" be the driver for determining mission size.

The Senate Commerce Committee's Subcommittee on Science, Technology, and Space held a hearing on March 22, 2000 on management problems at NASA where these and other issues were discussed. Allegations in the media that NASA test results were altered in the Mars Polar Lander program contributing to the probe's failure prompted the chairmen and ranking Democratic Senators on the full committee and subcommittee to request detailed documents from NASA. The House Science Committee's Subcommittee on Space and Aeronautics held a hearing on the Young Report April 12.

Military Space Issues

Congress has been quite supportive of DOD space programs in recent years. The DOD space budget is difficult to track, as noted already, but the major DOD space programs have been supported. Among them is a new early warning satellite system, the Space Based

Infrared System (SBIRS). Existing satellites in the Defense Support Program (DSP) series are primarily designed to detect intercontinental ballistic missiles (ICBMs) rather than shorter-range missiles, such as the Scud used by Iraq. After two failed attempts to initiate new early warning satellite programs, SBIRS was proposed and approved in the FY1996 DOD budget. It comprises satellites in both high orbits ("SBIRS-High") and low orbits ("SBIRS-Low"), unlike DSP which only uses the "high" orbit. Congress added money to accelerate the development of SBIRS in FY1996, FY1997, and FY1999.

Following a review that addressed technical, cost, and schedule issues in the program, however, DOD restructured both SBIRS-High and SBIRS-Low in the FY2000 request. The first launch of SBIRS-High was delayed from 2002 to 2004 and the first launch of SBIRS-Low from 2004 to 2006. Two demonstration projects for SBIRS-Low were canceled. The FY2000 request was $328.6 million for SBIRS-High and $229 million for SBIRS-Low. The House Intelligence Committee, and House and Senate Armed Services Committees all expressed concerns in their reports on intelligence and DOD funding bills about how the program was being managed. For SBIRS-Low, conferees on the DOD authorization bill designated the primary purpose of the program as ballistic missile defense and made other program management changes, including consolidating SBIRS-Low funding. The FY2000 DOD appropriations act also consolidated the SBIRS-Low funding, and for SBIRS-High, added $92 million to the $328.7 million requested but placed constraints on obligating more than $100 million. For FY2001, DOD is requesting $569 million for SBIRS-High and $241 million for SBIRS-Low. The House and Senate FY2001 DOD authorization bills (H.R. 4205/S. 2549), and the House and Senate DOD appropriations bill (H.R. 4576/S. 2593) approve the requested funding levels. In April 2000, DOD agreed that management of SBIRS-Low should return to BMDO and the Senate-reported version of the FY2001 DOD authorization bill shifts the funding to BMDO.

As noted earlier, since 1995 Congress has shown renewed interest in space-based weapons to destroy enemy missiles as part of a National Missile Defense (NMD), as well as in weapons to attack satellites (antisatellite, or ASAT, systems). In addition to funding ground-based NMD programs, Congress added $50 million in FY1996, $70 million in FY1997, $98 million in FY1998, and $74 million in FY1999 for space based laser (SBL) research and development in the DOD appropriations bills. The FY1999 DOD authorization conference report directed DOD to release promptly a request for proposals (RFP) for a space based laser readiness demonstrator (SBL-RD). However, the Air Force Scientific Advisory Board concluded that technology is not sufficiently advanced to proceed with the SBL-RD, now renamed the Integrated Flight Experiment (IFX). The Air Force has restructured the program so that instead of choosing a single contractor, a Boeing-Lockheed Martin-TRW team will jointly develop the IFX, after which a spacecraft contractor will be competitively selected. For FY2000, Congress added $10 million to the Air Force's $63.8 million request for SBL and approved the $75 million requested for defense-wide RDT&E for a total of $148.8 million. For FY2001, DOD is requesting $63 million for the Air Force program and $75 million for defense-wide RDT&E. In the FY2001 DOD authorization bills (H.R. 4205/S. 2549), the Senate Armed Services Committee added $30 million to the Air Force level while the House approved the requested amounts. In the FY2001 DOD appropriations bills (H.R. 4576/S. 2593), the House reduced the Air Force program by $28 million and the defense-wide RDT&E program by $16.6 million; the Senate Appropriations Committee added $10 million to the Air Force program

As for ASAT development, the Clinton Administration terminated a program to develop a ground-based kinetic-energy ASAT ("KEAsat") interceptor in 1993, permitting only technology studies. Congress revived the program in FY1996, however, adding $30 million that year, $50 million in FY1997, and $37.5 million in FY1998. President Clinton line-item vetoed the $37.5 million on the basis that DOD has other ASAT options and did not need the KEAsat program. After the Supreme Court rejected the line-item veto that money was restored to DOD, and the conference report on the FY1999 DOD authorization bill (H.R. 3616, H.Rept. 105-736) directed DOD to obligate the funds promptly. However, Congress apparently was persuaded that there are other methods for achieving the objective of space control, and stated that DOD could use some of that money for other space control technologies and added $15 million for space control technologies for FY1999. For FY2000, the Administration requested no funding for KEAsat, and $9.8 million for Air Force space control technologies. Congress added $7.5 million was added for KEAsat to the defense-wide RDT&E budget, and $3 million for Air Force space control technology in the FY2000 DOD appropriations act. Senator Smith reportedly has requested a GAO report on the status of the KEAsat program because of concern that the Army is planning to restructure it without congressional permission. DOD requested no funding for KEAsat and $9.7 million for Air Force space control R&D. In the FY2001 DOD authorization bills (H.R. 4205/S. 2549), the Senate Armed Services Committee added $20 million for the KEAsat program and $5 million for other Army space control technology development while the House approved the DOD requested levels. The House and the Senate Appropriations Committees did not add funding for this program (H.R. 4576/S. 2593).

Among the alternatives to the KEAsat is a ground-based laser called MIRACL (Mid-Infrared Advanced Chemical Laser) in New Mexico. A long-standing congressional restriction in DOD authorization bills prohibiting the use of MIRACL against targets in space expired in FY1996. On October 2, 1997, DOD Secretary William Cohen approved a test use of MIRACL against an Air Force satellite (MSTI-3). The test was conducted on October 17. DOD insists it was a defensive test designed to assess the satellite's vulnerability to laser attack. Others view it as a test of an offensive antisatellite capability.

Another controversial aspect of military space activities involves the NRO. Revelations beginning in September 1995 about poor financial management practices resulting in NRO accumulating almost $4 billion in unspent funds raised questions about how the agency is managed and led to a review by a panel chaired by retired Admiral David Jeremiah. The report, released in April 1997, made 47 recommendations, some of which were adopted while others were referred for further study. In its report on the FY1999 intelligence authorization bill (H.Rept. 105-508), the House Intelligence Committee expressed dissatisfaction with how NRO responded to its concerns about cost control and noted that NRO programs are taking an increasing percentage of the national foreign intelligence programs budget. NRO's budget is classified, but is thought to be on the order of $6 billion a year. Recognizing that future budgets could be constrained, NRO adopted the Future Imagery Architecture (FIA) plan that calls for developing more smaller, less expensive intelligence collection satellites and using commercial imagery to augment that provided by NRO's classified systems (discussed earlier). As noted above, the FY2000 intelligence authorization act (P.L. 106-120) establishes a National Commission on the Review of the National Reconnaissance Office to report by November 2000 on the roles and missions and other aspects of the NRO "to assure continuing success in satellite reconnaissance in the new millennium." The House and Senate Intelligence Committees' reports on the FY2001 intelligence authorization bill (H.R. 4392/S.

2507) express concern that insufficient funds will be available to NIMA for processing the data acquired by the FIA into usable products through NIMA's "tasking, processing, exploitation, and dissemination" (TPED) activities. The House report further states that technical problems with some of the satellite intelligence systems may mean schedule delays and cost increases, and lack of priority on developing cutting-edge technologies "ensures that the core mission of space intelligence—to collect secrets—will continue to languish and become increasingly limited" (page 9).

Space Launch Vehicles: 1998-1999 Failures and Developing New Systems

Government and private sector launch vehicles are discussed in CRS Issue Brief IB93062. Briefly, a 1994 Clinton Administration policy directive gives NASA primary responsibility for maintaining the space shuttle and developing new reusable launch vehicles (RLVs), while DOD is responsible for expendable launch vehicles (ELVs). Private sector companies also are developing new launch vehicles on their own or in partnership with the government. U.S. government satellites must be launched on U.S. launch vehicles unless the President grants a waiver. Government and commercial customers in the United States and commercial customers abroad purchase launch services from U.S. launch service companies.

New launch vehicles are in development both by the government and the private sector. NASA and Lockheed Martin are jointly developing technologies for a large "single-stage-to-orbit" RLV in a 3-year technology development program called X-33. Technical challenges have delayed the initiation of test flights from March 1999 to perhaps 2001. Consequently, NASA has delayed from 2000 to 2005 a decision on whether to invest in more upgrades to space shuttle to keep it operating for many more years, or to anticipate that the private sector will develop a new "2nd generation RLV" to replace it and be used for both government and commercial missions. In its FY2001 budget request, NASA completely restructured its space launch program, initiating a two pronged "space launch initiative." It involves assisting the private sector in developing new launch vehicles by risk reduction efforts such as providing NASA funding for technology demonstrations, for example, while also performing "safety and supportability" upgrades to the shuttle. The total cost for the 2nd generation RLV activity and shuttle upgrades is $6.4 billion for FY2001-2005. The House Appropriations Committee zeroed the FY2001 request of $290 million for the2nd generation RLV in its report the FY2001 VA-HUD appropriations bill (H.R. 4635, H.Rept. 106-674) on June 7. It approved the request for shuttle upgrades.

DOD is pursuing the Evolved Expendable Launch Vehicle (EELV) program to upgrade U.S. expendable launch vehicles to reduce launch costs by at least 25%. Although DOD originally planned to choose one EELV design, it later decided to fund development of two based on changing market forecasts in the late 1990s showing increased demand for launch vehicle services. Lockheed Martin and Boeing were selected to build the two EELVs (Atlas 5 and Delta 4, respectively). They and DOD are sharing the development costs. A downturn in the market forecast has caused DOD to reassess its EELV procurement strategy, however.

Several private companies also are developing their own launch vehicles (see CRS Report 98-658). Senator Breaux has introduced S. 469 to provide loan guarantees to companies attempting to develop low cost space transportation systems.

Environment

Satellites are used to study the Earth's atmosphere and surface and provide information relative to the study of global change, such as that expected from NASA's Earth Observing System (EOS) program within the Office of Earth Science. Strong interest developed over ensuring that data not only from civilian satellites, but from military satellites are used to the maximum extent possible in solving environmental issues. After years of discussion, President Clinton signed an executive order on February 24, 1995, which, for the first time, allowed public release of historical spy satellite imagery (taken between 1960 and 1972). Data from other previously classified satellite programs subsequently have been declassified.

EOS, once part of a program called Mission to Planet Earth (MTPE), has been controversial since its beginning (see CRS Report 97-601 SPR). Designed to gather a 15-year set of data on the Earth's environment, NASA's original plan was criticized by several advisory groups as too risky. Congress found the cost estimate prohibitive and told NASA to expect less funding through the year 2000 ($8 billion rather than $17 billion). Subsequent program restructurings reduced the expected cost through the year 2000 to $6.8 billion. In June 1995, GAO stated that total program costs through the end of the program in 2022 is $33 billion. In September 1995, a National Research Council report concluded that MTPE had been restructured enough and the spacecraft launches should not be delayed, while agreeing that more work is needed on the associated data system (EOSDIS). Problems with EOSDIS delayed the launch of the first satellite in the Earth Observing System (EOS) series, Terra. It was finally launched in December 1999.

Another program, Triana, is a new focus of controversy (see CRS Report RS20252). Proposed by Vice President Gore in 1998, the probe would be located at a point between the Earth and Sun and continuously transmit images of the Earth that could be viewed on the Internet. Critics claim that the project is politically motivated and was not subject to scientific peer review. Supporters counter that peer review was conducted on the project after it was proposed by the Vice President and it now will carry additional instruments that will provide useful scientific data. The additional instruments increased the cost of the mission from $50 million (including launch costs) to $75 million (not including launch costs). The House-passed version of the FY2000-2002 NASA authorization bill (H.R. 1654) would terminate Triana; the Senate-passed version does not. The FY2000 VA-HUD-IA appropriations act (P.L. 106-74) suspended work on the program until the National Academy of Sciences (NAS) evaluates its scientific goals. The NAS report was released on March 8, 2000 and was generally positive about the scientific goals.

Commercial Space and Trade Issues

Commercial space launch issues are discussed in CRS Issue Brief IB93062. Briefly, the role of the government in encouraging the growth of commercial space businesses either by direct or indirect subsidies, or policies that help stave off foreign competitors, continues to be debated. Some argue that the government provides indirect subsidies to launch services companies by allowing them to use government launch sites at nominal costs and providing a guaranteed market for a certain number of launches. Others insist that the U.S. government is doing no more than foreign governments.

The competitors to U.S. companies today are Europe, China, Russia, Ukraine, India, and Japan. Most of the satellites that require launches are built in the United States or contain U.S. components, meaning export licenses are required to ship them to the launch site. Thus, the United States has substantial leverage over the success of these competitors in offering launch services. Bilateral agreements have been signed with China, Russia, and Ukraine setting forth the conditions under which they offer launch services, both the number of launches and the price they can charge compared to Western prices (a table comparing these agreements appears in CRS Issue Brief IB93062). China's violations of the Missile Technology Control Regime (see next section) have long created a vacillating relationship where U.S. sanctions are imposed, lifted, and imposed again, and consequently export licenses are granted, suspended, or reinstated based on the political situation. Recent concerns that China has acquired militarily useful technical knowledge by launching U.S.-built satellites has resulted in new U.S. laws and regulations to ensure such technology or information is not transferred to China or other countries (see CRS Issue Brief IB93062 and CRS Report RL30231).

The 1996 Clinton space policy calls for a transition from "negotiated trade" in commercial space launch services to "free and open interaction of market economies" once the existing commercial launch services agreements with Russia, Ukraine, and China expire. President Clinton terminated the agreement with Ukraine in June 2000 in recognition of Ukraine's commitment to international nonproliferation norms.

As discussed above, another commercial space issue concerns the sale of remote sensing data with very good resolution. At issue is how to allow U.S. companies to compete in this market without sacrificing national security interests.

Ballistic Missile Proliferation

Space launch vehicles are close cousins of ballistic missiles, raising concerns about ensuring that certain space technologies are not exported to countries intending to build missiles. A May 1992 agreement between the Russian company Glavkosmos and the Indian Space Research Organization (ISRO) to sell Russian rocket engines and technology to ISRO prompted the imposition by the United States of 2-year sanctions against Glavkosmos and ISRO because the State Department asserted the sale violated the MTCR. To reach agreement on commercial space launch services and other space cooperation with the United States, in 1993 Russia agreed to terminate portions of the contract with India regarding the transfer of technology and know-how (the United States does not object to sale of the engines per se). The United States agreed to increase space cooperation with Russia, including merging the American and Russian space station programs (see CRS Issue Brief IB93017) and paying Russia $400 million, the same amount of money Russia said it would lose by restructuring the contract with India. Questions have arisen, however, as to whether Russia is abiding by the MTCR. The U.S. government has imposed sanctions against 10 Russian entities suspected of providing assistance to Iran's nuclear and ballistic missile programs and the Iran Nonproliferation Act (P.L. 106-178) prohibits, for example, the transfer of NASA money to Russia for the space station program unless the President certifies that Russian companies working on the program have not proliferated to Iran.

Also, export of space products has been used as leverage to get countries to accept U.S. proliferation policies generally. For example, President Bush announced in June 1991 that

no U.S.-built satellites would be exported to China for launch until China's policies regarding missile proliferation changed. China agreed to abide by the MTCR and the sanctions were lifted. The Clinton Administration charged China with violating the MTCR in August 1993 and imposed sanctions, which were lifted after China again pledged to abide by the MTCR.

International Relationships

The shifting world political situation has allowed new relationships to evolve in international space cooperation, as exemplified by the merger of the American and Russian space station programs. Since Europe, Canada, and Japan already had agreed to work with the United States, by the year 2004 a multi-national space station should be in orbit. Increased cooperation is the result not only of changed political circumstances, but also of constrained budgets throughout the world. All the major space-faring countries are questioning how much they should invest in space. The same budget constraints may preclude the initiation of new programs if a critical mass of funding is not available.

LEGISLATION

H.R. 1654 (Rohrabacher)

FY2000-2002 NASA Authorization Act. H.R. 1654 reported from Committee on Science May 18 (H.Rept. 106-145); passed House May 19, passed Senate November 5. S. 342 reported from Senate Committee on Commerce, Science, and Transportation June 16 (S.Rept. 106-77). House and Senate conferees have been named.

H.R. 3898 (Rohrabacher)

Zero Gravity, Zero Tax Act. Introduced March 9, 2000; referred to Committee on Way and Means.

H.R. 4205 (Spence)/S. 2549 (Warner)

FY2001 DOD authorization bill. H.R. 4205 reported from House Armed Services Committee May 12 (H. Rept. 106-616); passed House May 18. S. 2549 (replacing S. 2481) reported from Senate Armed Services Committee May 12 (S. Rept. 106-292).

H.R. 4392 (Goss)/S. 2507 (Shelby)

FY2001 intelligence authorization. H.R. 4392 reported from House Intelligence Committee May 16 (H. Rept. 106-620); passed House May 23. S. 2507 reported from Senate Intelligence Committee May 4 (S. Rept. 106-279).

H.R. 4576 (Lewis)/ S. 2593 (Stevens)

FY2001 DOD appropriations bill. Reported from House Appropriations Committee June 1 (H. Rept. 106-644); passed House June 7. Reported from Senate Appropriations Committee May 18 (S. Rept. 106-298).

H.R. 4635 (Walsh)

FY2001 VA-HUD-IA appropriations, including NASA. Reported from House Appropriations Committee June 12 (H. Rept. 106-674).