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

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

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CONTENTS

SUMMARY

MOST RECENT DEVELOPMENTS

BACKGROUND AND ANALYSIS

U.S. Government Civilian Space Programs
- National Aeronautics and Space Administration (NASA)
  - Human Spaceflight
  - Science Programs
- Other Civilian Government Agencies, including NOAA

Interagency Coordination

Commercial Space Programs
- Space Launch Services
- Commercial Remote Sensing, and Landsat
- Space Tourism

Military Space Programs

International Cooperation and Competition

NASA and DOD Space Budgets

Space Program Issues
- NASA Issues: The "Vision for Space Exploration"
- Military Space Issues
  - SBIRS-High
  - Space Radar and TSAT
- Developing New Space Launch Vehicles
- International Relationships

LEGISLATION

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

SUMMARY

The 109th 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. For FY2006, NASA received $16.623 billion when adjusted for two rescissions and an augmentation for hurricane recovery. The FY2007 request is $16.792 billion.

The future of the U.S. human space flight program is dominating debate about NASA. The space shuttle returned to flight in July 2005 after a two and one-half year hiatus following the 2003 *Columbia* tragedy, but the next launch has been indefinitely postponed because of a foam-shedding event during that launch similar to what led to the loss of *Columbia*. Pursuant to the "Vision for Space Exploration" announced by President Bush in January 2004, the shuttle program is to be terminated in 2010. The Vision directs NASA to focus its activities on returning humans to the Moon by 2020 and eventually sending them to Mars. The Vision has broad implications for the agency, especially since most of the money to implement it is expected to come from other NASA activities. Congress is debating the many issues raised by the Vision, including what the balance should be among NASA's various space and aeronautics activities, and whether the United States should end the shuttle program before a replacement is available.

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. Figures provided to CRS show a total (classified and unclassified) space budget of $19.4 billion for FY2003, $20 billion for FY2004, $19.8 billion for FY2005, and a request of $22.5 billion for FY2006. The final figure for FY2006 and the FY2007 requests are not yet available. How to manage DOD space programs to avoid the cost growth and schedule delays that have characterized several recent projects is a key issue facing DOD.

The appropriate role of the government in facilitating commercial space businesses is an ongoing debate. For many years, the focus has been on space launch services, but commercial remote sensing satellites also pose complex questions. President Bush signed a new commercial remote sensing policy in 2003, and a new space launch policy in 2004, that try to strike a balance between facilitating commercial activities while ensuring the U.S. government has needed data and services.

International cooperation and competition in space are affected by the world economic situation and the post-Cold War political climate. President Clinton's 1993 decision to merge NASA's space station program with Russia's is symbolic of the dramatic changes, and the risks.

MOST RECENT DEVELOPMENTS

NASA's FY2007 budget request is $16.792 billion, a 1% increase above the final amount NASA received in FY2006. NASA's FY2006 funding is a combination of $16.456 billion provided in the FY2006 Science, State, Justice, Commerce Appropriations Act (P.L. 109-108), minus a 0.28% across-the-board rescission in that act, minus a 1% across-the-board rescission in the FY2006 Department of Defense appropriations and hurricane recovery act (P.L. 109-148), plus $350 million added for NASA for hurricane recovery in P.L. 109-148. Administration officials characterize the FY2007 request as a 3.2% increase over FY2006 appropriations because they exclude the $350 million hurricane augmentation on the basis that it is a one-time appropriation. In 2005, Congress passed a NASA authorization act (P.L. 109-155), which authorizes $17.9 billion for FY2007.

DOD's FY2007 total request for space activities is not yet available from DOD. Nor is the total amount appropriated in FY2006. Two DOD space programs that were particularly controversial in FY2006 were Space Radar (formerly Space-Based Radar — SBR), and TSAT (the transformational communications satellite program). The programs are controversial because their cost estimates are high, and Congress is skeptical of those estimates and of DOD's ability to manage the programs successfully based on past performance. Congress cut DOD's $226 million FY2006 request for Space Radar by $126 million, and its $836 million FY2006 request for TSAT was cut by $400 million. The FY2007 requests for those programs are $266 million for Space Radar, and $867 million for TSAT.

BACKGROUND AND ANALYSIS

U.S. Government Civilian Space Programs

National Aeronautics and Space Administration (NASA)

The establishment of 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, 1961, though he made only a suborbital flight (the first American to orbit the earth was John Glenn in February 1962), as part of the Mercury program. Following Shepard's flight, on May 25, 1961, President Kennedy announced that the United States intended to put a man on the Moon within a decade,

initiating the Apollo program. Following successful completion of the Mercury and Gemini programs, NASA was ready to begin Apollo flights, but in January 1967, the first Apollo crew was killed when fire erupted in their Apollo command module during a pre-launch test. The first successful Apollo flight took place in 1968. On July 20, 1969, Neil Armstrong and Buzz Aldrin became the first humans to walk on the Moon as the Apollo 11 spacecraft and pilot Michael Collins orbited overhead. A total of six 2-man crews (Apollo 11, 12, 14, 15, 16 and 17) walked on the Moon through December 1972. Another crew (Apollo 13) intended to do so, but instead made an emergency return to Earth when the craft's Service Module exploded enroute to the Moon. Apollo was followed by the Skylab space station (to which three crews were sent in 1973-1974) and the 1975 Apollo-Soyuz Test Project in which a U.S. Apollo spacecraft with three astronauts and a Soviet Soyuz spacecraft with two cosmonauts docked for two days of joint experiments.

In 1972, President Nixon approved NASA's proposal to develop a reusable vehicle for taking crews and cargo into Earth orbit — the space shuttle. The first shuttle flight occurred in 1981 and NASA declared the system operational in 1982. The *Challenger* tragedy in January 1986 suspended shuttle operations for 32 months. Flights resumed in 1988. After 87 successful flights, on February 1, 2003, the space shuttle *Columbia* disintegrated during its return to Earth. NASA launched the space shuttle *Discovery* on July 26, 2005, the first flight since the *Columbia* tragedy (STS-114). After discovering that a problem occurred during *Discovery*'s launch that is similar to what happened to *Columbia*, NASA indefinitely postponed future shuttle launches. *Discovery* landed safely on August 9, 2005. The next shuttle launch is expected sometime in 2006.

The shuttle is NASA's sole means of launching humans into space. Beginning in the early 1980s, NASA, sometimes with DOD, attempted to develop a replacement for it (see **Developing New Space Launch Vehicles**, below). For many years, NASA's plan was to phase out the shuttle in 2012. The replacement programs were not successful, however, and in November 2002, NASA announced that it would keep the shuttle operational at least until 2015, and perhaps until 2020 or longer. However, in January 2004, President Bush announced a "Vision For Space Exploration" that calls for the space shuttle to be retired in 2010. He directed NASA to build a new "Crew Exploration Vehicle" (CEV) to take astronauts to and from the Moon, and that it be available for taking people to Earth orbit by 2014. Between 2010 and 2014, the United States would not have an ability to place astronauts in space, and would rely on Russia to provide such services instead. NASA Administrator Griffin hopes to have the CEV ready for Earth orbital flights earlier than 2014 to shorten that gap.

NASA continues to build and operate the International Space Station (ISS) in cooperation with Russia, Canada, Japan, and several European countries (see CRS Issue Brief IB93017, *Space Stations*, by Marcia S. Smith). The space station program began in 1984 (FY1985) and has been very controversial because of cost growth and schedule delays. Twenty-two attempts by Congress between 1991 and 2000 to terminate the program in NASA funding bills failed. The ISS is being assembled in orbit, with segments taken into space by the U.S. space shuttle or Russian launch vehicles. The first assembly flight was in 1998, and construction is now approximately 50% complete. Most of the remaining segments are designed to be launched on the shuttle, so assembly is suspended while NASA fixes the shuttle. Crews rotating on six-month schedules continue to live and work aboard the station using Russian Soyuz spacecraft for crew transport and "crew return" (essentially

a lifeboat to return the crew to Earth in an emergency), and Russian Progress spacecraft for cargo delivery. NASA was facing a deadline whereby U.S. astronauts could not have remained on the ISS for long-duration missions because NASA could not pay Russia for use of its Soyuz vehicles because of restrictions in the Iran Nonproliferation Act (INA, P.L. 106-178). Congress passed a law amending the INA (P.L. 109-112) to allow NASA to buy ISS-related goods and services through January 1, 2012 (they also must be delivered by that date).

Science Programs. NASA has launched many spacecraft for space science and earth science research. Robotic probes served as pathfinders to the Moon for astronauts, and have visited all the planets in the solar system except Pluto. A probe (New Horizons) was launched to Pluto in January 2006 and is expected to fly past that planet in 2015. Many of the probes have been quite successful, but there were failures, too. In 1999, for example, two NASA Mars missions (Mars Climate Orbiter and Mars Polar Lander) failed, at a combined cost of $328.5 million. 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 FBC approach was subsequently scrutinized and NASA restructured its Mars exploration program significantly. Two other NASA probes, Mars Odyssey and Mars Global Surveyor, are currently orbiting Mars, and twin rovers, Spirit and Opportunity, are investigating the planet's surface (a European probe, Mars Express, also is orbiting Mars). NASA also has sent, or plans to send, spacecraft to other planets, comets, and asteroids. These include Cassini, which arrived at Saturn on July 1, 2004 (GMT), after a seven-year journey and is studying that planet and its moons; and the Stardust probe that returned to Earth on January 15, 2006, after collecting samples of a comet.

Space-based observatories in Earth orbit 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: Hubble Space Telescope, launched April 1990 (primarily for the visible wavelengths); Compton Gamma Ray Observatory, launched April 1991, deorbited June 2000; Chandra X-Ray Observatory, launched July 1999; and the Spitzer Space Telescope (formerly the Space Infrared Telescope Facility), launched August 2003. NASA is planning the James Webb Space Telescope for further infrared observations. Hubble was designed to be serviced and eventually returned to Earth by the space shuttle, but NASA announced in January 2004 it would not send any more shuttles to Hubble because of safety concerns. NASA's current administrator, Dr. Griffin, agreed to reassess that decision once the shuttle completes its two Return to Flight missions (see CRS Report RS21767, *Hubble Space Telescope: Should NASA Proceed with a Servicing Mission?*, by Daniel Morgan).

NASA has solar-terrestrial physics programs that study the interaction between the Sun and the Earth. In FY2001, NASA began the Living with a Star program that envisions the launch of many spacecraft over the next decade to obtain more accurate information on how the Earth and society are affected by what has come to be known as "space weather" — including, for example, negative effects of solar activity on telecommunications.

During the 1960s and 1970s, NASA developed communications, meteorological, and land and ocean remote sensing satellites. NASA's role in this aspect of space utilization traditionally is R&D. Once the technology is proven, operational responsibility is transferred to other agencies or the private sector. NASA continues to perform research in many of these

areas, however, particularly earth sciences (including global climate change). NASA, sometimes in partnership with other countries, has a variety of earth science probes in orbit today, including three large satellites in the Earth Observing System (EOS). The United States also is leading the international Global Environmental Observing System and Systems (GEOSS) program [http://iwgeo.ssc.nasa.gov/]. The future of NASA's earth sciences program was explored at an April 28, 2005, House Science Committee hearing.

Other Civilian Government Agencies, including NOAA

Beginning in the 1960s, other civilian agencies became involved in space. Operation of weather satellites was transferred to what is now the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. NOAA is currently working with DOD to build a joint weather satellite system that merges the capabilities of its Polar Orbiting Environmental Satellite (POES) system with those of DOD's Defense Meteorological Satellite Program (DMSP). Called the National Polar-orbiting Operational Environmental Satellite System (NPOESS), it is managed by an Integrated Program Office (see [http://www.ipo.noaa.gov/]). NASA is developing new technology for NPOESS, and plans to launch the NPOESS Preparatory Project (NPP) satellite to demonstrate new sensors that could be used for NPOESS. The NPOESS program is experiencing significant cost overruns and schedule delays, which were highlighted at a November 16, 2005 House Science Committee hearing. The first NPOESS launch has slipped to 2012 (from 2010), and the program's cost has grown by $2-3 billion, to a new estimate of $9-10 billion. Committee members expressed deep concern about a potential gap that could develop between when the last of NOAA's POES satellites is operating and the first NPOESS is launched. Such a data gap could affect weather forecasting. Other parts of the Department of Commerce are involved in space issues as well due to the Department's role in trade policy and export of items on the Commerce Control List. It also has an Office of Space Commercialization (part of the Technology Administration) 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 [http://pnt.gov/]. 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 develops nuclear power sources for spacecraft; the U.S. Geological Survey in the Department of Interior, which operates the government's Landsat land remote sensing satellites; the Departments of Agriculture and other departments 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. The White House's National Security Council, Office of Management and Budget, and Office of Science and Technology Policy are involved in developing policy.

Interagency Coordination

Several mechanisms have been tried since 1958 to coordinate interagency space policy. Congress created a National Aeronautics and Space Council in the NASA Act. That Space Council was abolished in 1973 by President Nixon. President Carter established a Policy Review Committee on Space under the aegis of the National Security Council (NSC), but it was chaired by the Director of the Office of Science and Technology Policy. President Reagan established a Senior Interagency Group on Space (SIG/Space) under the NSC, chaired by the National Security Adviser. Congress was dissatisfied with SIG/Space, however, particularly in terms of slow decision making after the 1986 space shuttle *Challenger* tragedy. Congress created a National Space Council in the FY1989 NASA authorization act (P.L. 100-685), chaired by the Vice President. Under President George H. W. Bush, the Space Council was headed by Vice President Quayle.

President Clinton decided not to use the Space Council mechanism. It still exists in law, but is not staffed or funded. Instead, Space Council functions were merged into a National Science and Technology Council, administered through the Office of Science and Technology Policy. NSTC oversaw civil and commercial space policy; while military space activities were overseen by the National Security Council. Some space advocates hoped President George W. Bush would reactivate the Space Council, but instead his administration uses NSTC and a Policy Coordinating Committee under the NSC (similar to SIG/Space). NASA and DOD also have a "Partnership Council" to facilitate communication between their organizations and identify areas for collaboration and cooperation.

On July 28, 2002, in NSPD-15, President Bush directed the NSC to chair a review of national space policies. The first new policy, on commercial remote sensing, was signed April 25, 2003. On January 6, 2005, the White House released a new U.S. Space Transportation Policy, which had been authorized by President Bush on December 21, 2004. Also, President Bush announced a new Vision for Space Exploration for NASA on January 14, 2004. An overall national space policy reportedly is still being developed.

Commercial Space Programs

Commercial 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.

Space Launch Services

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 1998 Commercial Space Act, and the 2004 Commercial Space Launch Act Amendments). The development of a U.S. commercial launch services industry has been largely successful. DOD and NASA continue to play a role in developing new launch vehicles, though some private companies 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 (primarily in Europe and Russia), and trade and missile proliferation issues involved in exporting satellites to other countries for launch. In terms of competition, it must be mentioned that the two major U.S. space launch service companies operate in partnership with companies in other countries. Lockheed Martin and two Russian companies comprise International Launch Services, which offers launches on the U.S. Atlas and Russian Proton vehicles. Boeing offers launches on its Delta 2 launch vehicle, and also is a partner in the Sea Launch venture, where a Ukrainian Zenit launch vehicle with a Russian third stage is launched from a mobile oil rig built by Norway. See CRS Issue Brief IB93062, *Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports*, by Marcia S. Smith for more information.

Commercial Remote Sensing, and Landsat

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 purposes. The first Landsat satellite was launched in 1972. After a tumultuous eight 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. Landsat 5 and 7, built and operated by the government, are now in orbit; the U.S. Geological Survey (USGS) operates the satellites. Landsat 5, launched in 1984, is well past its design lifetime and only partially functioning. One of the sensors on Landsat 7, launched in 1999, also is not functioning properly. Whether and how the U.S. government should ensure the continuity of Landsat-type data has been controversial. NASA hoped the private sector, rather than the government, would build the next satellite. NASA solicited bids, but only one was received and NASA rejected it. The decision was then made to place Landsat-type sensors (called OLIs, for Operational Land Imagers) on the NPOESS satellites, but concerns about delays and cost overruns on NPOESS (discussed earlier) led to a reassessment of that plan. On December 23, 2005, the White House Office of Science and Technology Policy (OSTP) issued a new policy. For the near-term, the plan to put OLI's on NPOESS was terminated. Instead, OSTP directed NASA to acquire a new satellite to provide Landsat-type data, which will be operated by USGS. For the long-term, OSTP will lead an effort to develop a strategy for providing this type of data.

The Land Remote Sensing Policy 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 these systems, and certain conditions apply. For example, the government may exercise "shutter control" for national security reasons, requiring a satellite operator to cease obtaining or distributing imagery. Two U.S. companies — DigitalGlobe and GeoEye (established in January 2006 by Orbimage's acquisition of Space Imaging) — have commercial remote sensing satellites in orbit. The market for their products is limited, however, and they reportedly are struggling financially. Partially in response to that concern, President Bush signed a new commercial remote sensing policy on April 25, 2003, that is intended to sustain and enhance the U.S. remote sensing industry.

Controversy over the fact that the imagery has military as well as civilian uses complicates this commercial space effort, however. Though not as precise as military reconnaissance satellites, the U.S. private-sector satellites produce imagery with resolution (the ability to "see" an object or feature of a certain size) of 1 meter or less. Competitors include French, Russian, Indian, and Israeli companies that offer imagery with 2.5-meter, 1-meter, 1-meter, and 1.8-meter resolution respectively. One major issue is when the U.S. government can exercise shutter control (discussed above). When the United States initiated attacks in Afghanistan, instead of requiring the one company that had a commercial satellite in orbit at the time (Space Imaging, now part of GeoEye) to stop taking images, DOD took a different approach. For two months, the National Imagery and Mapping Agency (NIMA, now the National Geospatial-Intelligence Agency or NGA) bought exclusive rights to Ikonos imagery of that area so that no one else could use the data without NIMA's approval. The practice was dubbed "checkbook shutter control" in the media. The government apparently did not limit access to commercial satellite imagery during the 2003 Iraqi war. 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. The 2003 Bush policy states that the government will provide a timely and responsive regulatory environment.

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 a planned satellite called Eyeglass (subsequently renamed Orbview, and now part of GeoEye's satellite fleet) that could be used against Israel would be made available to Saudi Arabia, which was providing partial financing for the system and would be the location of a ground station. The FY1997 DOD authorization bill (P.L. 104-201) prohibits 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. Congress has strongly encouraged NIMA (now NGA) to purchase commercial imagery to augment classified imagery. The 2003 Bush policy directs the U.S. government to utilize U.S. commercial remote sensing space capabilities, for both civil and national security purposes, to the maximum extent practicable. Foreign commercial remote sensing space capabilities may be used consistent with national security and foreign policy objectives. (See below for more on the use of commercial imagery by NGA/NIMA.)

Space Tourism

A nascent commercial space area is "space tourism." On June 21, 2004, Mike Melvill became the first person to reach space (on a suborbital flight) aboard a privately funded launch vehicle, SpaceShipOne, designed by Scaled Composites. Mr. Melvill is sometimes referred as the first "commercial astronaut," but several representatives of commercial companies, and other private individuals, have flown in space. Mr. Melvill's flight is notable because SpaceShipOne was developed without government funding, and some hope it will usher in an era of "affordable" space tourism. In 2004, Congress passed the Commercial Space Launch Act Amendments (P.L. 108-492) that, inter alia, direct the FAA to create a

regulatory structure for space tourism. The FAA issued a notice of proposed rulemaking for crew and space flight participants in the December 29, 2005, *Federal Register* (p. 77262 ff).

Military Space Programs

The 1958 National Aeronautics and Space Act specified that military space activities be conducted by the Department of Defense (DOD). The Undersecretary of the Air Force is DOD's executive agent for space, and the Air Force acquisition executive for space. The intelligence community makes significant use of space-based intelligence collection capabilities. The National Reconnaissance Office (NRO), an agency within DOD, builds and operates intelligence collection satellites, and collects and processes the resulting data, which are provided to users such as the National Geospatial-Intelligence Agency (NGA) and the National Security Agency (NSA). NRO, NGA, and NSA also are under the oversight of the new Director of National Intelligence (DNI). See CRS Report RL32515, *Intelligence Community Reorganization: Potential Effects on DOD Intelligence Agencies*, by Richard A. Best, Jr., for more on the DNI and potential effects for DOD intelligence agencies, including NRO, NGA, and NSA.

DOD and the intelligence community manage a broad array of space activities, including launch vehicle development, communications satellites, navigation satellites (the Global Positioning System — GPS), early warning satellites to alert the United States to foreign missile launches, weather satellites, reconnaissance satellites, and developing capabilities to protect U.S. satellite systems and to deny the use of space to adversaries (called "space control" or "counterspace systems"). The 1990-1991 Persian Gulf War is dubbed by some as the first "space war" because support from space displayed great improvement over what was available during the previous major conflict, Vietnam. These systems continue to play significant roles in U.S. military operations.

How to organize DOD and the intelligence community to work effectively on space programs has been an issue for many years. Congress established commissions to review the NRO in the FY2000 intelligence authorization act, P.L. 106-120; NGA (then called NIMA, the National Imagery and Mapping Agency) in the classified annex to the FY2000 DOD appropriations act, P.L. 106-79; and overall U.S. national security space management and organization in the FY2000 DOD authorization act, P.L. 106-65. The NRO, NGA/NIMA, and "Rumsfeld Space Commission" reports are discussed below.

Although U.S. military and civilian space programs are separated organizationally, 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 versa.

After the Cold War, interest in space weapons to attack satellites (antisatellite, or ASAT, weapons) or ballistic missiles declined initially, but was rekindled beginning with the 104th Congress. Using satellites to attack ballistic missiles has been controversial since President Reagan's 1983 announcement of a Strategic Defense Initiative to study the viability of building a ballistic missile defense system to protect the United States and its allies. The

Clinton Administration changed the name of the Strategic Defense Initiative Organization to the Ballistic Missile Defense Organization to reflect a new focus on theater missile defense in the wake of the Persian Gulf War, rather than national missile defense. The George W. Bush Administration changed the name to the Missile Defense Agency (MDA) to reflect its interest in broad missile defense goals (see CRS Report RL31111, *Missile Defense: The Current Debate*, coordinated by Steven A. Hildreth).

The concept of placing weapons in space, as part of a missile defense system or otherwise, remains controversial. A May 18, 2005 *New York Times* article reported that the new national space policy being developed by the Bush Administration (discussed earlier) would "move the United States closer to fielding offensive and defensive space weapons." White House Press Secretary Scott McClellan, responding to questions at that day's White House press briefing, stressed that the new policy, still being developed, does not represent a substantial shift in U.S. policy . The same day, Representative Kucinich introduced a bill (H.R. 2420) to ban weapons in space, and the use of weapons to damage or destroy objects in orbit. The House rejected (124-302) a Kucinich amendment to the Foreign Relations Authorization Act (H.R. 2601) on July 20, 2005 that was similar to his bill.

International Cooperation and Competition

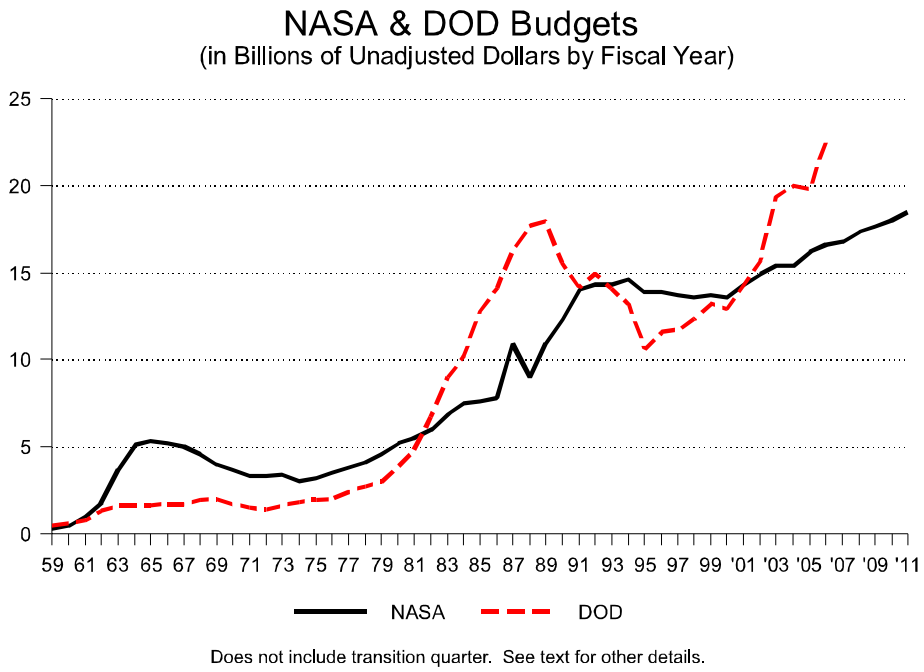
Virtually every country in the world uses satellites for communications and obtaining weather data, but the usual measure of whether a country is a member of the "space-faring" club is its ability to launch satellites. By that criterion, Russia, the United States, China, Japan, India, Israel, Ukraine, and the European Space Agency (ESA) are members. ESA developed the Ariane launch vehicle; Ariane launches are conducted by the French company Arianespace. These countries, including many of the individual members of ESA, present opportunities for cooperation, as well as competition. The 17 members of ESA are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

The NASA Act specifically states that NASA may conduct international space activities. Many NASA programs today have an international component. One of the major cooperative projects today is the International Space Station (see CRS Issue Brief IB93017, *Space Stations*, by Marcia S. Smith). European countries, both individually and through ESA, Canada, and Japan, in particular, have participated in many cooperative space programs with NASA. They also compete with U.S. companies in some space areas. Europe, India, Ukraine, and Russia compete in launch services. France, Russia, India and Israel compete in satellite remote sensing, and Europe competes in communications satellite manufacturing. Cooperation and competition between the United States and the former Soviet Union attracted much attention. Competition with the Soviet Union was measured less in economic terms than in prestige and national defense. The main area of competition today seems to be on the economic front, although Russian and Ukrainian companies have joint ventures with U.S. firms to provide launch services, so economic cooperation also exists. China has launched two human spaceflight missions, and some suggest that this may usher in a new era of national prestige competition, with China attempting to send "taikonauts" to the Moon before U.S. astronauts return there. Some Chinese commentators suggest that China may adopt the goal of a human lunar landing mission by 2020, but many other Chinese experts

suggest that China's focus is on robotic exploration of the Moon (see CRS Report RS21641, *China's Space Program: An Overview*, by Marcia S. Smith).

NASA and DOD Space Budgets

The majority of U.S. government space funding goes to NASA and DOD. This table shows NASA and DOD space funding from FY1959 to FY2006, with projections for NASA through FY2011. The DOD funding figures must be used cautiously, however. Space is not a line item in the DOD budget, and DOD's annual budget justifications do not include a figure for "space activities." DOD sometimes releases only partial information or will release without explanation new figures for prior years that are quite different from what was previously reported. Space spending by all federal government agencies, by year since FY1959, is provided in Appendix E of the annual Aeronautics and Space Report of the President, submitted to Congress by NASA. The most recent edition [http://history.nasa.gov/presrep2004.pdf] covers through FY2004. This table uses data from that report for NASA



and DOD through FY2004. NASA figures for FY2005 and beyond, including projections through FY2011, are from NASA's annual budget justifications. The DOD figure for FY2006 was supplied to CRS by DOD's Office of the Comptroller in the spring of 2005; out-year projections were not provided. Newer figures, showing what Congress appropriated for FY2006 and the request for FY2007, are not yet available. According to the data provided in 2005, DOD requested $22.5 billion in FY2006. According to NASA budget documents, NASA requested $16.5 billion for FY2006 and received $16.6 billion. That figure reflects an appropriation of $16,456.8 million in the FY2006 Science, State, Justice, Commerce appropriations act (P.L. 109-108), subject to a 0.28% rescission in that act, a 1% across-the-board rescission in the FY2006 DOD appropriations and hurricane recovery act (P.L. 109-148), and an addition of $350 million to cover costs associated with hurricane recovery in P.L. 109-148. NASA's Stennis Space Center near Slidell, LA, and the Michoud Assembly Facility in New Orleans, LA, were damaged by the hurricane. All NASA figures include aeronautics funding ($400 million-$1 billion annually in recent years).

Space Program Issues

NASA Issues: The "Vision for Space Exploration"

President Bush's January 14, 2004, announcement of a new "Vision for Space Exploration" is capturing the spotlight of NASA issues. The President's directive called for redirecting NASA's human exploration program from low Earth orbit to the Moon, Mars, and "worlds beyond." Achieving that goal involves both robotic and human missions. According to the President's speech, humans would return to the Moon in 2015-2020, and eventually go to Mars (no date given). The space shuttle program would be terminated when construction of the International Space Station (ISS) is completed, currently expected in 2010. The President also asserted that the United States would meet its obligations to the other partners in the program (see CRS Issue Brief IB93017, *Space Stations*, by Marcia S. Smith). How it will do so without the shuttle is uncertain; NASA is assessing what other government or commercial launch vehicles and spacecraft might be able to accomplish those tasks. The President invited other countries to join the United States in the Vision.

U.S. research aboard the ISS would focus only on that which is needed to support the Vision instead of the broadly-based program that was planned. NASA officials indicate that the agency will complete its research program aboard the ISS by 2016. The President directed NASA to build a Crew Exploration Vehicle (CEV) to take crews to and from the Moon, with an Earth-orbital capability by 2014. U.S. astronauts would have to rely on Russia to take them to and from ISS during the gap between the end of the shuttle program in 2010 and the availability of the CEV. In September 2005, NASA announced its implementation plan for the Vision, with 2012 as the goal for availability of the CEV for earth orbital flights. That would shorten the gap, but still require NASA to purchase services from Russia.

In September 2005, based on the implementation plan he announced at that time, NASA Administrator Griffin estimated the cost of returning humans to the Moon by 2018 (the current goal) at $104 billion. (That figure excludes another $20 billion estimated for the costs of servicing the ISS with the CEV.) A September 2004 Congressional Budget Office [http://www.cbo.gov] report, *Budgetary Analysis of NASA's New Vision for Space Exploration*, concluded that, based on historical NASA experience, the cost could be much higher than NASA estimates. NASA has not provided an estimate for sending astronauts to Mars. Most of the required funding would come from redirecting funds from other NASA activities. Dr. Griffin repeatedly stated that he would not take money from NASA's space science, earth science, or aeronautics programs to pay for the Vision, but the FY2007 budget does reduce funding for aeronautics and reduces the planned growth in funding for science programs. Much of the money shifted from science programs is being used to fund higher costs incurred in the space shuttle and ISS programs. NASA's funding constraints are caused not only by the requirements imposed by the Vision, but also by increased costs for space shuttle Return to Flight activities, costs associated with preserving the option to conduct a Hubble shuttle servicing mission, costs for other congressionally directed items, and cost increases in several science programs. Issues associated with the impact of attempting to fund the Vision and continue support for NASA's other activities within a budget that is projected to increase only at the rate of inflation was explored at a November 3, 2005, House Science Committee hearing.

Military Space Issues

For many years, questions have arisen about whether DOD effectively manages its space activities, and several commissions and task forces have studied the issue. Congress created a commission in the FY2000 DOD authorization bill to make recommendations on the overall management of national security space programs. Chaired by Donald Rumsfeld, the Commission released its report on January 11, 2001, shortly after Mr. Rumsfeld became Secretary of Defense. The "Rumsfeld Space Commission" made sweeping recommendations for management of DOD and intelligence community space programs. According to two GAO reports (GAO-02-772, June 2002; GAO-03-379, April 2003), DOD intended to implement 10 of the 13 organizational recommendations.

Several DOD space programs have experienced significant cost overruns and schedule delays, raising concerns about DOD's acquisition process for space systems. The Defense Science Board (DSB) and Air Force Scientific Advisory Board (AFSAB) commissioned a task force to review DOD space program acquisition because of significant cost increases in several programs. Chaired by retired Lockheed Martin executive Tom Young, its May 2003 report was publicly released in September 2003 [http://www.acq.osd.mil/dsb/reports/space.pdf]. Four key points are that cost has replaced mission success as the primary driver in managing acquisition processes, creating excessive technical and schedule risk; the space acquisition system is strongly biased to produce unrealistically low cost estimates; government capabilities to lead and manage the acquisition process have seriously eroded; and there are long term concerns about the space industrial base. According to press reports (e.g., *Wall Street Journal*, August 25, 2004, B7), the task force produced an update in August 2004 that concluded that some of the space programs it criticized were making progress but still required close review, and that better coordination in needed between the military and intelligence agencies in setting requirements.

Meanwhile, figures from the DOD Comptroller's Office over several years showed that the Bush Administration planned to increase DOD's space budget significantly — from $15.7 billion in FY2002, to $20 billion in FY2004, to a request of $21.7 billion for FY2005, and continued increases to a projected $28.7 billion in FY2008. However, in its 2004 report on the FY2005 DOD appropriations bill (S. 2559, S.Rept. 108-284), the Senate Appropriations Committee cautioned that funding for DOD's space activities may not be sustainable. Figures provided to CRS by the DOD Comptroller's Office in March 2005 showed that DOD received $19.8 billion for FY2005 (compared to the $21.7 billion requested). The FY2006 request was $22.5 billion. Projected future year funding was not provided. DOD has not yet released its estimate of how much was appropriated for space programs in the FY2006 DOD appropriations act (P.L. 109-148).

SBIRS-High. DOD is developing a new satellite system to replace its Defense Support Program series of early warning satellites that alert the National Command Authority to foreign missile launches. Called SBIRS-High (Space-Based Infrared System-High), it has encountered significant schedule delays and cost growth, breaching "Nunn-McCurdy" cost growth limits several times. A May 2003 report of the Defense Science Board and Air Force Scientific Advisory Board criticized early program management of SBIRS-High, and took a cautious attitude concerning whether the restructured program would succeed [http://www.acq.osd.mil/dsb/reports/space.pdf]. An October 2003 GAO report (GAO-04-48) concluded the program remained at "substantial risk of cost and schedule increases." SBIRS-

High was designed as a constellation of five satellites above the equator in geostationary orbit (GEO) plus sensors on two other satellites in highly-elliptical orbits (HEO). DOD still plans to launch the sensors on the two HEO satellites, but will procure, at most, three of the GEO satellites. The funds that would have been spent for the fourth and fifth GEO satellites reportedly will be used instead to design an alternative system using state-of-the-art technologies. DOD's Selected Acquisition Report for the quarter ending September 2005 [http://www.acq.osd.mil/ara/am/sar/2005-SEP-SST.pdf] shows the original cost estimate for SBIRS-High as $3.68 billion in FY1995 dollars ($4.15 billion in current year dollars, i.e., adjusted for inflation), compared with a new estimate of $9.01 billion in FY1995 dollars ($10.64 billion in current year dollars). The FY2007 request for SBIRS-High is $669 million.

Space Radar and TSAT. In addition to SBIRS-High, other DOD space programs are encountering cost growth and schedule delays, including the Air Force's Advanced Extremely High Frequency (AEHF) communications satellite system, and the National Reconnaissance Office's (NRO's) Future Imagery Architecture reconnaissance satellite system. DOD's requests to initiate new programs, including a Space Radar program (previously called Space-Based Radar), and the Transformational Satellite (TSAT) communications satellite program, are controversial because of the potentially large costs involved, whether the technologies they require are sufficiently mature, and how to avoid the cost growth and schedule delays experienced in other DOD space programs.

Space Radar would be a system of many satellites (the exact number has not been determined) that would track mobile targets (as opposed to fixed targets) on the ground. The House Appropriations Committee has sharply criticized the program for the past several years. In its 2004 report on the FY2005 DOD appropriations bill (H.Rept. 108-557), the committee noted that the estimated cost for a nine-satellite constellation was $34 billion, and the Air Force considers nine satellite to be less than half the number required. The committee expressed skepticism about the $34 billion estimate, as well.

The TSAT program would be a follow-on to the AEHF program, which, in turn, is a follow-on to the current series of Milstar satellites. AEHF itself is controversial because of cost overruns, and, in 2002, DOD decided to procure only three instead of five AEHF satellites. The first AEHF launch is scheduled for 2008. TSAT is expected to "transform" DOD communications by providing vastly greater capacity than is available today by operating at much higher (optical) frequencies. If TSAT is delayed, additional AEHF satellites may be needed.

The FY2006 DOD authorization act (H.R. 1815, conference report H.Rept. 109-360) was signed into law on January 6, 2006 (P.L. 109-163). The FY2006 DOD appropriations act (H.R. 2863, conference report H.Rept. 109-359) was signed into law on December 30, 2005 (P.L. 109-148).

The FY2006 request for Space Radar was $226 million. Congress cut $126 million in both the FY2006 DOD authorization and appropriations acts. The Senate Armed Services Committee (SASC) and the House Armed Services Committee (HASC) commented extensively on the program (pp. 200-201 of S.Rept. 109-69; pp. 214-216 of H.Rept. 109-89). Both discussed the need to integrate the Space Radar into a broader architecture of radar capabilities, including airborne radars. SASC also emphasized the need for a single space radar system to meet military and intelligence needs, and expressed concern about the lack

of certainty about cost and other issues. HASC noted a number of concerns, including that the Air Force has not sufficiently emphasized affordability as a key objective or fully considered the requirements for a demonstration program. HASC provided specific direction as to what is needed for such a program, utilizing ground, airborne, and existing space assets.

The FY2006 request for TSAT was $836 million. Congress cut $400 million in the FY2006 DOD authorization and appropriations acts. In its report on the bill (S.Rept. 109-69), SASC expressed support for TSAT, but noted that GAO found that only one of its seven critical technologies is mature (p. 200). Thus, SASC recommended that a fourth AEHF satellite be procured (adding $100 million for that satellite) while the TSAT technologies are developed, and that some of those technologies could be incorporated into the fourth AEHF satellite if feasible. The Senate Appropriations Committee did not add funding for a fourth EHF satellite, but restricted the use of $150 million of the funds it provided for TSAT in order to fund a fourth EHF satellite if needed (S.Rept. 109-141, p. 218). HASC also supported the concept of TSAT, and commended the Air Force on its vision for revolutionary solutions (pp. 216-217). However, it cited the recent history of cost overruns and schedule growth associated with other Air Force space programs as cause for skepticism about the ability of the current acquisition system to accommodate the risks associated with revolutionary technologies. The HASC directed that the focus of the TSAT program shift to technology development rather than acquisition. It added that it did not believe additional funding for AEHF would be needed until FY2007.

In addition to discussing problems with DOD's space acquisition system in connection with specific programs, SASC and HASC included a number of recommendations about DOD's acquisition system (SASC, Title VIII; HASC, pp. 13-14, 202). HASC also expressed concern about the need to develop closer relationships between "black" (classified) and "white" (unclassified) space activities (pp. 208-209). The Senate Appropriations Committee expressed concern about defense space acquisition (S.Rept. 109-141, p. 217) as well.

Developing New Space Launch Vehicles

Government and private sector launch vehicles are discussed in CRS Issue Brief IB93062, *Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports*, by Marcia S. Smith. There are two types of launch vehicles: Expendable Launch Vehicles (ELVs, which can only be used once) and Reusable Launch Vehicles (RLVs). The space shuttle is the only RLV in the world.

NASA began its attempts to develop a new RLV to replace the space shuttle in the 1980s that would cost less and improve safety. Several programs were started and later abandoned: the National Aero-Space Plane (NASP), jointly with DOD; X-33; X-34; and the Space Launch Initiative (SLI). SLI was terminated following President Bush's January 2004 announcement of the Vision for Space Exploration, The Vision involves sending astronauts back to the Moon, but NASA officials have not yet determined what launch vehicles are needed to take crews there, or cargo. NASA has concluded that it is preferable to separate the functions of crew transport and cargo (the shuttle does both).

Under a 1994 Clinton policy, NASA was the lead agency for developing new RLVs, while DOD was the lead agency for ELVs. DOD initiated the Evolved Expendable Launch Vehicle (EELV) program to upgrade U.S. expendable launch vehicles to reduce launch costs

by at least 25%. Lockheed Martin and Boeing each built EELVs: the Atlas V and the Delta IV respectively, which are now in operation. The companies and DOD shared the development costs, with the expectation that the companies would recoup their costs through selling launches to commercial customers. Market demand did not materialize as expected, however, and the companies now are seeking additional funds from DOD. DOD has been supportive of industry's position, asserting that by ensuring the health of both companies, it will have "assured access to space" should technical problems arise with one of the vehicles. DOD notified Congress in 2004 that the EELV program breached a "Nunn-McCurdy" limit of 25% cost growth, which required DOD to cancel or restructure the program, or certify that it is essential to national security. In April 2004, DOD certified that the program is essential for national security. Questions began to arise, however, about whether the government could afford both EELV service providers. In May 2005, Boeing and Lockheed Martin announced they would merge their EELV launch services for U.S. government customers; the proposal is being reviewed for antitrust compliance by the Federal Trade Commission.

In January 2005, the Bush White House released a new U.S. space launch policy [http://www.ostp.gov/html/SpaceTransFactSheetJan2005.pdf]. Under the new policy, DOD is the lead agency for the national security space sector, and NASA is the lead agency for the civil sector. DOD is directed to maintain the capability to develop, evolve, operate and purchase services for the space transportation systems, infrastructure, and support activities necessary to meet national security requirements. NASA is directed to do the same for the civil sector, but is permitted to engage in development activities only for requirements that cannot be met by capabilities being used by the national security or commercial sectors. Regarding the EELV program, DOD is directed to fund the annual fixed costs for both launch service providers unless or until the Secretary of Defense (SecDef) certifies to the President that a capability to reliably assure access to space can be maintained without two EELV providers. No later than 2010, the SecDef, Director of Central Intelligence, and the Administrator of NASA are to evaluate the long term requirements for the EELV, including a recommended "proportionate shift" of funding responsibility to reflect any change in the balance between national security and civil missions requiring an EELV. Any department or agency seeking to modify or develop new launch systems derived from the EELV, including human rating (such as may be needed for NASA to accomplish the Vision for Space Exploration), is responsible for related funding.

In September 2005, NASA announced its implementation plan for the President's Vision for Space Exploration. Under the plan, NASA will develop two "shuttle derived launch vehicles" (SDLVs). One, the Crew Launch Vehicle, would use a single Solid Rocket Booster (the shuttle uses two, one on either side of the External Tank) augmented by a new "upper stage," with the Crew Exploration Vehicle (CEV) on top (the CEV is designed to take astronauts to and from space). The second, often referred to as the "heavy lift" launcher, would use a modified External Tank (the large cylindrical tank that carried fuel for the orbiter's main engines) in conjunction with SRBs, with a cargo-carrying spacecraft on top. NASA and DOD agreed that NASA would develop these new vehicles for the Vision, but use the EELVs for its other spacecraft in the 5-20 metric ton range to the maximum extent possible (although commercial companies may offer other launch vehicles in competition with the EELVs if they become available.)

Several private companies are attempting to develop their own launch vehicles. One focus today is building suborbital launch vehicles that would take passengers into space

(though not to orbit). The first successful launch of a person into space on a craft (SpaceShipOne) that was developed with private capital was conducted on June 21, 2004 (discussed earlier). The 2005 Bush policy calls both for continued government support for space transportation capabilities, and for capitalizing on the U.S. private sector's "entrepreneurial spirit." NASA is hoping that the private sector can field systems to take cargo to and from the ISS after the space shuttle is retired in 2010.

International Relationships

The shifting world political situation has allowed new relationships to evolve in international space cooperation. 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. Other countries are responding cautiously to President Bush's invitation to join in the new Vision for Space Exploration. Some of the partners in the ISS program say they want that program completed before agreeing to further cooperation. NASA Administrator Griffin has stated that he does not want the new Crew Exploration Vehicle or Crew Launch Vehicle to be dependent on foreign suppliers, but is open to discussions with potential partners about other aspects of the Vision. Many of NASA's current partners, as well as potentially new partners such as China, are participating in NASA-led discussions.

LEGISLATION

P.L. 109-108, H.R. 2862. FY2006 Science, State, Justice, Commerce appropriations (includes NASA). Reported from House Appropriations Committee June 10, 2005 (H.Rept. 109-118); passed House June 16. Reported from Senate Appropriations Committee June 23 (S.Rept. 109-88); passed Senate September 15. Conference report (H.Rept. 109-272) passed House November 9, Senate November 16. Signed into law November 22.

P.L. 109-148, H.R. 2863. FY2006 DOD appropriations bill. Reported from House Appropriations Committee June 10, 2005 (H.Rept. 109-119); passed House June 20. Reported from Senate Appropriations Committee September 29 (S.Rept. 109-141); passed Senate October 7. Conference report (H.Rept. 109-359) passed House December 19. Signed into law December 30, 2005.

P.L. 109-155, S. 1281. NASA FY207-2008 authorization bill. H.R. 3070 would have authorized NASA funding for FY2006-FY2007; reported by the House Science Committee July 18 (H.Rept. 109-173), passed House July 22, 2005. S. 1281 would have authorized NASA funding for FY2006-FY2010; reported by Senate Commerce Committee July 26 (S.Rept. 109-108), passed Senate September 28, 2005. Conference report (H.Rept. 109-354), authorizing funds for FY2007-FY2008, passed House December 17. Signed into law December 30, 2005.

P.L. 109-163, H.R. 1815. FY2006 DOD authorization bill. Reported from House Armed Services Committee May 20, 2005, H.Rept. 109-89; passed House May 25. S. 1042 reported from Senate Armed Services Committee May 17 (S.Rept. 109-69); passed Senate November 15. Conference report (H.Rept. 109-360) passed House December 19, Senate December 21. Signed into law January 6, 2006.