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Issue Brief for Congress

Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports

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SUMMARY

Launching satellites into orbit, once the exclusive domain of the U.S. and Soviet governments, today is an industry in which companies in the United States, Europe, China, Russia, Ukraine, Japan, and India compete. In the United States, the National Aeronautics and Space Administration (NASA) continues to be responsible for launches of its space shuttle, and the Air Force has responsibility for launches associated with U.S. military and intelligence satellites, but all other launches are conducted by private sector companies. Since the early 1980s, Congress and successive Administrations have taken actions, including passage of several laws, to facilitate the U.S. commercial space launch services business. The Federal Aviation Administration (FAA) regulates the industry.

During the mid-1990s, demand for launching commercial communications satellites was forecast to grow significantly through the early 21st Century. Those forecasts sparked plans to develop new launch vehicles here and abroad. In the United States, NASA and the Department of Defense (DOD) created government-industry partnerships to develop new reusable launch vehicles (RLVs) and "evolved" expendable launch vehicles (ELVs), respectively. The U.S. space shuttle is the only operational RLV today. All other operational launch vehicles are expendable (i.e., they can only be used once). Some U.S. private sector companies began developing their own launch vehicles without direct government financial involvement, although some have sought government loan guarantees or tax incentives. H.R. 2177 would create tax incentives; H.R. 2443 would offer loan guarantees for vehicles intended to be use for space tourism.

Since 1999, projections for launch services demand have decreased dramatically, however. At the same time, NASA's main RLV program, X-33, suffered delays. NASA terminated the program in March 2001. Companies developing new launch vehicles are reassessing their plans, and NASA has initiated a new "Space Launch Initiative" (SLI) to broaden the choices from which it can choose a new RLV design. Some SLI funding is going to companies that have been trying to develop their own new launch vehicles. DOD also is reevaluating its EELV plans.

Until a replacement is developed, NASA will rely upon the space shuttle for launching humans into space, including to the International Space Station. Safe operation of the shuttle remains a top NASA concern.

In the commercial launch services market, U.S. companies are concerned about foreign competition, particularly with countries that have non-market economies such as China, Russia, and Ukraine. The U.S. has leverage over how these countries compete because almost all commercial satellites are U.S.-built or have U.S. components, and hence require U.S. export licenses. The U.S. signed bilateral trade agreements with each of those countries setting forth the conditions under which they could participate in the market, including quotas on how many launches they could conduct. The agreement with China expired Dec. 31, 2001. The Clinton Administration ended quotas for Ukraine and Russia in 2000. Export of U.S.-built satellites to became an issue in terms of whether U.S. satellite manufacturing companies provide militarily significant information to those countries in the course of the satellite launches.

MOST RECENT DEVELOPMENTS

On August 2, NASA announced its plan of action for repairing cracks found in the liners of hydrogen fuel lines in all four space shuttle orbiters. The discovery of the cracks led NASA to ground the shuttle fleet. NASA now hopes to launch the next mission, using Atlantis to take additional segments to the International Space Station (see CRS Issue Brief 93017), on September 28. Endeavour now is scheduled for a November 2 launch to ISS on a crew-exchange mission. A third shuttle mission, using Columbia, that was scheduled for July 2002, will slip until November 29. However, the liners for Columbia are made of a different material and NASA continues to assess whether the same repair can be used. The fourth orbiter, Discovery, is in a maintenance period, and was not expected to be launched until 2004 anyway.

On July 25, the Senate Appropriations Committee reported the FY2003 VA-HUD-IA appropriations bill (S. 2797, S.Rept. 107-222), which includes NASA, approving the $3.2 billion requested for the space shuttle, and cutting the $759 million requested for the Space Launch Initiative by $30 million. On August 1, the Senate passed the FY2003 DOD appropriations bill (H.R. 5010), approving the same funding figures for the Evolved Expendable Launch Vehicle (EELV) program as had been approved in the Senate version of the DOD authorization bill (S. 2514): an addition of $14.5 million to the $159 million requested for procurement, and the $58 million requested for R&D. The Senate version of the DOD appropriations bill also would create a loan guarantee program for developing commercial reusable in-orbit transfer vehicles. The House approved the requested amounts for EELV R&D and procurement in its versions of the DOD authorization bill (H.R. 4546) and the DOD appropriations bill (H.R. 5010).

BACKGROUND AND ANALYSIS

U.S. Launch Vehicle Policy

The National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD) have each developed expendable launch vehicles (ELVs) to satisfy their requirements. NASA also developed the partially reusable space shuttle. DOD developed the Atlas, Delta, and Titan families of ELVs (called expendable because they can only be used once) from ballistic missile technology. NASA developed Scout and Saturn, both no longer produced. Atlas and Titan rockets today are built by Lockheed Martin. Delta is built by Boeing. Private companies also have developed ELVs: Pegasus and Taurus (Orbital Sciences Corporation), and Athena (Lockheed Martin). Which launch vehicle is used for a particular spacecraft initially depends on the size, weight, and destination of the spacecraft.

From "Shuttle-Only" to "Mixed Fleet"

In 1972, President Nixon approved NASA's plan to create the first reusable launch vehicle, called the space shuttle, and directed that it become the nation's primary launch vehicle, replacing all the ELVs except Scout (later discontinued for unrelated reasons). This would have made NASA and DOD dependent on a single launch vehicle, but the resulting high launch rate was expected to reduce the cost per flight significantly. The shuttle was first

launched in 1981, and was declared operational in 1982. The phase-out of the ELVs began, but in 1984 the Air Force successfully argued that it needed a "complementary" ELV as a backup to the shuttle for "assured access to space" and initiated what is now known as the Titan IV program. Production lines for the Delta and Atlas began to close down, and it was expected that only the shuttle, Scouts, and Titan IVs would be in use by the mid-1980s.

Everything changed on January 28, 1986, however, when the space shuttle *Challenger* exploded 73 seconds after launch. Apart from the human tragedy, the *Challenger* accident deeply affected U.S. space launch policy, demonstrating the vulnerability of relying too heavily on a single system. Many military and civilian satellites had been designed to be launched on the shuttle, and could not have been transferred to ELVs even if the ELVs were not already being phased out. The remaining ELVs had their own problems in 1986. A Titan exploded in April and a Delta failed in May, which also grounded Atlas because of design similarities. Consequently, the Reagan Administration revised U.S. launch policy from primary dependence on the shuttle to a "mixed fleet" approach where a wide variety of launch vehicles are available. The shuttle is used principally for missions that require crew interaction, while ELVs are used for launching spacecraft. President Reagan also decided that commercial payloads could not be flown on the shuttle unless they were "shuttle-unique" (capable of being launched only by the shuttle or requiring crew interaction) or if there were foreign policy considerations. That action facilitated the emergence of a U.S. commercial space launch industry whose participants had long argued that they could not compete against government-subsidized shuttle launch prices. The White House and Congress had taken steps beginning in 1983 to assist in developing a commercial space launch services business, including President Reagan's 1983 designation of the Department of Transportation as the agency responsible for facilitating and regulating the commercial space launch sector. Passage of the 1984 Commercial Space Launch Act (P.L. 98- 575), the Commercial Space Launch Act Amendments of 1988 (P.L. 100-657), and the Commercial Space Act of 1998 (P.L. 105-303) also have helped. But removing the shuttle as a competitor was the major factor in fostering the U.S. launch businesses.

Clinton Administration Policy

On August 5, 1994, President Clinton released a National Space Transportation Policy that gave DOD lead responsibility for improving ELVs and NASA lead responsibility for upgrading the space shuttle and technology development and demonstration of new reusable launch vehicles. The policy sets guidelines for the use of foreign launch systems and components, the use of excess ballistic missile assets for space launch, and encourages an expanded private sector role in space transportation R&D. Unless exempted by the President or his designee, U.S. government payloads must launched by U.S. manufactured launch vehicles. On September 19, 1996, the Clinton Administration released a comprehensive space policy, covering civil, military and commercial space activities.

George W. Bush Administration Activity

On June 28, 2002, President Bush ordered the National Security Council to chair a review of several U.S. space policies. The review of space transportation policy is due by December 31, 2002.

U.S. Launch Vehicle Programs and Issues

NASA's Space Shuttle Program

The space shuttle is a partially reusable launch vehicle (the large, cylindrical external tank is not reused) and is the sole U.S. means for launching humans into orbit. The 1986 *Challenger* accident and occasional shuttle launch delays led to questions about the reliability of the shuttle system. *Challenger*, however, is the only failure so far in more than 100 launches since 1981. Nonetheless, concerns remain that cuts to the shuttle budget and associated personnel reductions, and NASA's decision to turn much of the ground operations of the shuttle over to a "single prime contractor," could affect shuttle safety. NASA signed a $7 billion, 6-year Space Flight Operations Contract (SFOC) with United Space Alliance (USA)—a joint venture between Boeing and Lockheed Martin—to serve as single prime contractor on September 26, 1996 with the goal of reducing shuttle operational costs. The contract has options to extend for two two-year periods. On August 2, NASA exercised the first option, extending the contract until September 30, 2004. NASA asserts that SFOC has saved the agency approximately $1 billion per year. For FY2002, NASA requested and received $3.3 billion for the shuttle program. The FY2003 request is $3.2 billion. The Senate Appropriations Committee approved that request (S. 2797, S.Rept. 107-222).

NASA is still deciding what the future holds for the shuttle. The debate is over whether to continue to rely on the shuttle for the indefinite future, or replace it with a new "second generation" reusable launch vehicle (RLV) in the next decade or so. Shuttle advocates insist that the four space shuttle orbiters are less than 30% through their useful life, and, with adequate upgrades, can operate through 2030. Advocates of a 2nd generation RLV argue that the shuttle is too expensive and must be replaced by a more cost effective vehicle.

The 1994 Clinton policy directed NASA to pursue technology development and demonstration efforts to support a decision by the year 2000 on developing a 2nd generation RLV. This led to the X-33 program (see below). At the same time, NASA began implementing a four-phase "shuttle upgrades" program to improve shuttle reliability, performance, and longevity. Initial upgrades (Phases I and II) were designed to combat obsolescence and ensure shuttle safety, while longer term upgrades (Phases III and IV) to improve performance were to be implemented if efforts to develop a 2nd generation RLV were unsuccessful. When 2000 arrived, it was clear that the X-33 program would not meet its deadlines and that program was cancelled. Instead of moving forward with the Phase III and IV upgrades to the shuttle, however, NASA initiated a new 2nd generation RLV program, the Space Launch Initiative (SLI, see below). The decision on whether to retain the shuttle or replace it with a new vehicle was pushed to 2005 (NASA now refers to it as a "mid-decade" decision). NASA asserts that the shuttle will be one competitor in the decision on what RLV to use in the future. In the meantime, NASA is funding only those shuttle upgrades needed for safety and "supportability," not to improve the shuttle's performance.

The question then arises as to what safety and supportability upgrades are needed while awaiting the outcome of the SLI effort. A key issue is when a replacement for the shuttle might be operational. NASA uses the year 2012, but many are skeptical that a new vehicle will be operational by then. Debate over shuttle upgrades became more intense during the FY2002 budget cycle after NASA decided to terminate what it earlier had described as its

highest priority safety upgrade, the Electric Auxiliary Power Unit, because of cost increases and weight gain. The issue remains controversial because of NASA's decision to significantly reduce how much it plans to spend on both safety and supportability upgrades in the FY2002-2006 time period. In the FY2002 request, NASA planned to spend $1.836 billion on those upgrades. In the FY2003 request, that figure is $1.220 billion, a 34% reduction. Of the $1.836 billion, $1.306 billion was slated for safety upgrades. That would decline to $745 million in the FY2003 request, a 43% reduction. NASA Administrator O'Keefe insists the proposed funding level will not compromise shuttle safety.

The independent Aerospace Safety Advisory Panel (ASAP), created after the 1967 Apollo fire that killed three astronauts, reviews safety in NASA human spaceflight programs. In its March 2002 report, ASAP concluded that "current and proposed budgets are not sufficient to improve or even maintain the safety risk levels of operating the Space Shuttle or the ISS." At an April 18 hearing before a House Science subcommittee, ASAP's outgoing chairman, Richard Blomberg, said that: "In all the years of my involvement, I have never been as concerned for Space Shuttle safety as I am right now."

Meanwhile, in July 2002, NASA grounded the shuttle fleet after cracks were discovered in the liners of liquid hydrogen fuel lines in each of the four shuttle orbiters. Three shuttle launches remain on the 2002 schedule: STS 107 (*Columbia*), which had been scheduled for July, is a dedicated science research mission and includes the first Israeli astronaut among its crew; STS-112 (*Atlantis*), for continued construction of the International Space Station (see CRS Issue Brief IB93017 for more on ISS); and STS-113 (*Endeavour*), an ISS crew exchange mission. On August 2, NASA announced plans for repairing the liners and a new launch schedule. STS-107 was delayed until after the two ISS-related missions, and is now scheduled for November 29. However, its liners are made of a different material than on the other orbiters and NASA continues to assess whether the same repair can be used. STS-112 is now scheduled for September 28, and STS-113 for November 2.

The 1996 decision to choose a single prime contractor for the shuttle was described as a first step towards shuttle privatization, although the precise meaning of that term remains unclear. The Bush Administration intends to move forward with privatization, or "competitive sourcing," as well. Some envision the shuttle someday being operated entirely by the private sector, similar to an airline, with the government as one customer. Others believe that the shuttle's high operational costs will not attract private sector customers, and it will remain a vehicle used primarily by, and paid for by, the government. NASA is assessing different options, and hopes to release a Request for Information to industry in 2002. NASA has targeted FY2004 as the time when it would move to a new arrangement.

Future Launch Vehicle Development Programs

Despite hopes that the space shuttle would reduce the cost of reaching orbit, U.S. launch systems remain expensive and less efficient and reliable than desired. Thus, efforts continue to reduce costs for both expendable and reusable U.S. launch systems. DOD and NASA initiated several efforts in the late 1980s and early 1990s to develop a new ELV system, but each was terminated in turn because Congress or the agencies themselves were not convinced that the required investment had sufficient priority. In response to the 1994 Clinton policy, two programs were initiated: DOD's Evolved Expendable Launch Vehicle (EELV) program and NASA's Reusable Launch Vehicle (RLV) program.

DOD's Evolved Expendable Launch Vehicle (EELV) Program. The EELV program is the successor to several failed attempts to begin new ELV programs since 1985. DOD began what is now known as the EELV program in FY1995 (P.L. 103-335) with a $30 million appropriation. EELV was first formally identified in DOD's FY1996 budget. EELV's goal is to reduce launch costs by at least 25%.

In 1996, the Air Force selected Lockheed Martin and McDonnell Douglas (later bought by Boeing) for pre-engineering and manufacturing development contracts worth $60 million. Originally, one of those companies would have been selected in 1998 to develop the EELV. In November 1997, responding to indicators at the time that the commercial space launch market would be larger than expected, DOD announced that it would help fund development of both the Lockheed Martin and the Boeing vehicles—Atlas V and Delta IV, respectively. In October 1998, DOD awarded Boeing $1.88 billion for the Delta IV ($500 million for further development plus $1.38 billion for 19 launches). At the same time, it awarded Lockheed Martin $1.15 billion for the Atlas V ($500 million for further development plus $650 million for 9 launches). The companies were expected to pay the rest of the development costs themselves. The launches are scheduled to take place beginning in 2002. In 2000, however, new market forecasts showed a reduction in expected commercial demand, and DOD began reevaluating its EELV strategy. It renegotiated the contracts with both companies, relieving Lockheed Martin (reportedly at the company's request) of the requirement to build a launch pad at Vandenberg AFB, CA, and shifting two of the launches previously awarded to Lockheed Martin to Boeing instead. On January 25, 2002, the *Wall Street Journal* reported that the companies had approached DOD to obtain "hundreds of millions of government assistance" because of the downturn in the commercial market. *Inside Defense* reported on May 15, 2002, that the Air Force is considering adding up to $200 million per year for FY2004 and beyond. Undersecretary of the Air Force Teets told the Commission of the Future of the U.S. Aerospace Industry on May 14 that the Air Force "may need to augment the industrial base to keep both companies competing head-to-head for the life of the program." [http://www.aerospacecommission.gov/051402testimony/teets.shtml].

For FY2002, DOD requested $320 million for R&D and $98 million for procurement. Congress appropriated $315 million for R&D and $98 million for procurement (P.L. 107-117). The FY2003 request is $58 million for R&D and $159 million for procurement. The House approved both requests in the FY2003 DOD authorization act (H.R. 4546) and the FY2003 DOD appropriations act (H.R. 5010). The Senate added $14.5 million for procurement (S. 2514).

Government-Led Reusable Launch Vehicle (RLV) Programs. The 1994 Clinton policy gave NASA lead responsibility for technology development for a next-generation reusable space transportation system. NASA initiated the Reusable Launch Vehicle (RLV) program to develop and flight test experimental RLVs to form the basis for next-generation vehicles to replace the space shuttle and replace or augment ELVs. Proponents believe that RLV technology can dramatically lower the cost of accessing space.

The X-33 and X-34 Programs. From 1995 to 2000, NASA's approach to developing new RLVs was based on establishing new forms of cooperation with industry by sharing the costs of developing technology with the intent that industry take over development, operation, and financing of the operational vehicle. Two "X" (for "experimental") flight test programs were begun under this philosophy: X-33, a large RLV

based on single-stage-to-orbit (SSTO) technology to demonstrate technologies in the Mach 13-15 range (13-15 times the speed of sound); and X-34, a small RLV "testbed" to demonstrate reusable technologies at Mach 8. The SSTO concept involves a rocket that can attain orbit with only one stage (instead of two or more as is common today) carrying people or cargo. The goal had been to develop a vehicle capable of being launched, returning to Earth, being serviced quickly, and flying again within a very short time.

In March 2001, NASA announced the termination of X-33 and X-34. X-33 was a cooperative program between NASA and Lockheed Martin. According to the contract signed in 1996, NASA's costs were fixed at $912 million (not including civil service costs, which raise NASA's cost to about $1.2 billion). Lockheed Martin says that by the end of the program it had spent $356 million of its own funding on the program. X-33 was a suborbital prototype of a vehicle, which, if it had been built, was to be called VentureStar. Technical problems with the X-33, particularly its new "aerospike" engines and construction of its composite hydrogen fuel tanks, led to delays in test flights from 2000 to 2003. NASA concluded that the cost to complete the program was too high compared to the benefits and terminated its participation in the program. X-34 was a "technology testbed" being built under contract to NASA by Orbital Sciences Corporation. The program had begun as a cooperative program like X-33, but the companies (Orbital and Rockwell International) that partnered with NASA decided not to continue it under those terms. NASA later modified the program and signed a traditional contract with Orbital. As with X-33, NASA concluded that the cost to complete the program was too high relative to the value of the technologies to be demonstrated. NASA spent $205 million on X-34. Lockheed Martin and Orbital each approached DOD about continuing their respective programs, but DOD declined.

Space Launch Initiative (SLI). In 2000, as part of its FY2001 budget request, NASA restructured its RLV program and initiated the Space Launch Initiative (SLI). Under SLI, NASA is working with the private sector and universities to develop new technologies that will allow a decision in 2006 (a slip of one year from the original plan) on what new RLV could be developed. NASA hopes that by funding a variety of companies and universities, at least two RLV "system architecture" choices will be available in 2006. At that point, the government and industry would have to decide what, if any, new RLV to build, and who would pay for it. NASA initially specified that it expected the private sector to pay some of the development costs, but more recently has conceded that market conditions make it unlikely that the private sector will do so. Cost estimates for a new RLV are notional at this time, but are on the order of $10 billion, in addition to the approximately $5 billion NASA plans to spend on SLI from FY2001 to FY2006. A more definitive cost estimate will not be available until SLI is completed. According to NASA, the goal is an RLV developed from technology demonstrated through the SLI program that will be "10 times safer and crew survivability 100 times greater, all at one-tenth the cost of today's space launch systems."

The focus of the SLI program is to meet NASA's future needs, primarily servicing the International Space Station. However, NASA also is trying to "converge" its requirements with those of the commercial sector so the new RLV can serve both markets. NASA also is in discussions with the Air Force to assess the possibility of developing a vehicle that could also meet DOD requirements.

Two rounds of contract awards have been made by NASA to companies and universities to develop RLV technologies—the list is available at [http://www.slinews.com/]. Boeing,

Lockheed Martin, and an Orbital Sciences/Northrop Grumman team presented candidate system architectures to NASA in April 2002.

Congressional testimony by GAO in 2001 (GAO-01-826T) on lessons learned from X-33 and X-34 cautioned NASA against making similar mistakes with SLI. The failure of the X-33 and X-34 programs, and of the National AeroSpace Plane (NASP) program before them, has made some observers skeptical about NASA's ability to develop a next generation space launch vehicle successfully. Hence, the SLI program is under scrutiny. Total planned SLI funding for FY2001-2006 is $4.8 billion. For FY2001, NASA requested and received $290 million for SLI. For FY2002, NASA requested $475 million and received $465 million. The FY2003 budget request is $759.2 million. The Senate Appropriations Committee cut the request by $30 million (S. 2797, S.Rept. 107-222).

Private Sector RLV Development Efforts. In addition to the government-led programs, several entrepreneurial U.S. companies have been attempting to develop RLVs through private financing. The companies have encountered difficulties in obtaining financing from the financial markets, and some have been seeking government loan guarantees or tax credits. Some (e.g. Kistler Aerospace and Universal Space Lines) were included in the SLI contract awards announced on May 17, 2001 (see above), so will receive direct government funding. Legislation related to loan guarantees and tax incentives are discussed in the next section.

U.S. Commercial Launch Services Industry

Congressional Interest

The 107th Congress is debating issues involving satellite exports (discussed below) and the domestic launch services industry. Several bills are pending. One issue is what the government should do to stimulate development of new launch vehicles by the private sector, particularly in a market that is stagnant or declining. Debate has focused on whether tax incentives or loan guarantees should be created for companies attempting to develop lower cost launch vehicles. Tax incentive advocates argue that loan guarantee programs allow the government to pick winners and losers; loan guarantee advocates argue that tax incentives are insufficient to promote necessary investment in capital intensive projects. H.R. 2177 (Calvert) would create tax incentives, while H.R. 2443 (Lampson) would provide loan guarantees for developing transportation systems needed for space tourism, and tax incentives for space tourism companies. Title IX of the FY2003 DOD appropriations bill (H.R. 5010) as passed by the Senate creates a loan guarantee program for companies developing commercial, reusable, in-orbit transportation systems for taking satellites from one orbit to another. Bills to make spaceports eligible for tax exempt bonds also are pending (H.R. 1931/S. 1243).

One difficulty facing entrepreneurial companies attempting to develop new launch vehicles, and existing launch service providers, is dramatically changed market forecasts for launch services. In the mid- to late-1990s when many of the entrepreneurial companies emerged, a very large market was predicted for placing satellites into low Earth orbit (LEO), particularly for satellite systems to provide mobile satellite telephony services. Many of the entrepreneurial companies targeted the LEO market, but it has shrunk markedly in the

intervening years. Three satellite mobile telephone companies (Iridium, ICO, and Globalstar), and a company that offered data services using LEO satellites (Orbcomm), all declared bankruptcy. Though Iridium and ICO were later brought out of bankruptcy, and Orbcomm was purchased by another company at auction, many investors remain skeptical about the prospects for such systems. (Globalstar is working to restructure its debt.) Another factor is that technological advances permit longer satellite lifetimes and enlarge capacity, reducing the need for new satellites in established markets. Declining launch forecasts published by FAA (available at [http://ast.faa.gov]) reflect the changing market conditions. The constricting market affects existing launch service providers, both here and abroad, as well as companies planning to introduce new vehicles.

Foreign Competition (Including Satellite Export Issues)

Europe, China, Russia, Ukraine, India, and Japan offer commercial launch services in competition with U.S. companies. Most satellites are manufactured by U.S. companies or include U.S. components and hence require export licenses, giving the United States considerable influence over how other countries participate in the commercial launch services market. The United States negotiated bilateral trade agreements with China, Russia, and Ukraine on "rules of the road" for participating in the market to ensure they did not offer unfair competition because of their non-market economies. Launch quotas were set in each of the agreements. However, President Clinton terminated the quotas for Russia and Ukraine in 2000, and the agreement with China expired at the end of 2001.

Europe. The European Space Agency (ESA) developed the Ariane family of launch vehicles. The first test launch of an Ariane was in 1979; operational launches began in 1982. ESA continued to develop new variants of Ariane and two models, Ariane 4 and Ariane 5, are now in use. ESA also is developing a smaller launch vehicle, Vega, whose first launch is expected in 2005. Operational launches are conducted by the French company Arianespace, which is owned by the French space agency (CNES) and European aerospace companies and banks. Arianespace conducts its launches from Kourou, French Guiana, on the northern coast of South America. Arianespace also markets Russia's Soyuz launch vehicle as part of a French-Russian joint venture, Starsem.

In 1985, a U.S. company (Transpace Carriers Inc.) filed an unfair trade practices complaint against Arianespace, asserting that European governments were unfairly subsidizing Ariane. The Office of the U.S. Trade Representative (USTR) investigated and found that Europe was not behaving differently from the United States in pricing commercial launch services (then offered primarily on the government-owned space shuttle). The incident raised questions about what "rules of the road" to follow in pricing launch services. In the fall of 1990, USTR and Europe began talks to establish such rules of the road and assess how to respond to the entry of non-market economies into the launch services business. The only formal negotiating session was held in February 1991.

Each side is concerned about how much the respective governments subsidize commercial launch operations, but another controversial topic (not formally part of the talks) was whether Arianespace should be able to bid for launches of U.S. government satellites, which now must be launched on U.S. launch vehicles as a matter of U.S. policy. Arianespace wants that restriction lifted. France and other European governments do not have written policies requiring the use of Ariane for their government satellites. However,

the member governments of ESA originally agreed to pay a surcharge of as much as 15-20% if they chose Ariane. The surcharge led some cost-conscious European governments to buy launch services from other (notably U.S.) suppliers. In the fall of 1995, ESA's member governments reached agreement with Arianespace to reduce the surcharge to encourage use of Ariane. (ESA itself gives preference to using Ariane, but is not legally constrained from using other launch vehicles.) Arianespace is encountering significant financial difficulties, however, posting a loss of $178 million for 2001, higher than the $48 million loss its chairman had earlier forecast. In 2001, ESA agreed to pay additional costs associated with operating the Kourou launch site, but, according to media reports, is now considering additional measures to support the company. At a June 2002 meeting, ESA proposed to its member governments that ESA make a guaranteed purchase of three Ariane and two Vega launches annually, at a reported cost of $650 million euros ($613 million) per year.

China. The People's Republic of China offers several versions of its Long March launch vehicles commercially. China poses special issues not only because of its non-market economy, but because of technology transfer and political concerns. Launch services are offered through China Great Wall Industry Corp. (CGWIC).

U.S.-China Bilateral Trade Agreements for Launch Services. In 1989, China and the United States signed a 6-year bilateral trade agreement restricting the number of Chinese commercial space launches to ensure China, with its nonmarket economy, did not unfairly compete with U.S. companies. A new 7-year agreement was reached in 1995, and amended in 1997. The agreement expired on December 31, 2001. While the agreements were in force, they established quotas on how many commercial satellites China could launch each year, and included pricing provisions to try to ensure that China did not unfairly compete with U.S. commercial launch service providers because of its non-market economy.

U.S. Satellite Exports to China: 1988-1997. In September 1988, the U.S. government agreed to grant three export licenses for satellites manufactured by Hughes to be launched by CGWIC. Two were Optus communications satellites (formerly called AUSSAT) built for Australia and the third was AsiaSat 1, owned by the Hong Kong-based Asiasat Co. (of which China's International Trust and Investment Corp. is a one-third owner). The Reagan Administration granted the export licenses on the conditions that China sign three international treaties related to liability for satellite launches and other subjects; agree to price its launch services "on a par" with Western companies; and establish a government-to-government level regime for protecting technology from possible misuse or diversion. China met the conditions and the two countries signed a 6-year agreement in January 1989. The now-defunct Coordinating Committee on Multilateral Export Controls (COCOM) approved the licenses that March.

On June 5, 1989, after the Tiananmen Square uprising, President George H. W. Bush suspended all military exports to China. At the time, exports of communications satellites were governed by the State Department's Munitions List. The satellites counted as military exports and the licenses were suspended. Then Congress passed language in the FY1990 Commerce, Justice, State and Judiciary appropriations (P.L. 101-162) and the 1990-91 Foreign Relations Authorization Act (P.L. 101-246, Section 902) prohibiting the export of U.S.-built satellites to China unless the President reported to Congress that (1) China had achieved certain political and human rights reforms, or (2) it was in the national interest of the United States. In December 1989, President Bush notified Congress that export of the

satellites was in the national interest and the licenses were reinstated. AsiaSat-1 became China's first commercial launch of a U.S.-built satellite in April 1990. Final export approval for Optus 1 and 2 was granted in April 1991. They were launched in 1992.

A different issue arose in 1990. China signed a contract to launch an Arabsat Consortium satellite for $25 million, much less than what many consider "on a par" with Western companies. The main competitor was Arianespace, which turned to both the French and U.S. governments to prohibit export of the satellite (the prime contractor was French and it included American components). No formal action was taken by the United States. In 1991, the Arabsat Consortium terminated the contract with the Chinese and signed an agreement with Arianespace, so the case became moot, but the issue of what constituted "on a par" remained. China argued that because its costs are so low, it could offer lower prices and still adhere to international norms as to what costs are included in setting the price. Yet another issue arose in 1991 — linkage of satellite export licenses with U.S. concern over China's ballistic missile proliferation policies. On April 30, 1991, the Bush Administration approved final export licenses for Optus 1 and 2, and for U.S. components of a Swedish satellite called Freja (launched by China in October 1992). To emphasize its concern about Chinese missile proliferation, however, the White House disapproved export of U.S. components for a satellite China itself was building (Dong Fang Hong 3). Then, on June 16, the White House announced that it would be "inappropriate for the United States to approve any further export licenses for commercial satellite launches at this time." On July 17, the State Department identified CGWIC as one of two Chinese entities engaged in missile technology proliferation activities that require the imposition of trade sanctions in accordance with the Arms Export Control Act, including denial of license applications for export items covered by the Missile Technology Control Regime (MTCR). Although the MTCR does not cover satellites (only satellite launch vehicles, which are close cousins of ballistic missiles), the identification of CGWIC as a cause of concern complicated China's marketing plans. China agreed to adhere to the MTCR, and the sanctions were lifted on February 21, 1992.

China's fortunes improved. In May 1992, the International Telecommunications Satellite Organization (Intelsat) agreed to launch at least one of its satellites on a Chinese launch vehicle. On September 11, 1992, the State Department notified Congress that it was waiving legislative restrictions on U.S. exports for six satellite projects with China: APSAT, AsiaSat-2, Intelsat 7A, STARSAT, AfriStar, and Dong Fang Hong 3. The first five were satellites China wanted to launch; the sixth was for satellite components for which export was disapproved in April 1991. (The satellite was launched in 1994, but failed once it was in orbit). Many observers saw the move as a conciliatory gesture in the wake of the U.S. decision to sell F-16s to Taiwan.

On August 25, 1993, however, the U.S. government again imposed sanctions against China for ballistic missile proliferation activities, and the State Department said that satellite exports would not be permitted. The State Department announced October 4, 1994 it would lift the sanctions after China pledged to abide by the MTCR. During this period, tensions were acute between those viewing the sanctions as harmful to U.S. business interests and those seeking to prevent sensitive technology from reaching China and/or to punish China for MTCR infractions. The debate centered on whether the satellites should be governed by export guidelines of the State Department (Munitions List) or the Commerce Department (Commerce Control List). Some responsibility for export of commercial communications

satellites was transferred from the State Department to the Commerce Department in 1992; in October 1996 primary responsibility was transferred to Commerce.

In January 1995, the launch of the Hughes-built APStar-2 satellite failed in-flight. Falling debris killed 6 and injured 23 on the ground. On February 6, 1996, President Clinton approved the export of four satellites to China for launch (2 COSAT satellites, Chinasat 7, and Mabuhay) despite concerns about China exporting nuclear weapons-related equipment to Pakistan. [The COSAT satellites, now called Chinastar, are built by Lockheed Martin and the first was successfully launched on May 30, 1998. Chinasat 7 was built by Hughes, and Mabuhay (now Agila 2) by Loral.] On February 14, 1996, a Long March 3B rocket carrying the Intelsat 708 communications satellite built by Loral malfunctioned seconds after liftoff impacting the ground and spreading debris and toxic fumes over the launch site and a nearby village. The Chinese reported 6 dead and 57 injured, but other reports suggested a higher figure. After this second Chinese launch failure involving fatalities, some customers, including Intelsat, canceled contracts.

In May 1997, USTR stated that it believed China violated the pricing provisions of the bilateral agreement for the launching of Agila 2 (formerly called Mabuhay) for the Philippines. Chinese officials disagreed. On September 10, 1997, the *Washington Times* published a story that Chinese and Russian entities (including CGWIC) were selling missile technology to Iran. China denied the allegations.

Satellite Exports to China: 1998-2000 (Including the "Loral/Hughes" Issue, the Cox Committee Report, and Lockheed Martin). On February 18, 1998, the President notified Congress that it was in the national interest to export Loral's Chinasat 8 to China. On April 4, 1998, the *New York Times* reported that a 1997 classified DOD report alleged that Space Systems/Loral (part of Loral Space & Communications) and Hughes Electronics' satellite manufacturing division (then a subsidiary of General Motors; now Boeing Satellite Systems) provided technical information to China that improved the reliability of Chinese nuclear missiles. The assistance was provided in the wake of the February 1996 Intelsat 708 launch failure (see above). The Intelsat satellite was built by Loral, which participated in an inquiry into the accident at the request of insurance companies seeking assurances that the Chinese had correctly diagnosed and solved the cause of the failure. Loral formed a review committee that included representatives of other satellite companies, including Hughes. According to Loral, the review committee did not itself investigate the accident, but listened to Chinese officials explain their investigation and then wrote a report. Loral conceded that a copy of the report was given to the Chinese before it was provided to the State Department, in violation of Loral's internal policies. Loral says it notified the State Department when it learned that the Chinese had been given a copy. According to media sources, DOD's 1997 report says that the companies provided technical information in violation of the export license that allowed the export of the satellite to China for launch. The companies insist they did nothing that violated the export license. The Justice Department investigated the allegations and reportedly expanded the probe to include Hughes' response to the 1995 APStar-2 failure. A grand jury reportedly was empaneled in 1999. The *Wall Street Journal* reported on August 31, 2001, that the government and Loral were close to reaching a civil settlement, and a similar settlement was expected for Hughes. The settlement with Loral was announced on January 9, 2002. Loral will pay a $14 million civil fine, and spend $6 million on strengthening its export compliance program.

Many hearings on the "Loral/Hughes" issue were held by various House and Senate committees. In addition, the House established the Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China chaired by Representative Cox to investigate the issues. The Cox committee concluded that Hughes and Loral deliberately transferred technical information and know-how to China during the course of accident investigations. The committee investigated other cases of China acquiring technical information from the United States and made 38 recommendations (see CRS Report RL30231), including that the United States should increase its space launch capacity.

The FY2000 DOD authorization Act (P.L. 106-65) included language implementing many of the Cox committee recommendations. In brief, the Department of Justice must notify appropriate congressional committees when it is investigating alleged export violations in connection with commercial satellites or items on the munitions list if the violation is likely to cause significant harm or damage to national security with exceptions to protect national security or ongoing criminal investigations; companies must be provided with timely notice of the status of their export applications; enhanced participation by the intelligence community in export decisions is required; adequate resources must be provided for the offices at DOD and the State Department that approve export licenses; individuals providing security at overseas launch sites do not have to be DOD employees, but must report to a DOD launch monitor; and DOD must promulgate regulations concerning the qualifications and training for DOD space launch monitors and take other actions regarding those monitors and the records they maintain.

In February 1999, the Clinton Administration denied Hughes permission to export two satellites for the Asia Pacific Mobile Telecommunication (APMT) system to China for launch. Export permission for APMT had been granted in 1997 (the President notified Congress on June 25, 1997), but Hughes changed the spacecraft design, necessitating new export approval. That application was denied. On May 10, 2000, the White House made its first certification to Congress under the new process detailed in the FY1999 DOD authorization bill, approving the export to China of satellite fuels and separation systems for the Iridium program. On August 18, 2000, the State Department stated it would continue the suspension of a technical assistance agreement for Loral regarding launch of Chinasat 8 because the concerns that initiated the suspension in December 1998 had not been rectified. In January 2001, *Space News* reported that the Chinasat 8 export application was returned to Loral without action.

In April 2000, it became known that Lockheed Martin also was under investigation, in this case for performing a technical assessment, without an export license, of a Chinese "kick motor" used to place a satellite into its final orbit. On June 14, 2000, the State Department announced it had reached agreement with Lockheed Martin involving $13 million in penalties — $8 million that the company will pay over a 4-year period and $5 million that was suspended and that the company can draw upon to fund a series of remedial compliance measures specified in the consent agreement.

Satellite Exports to China: 2001. In July 2001, Senators Helms, Thompson, Shelby, and Kyl wrote to President Bush reportedly asking the President not to grant waivers for the export of satellites to China. As noted earlier, such waivers are required under the FY1990-91 Foreign Relations Authorization Act (P.L. 101-246). According to a July 9, 2001 *Space.com* story, two European companies (Astrium and Alenia Spazio) built satellites

for two multinational satellite organizations (Intelsat and Eutelsat, respectively) that were scheduled for launch by China. The satellites contain U.S. components, and therefore require U.S. export licenses. The companies reportedly had received State Department approval to ship the satellites to China, but waivers still were needed. In August 2001, Intelsat canceled its contract with Astrium for the APR-3 satellite, citing several factors including the delay in obtaining U.S. export approval. Eutelsat switched the launch of its satellite to Arianespace. Other satellites being manufactured by U.S. companies, however, such as Chinasat 8 and another being built by Loral (Apstar-5, for APT Satellite Co.), or containing U.S. components may require waivers in the future (see CRS Report 98-485 for a list of pending satellite exports). The FY2002 Commerce, Justice, State Appropriations Act (P.L. 107-77) requires 15 days notice to Congress before processing licenses for exporting satellites. H.R. 2581, discussed in the next section, also has specific provisions regarding the launch of satellites from China.

Agency Jurisdiction Over Satellite Export Licenses. Between 1992 and 1996, the George H. W. Bush and Clinton Administrations transferred responsibility for decisions regarding export of commercial satellites from the State Department to the Commerce Department. A January 1997 GAO report (GAO/NSIAD-97-24) examines that decision. In response to concerns about the Loral/Hughes issue, Congress directed in the FY1999 DOD authorization bill (P.L. 105-261) that export control responsibility be returned to the State Department effective March 15, 1999. Which agency should control these exports remains controversial. The Security Assistance Act (P.L. 106-280) called for a reexamination of the jurisdiction question.

Some of the controversy reflects concerns of the aerospace and space insurance industries in the United States and abroad that the new regulations are being implemented too broadly and vigorously and exports for launches on non-Chinese launch vehicles (such as Europe's Ariane) also are being affected. DOD officials and others have cited potential harm to the U.S. defense industrial base if U.S. exports are stifled, too. One of the concerns is the length of time needed to obtain a State Department approval, one factor being whether State has sufficient export license examiners. Section 309 of the FY2000 State Department authorization act (incorporated into the FY2000 Consolidated Appropriations Act, P.L. 106-113) directed the Secretary of State to establish an export regime that includes expedited approval for exports to NATO allies and major non-NATO allies. The State Department announced those new rules in May 2000; they took effect July 1. Also in May 2000, the State Department reportedly notified France that it would not apply strict technology export control on satellites to be launched by Ariane (*Space News*, May 29, 2000, p. 1). Other reforms to broader U.S. export controls for NATO allies also were announced the same month. The Security Assistance Act (P.L. 106-280) reduces from 30 days to15 days the time Congress has to review decisions on exporting commercial communications satellites to Russia, Ukraine, and Kazakhstan, making the time period the same as for NATO allies.

H.R.2581, as reported from the House International Relations Committee on November 16, 2001, includes Title VII, which would return jurisdiction over commercial communications satellite exports to the Commerce Department. Commerce would consult with the State and Defense Departments and other appropriate departments and agencies. The Director of Central Intelligence would be consulted as appropriate. Within 30 days of such referral, the department or agency would have to make a recommendation to approve or deny the license; no response would be deemed as approval. If the agencies cannot agree,

the dispute would be resolved by the President within 60 days. "Defense services" provided in connection with a satellite launch from China or by Chinese nationals would be subject to section 38 of the Arms Export Control Act and Congress must receive a presidential certification 30 days before any export license or technical assistance agreement is so approved. The language is a modified version of H.R. 1707 (Berman). The House Armed Services Committee (HASC) reported its version of the bill on March 8, 2002 (H. Rept. 107-297, Part II), striking Title VII and thereby retaining jurisdiction at the State Department.

GAO released a report (GAO-01-528) in June 2001 concluding that the length of time required to process export license applications through the Department of Commerce versus the State Department is similar, but the type of commodity being exported can have a significant impact on processing time. The Satellite Industry Association (SIA) released figures in May 2001 showing U.S. satellite manufacturers losing market share to foreign companies. SIA and others attribute that loss in part to the shift in jurisdiction to State, which they assert creates uncertainty for satellite customers over when and whether export licenses will be approved. For 2001, however, U.S. companies won 19 of the 22 commercial satellite manufacturing contracts world-wide (*Space News*, Jan. 21, 2002).

Russia. U.S. policy prohibited U.S.-built satellites from being exported to the Soviet Union. In June 1992, however, following its collapse, President George H. Bush said he would not oppose Russia launching an Inmarsat (International Maritime Satellite Organization) satellite and the United States would negotiate with Russia over "rules of the road" for future commercial launches. Discussions were held in the fall of 1992, agreement in principle was reached in May 1993, and the agreement was signed on September 2, 1993, after Russia agreed to abide by the terms of the MTCR (see below). On January 30, 1996, the countries amended the agreement. Prior to Russia's first launch of a U.S.-built satellite, an agreement to protect American technology was reached. A formal Technology Safeguard Agreement among the United States, Russia, and Kazakstan (where the launch site is located) was signed in January 1999. A similar agreement for launches from Russia's Plesetsk, Svobodny, and Kapustin Yar launch sites was signed in January 2000.

The 1993 agreement was signed only after Russia agreed to comply with the MTCR in a case involving a Russian company, Glavkosmos, that planned to sell rocket engine technology to the Indian Space Research Organization (ISRO). The United States declared it violated the MTCR and imposed 2-year sanctions against Glavkosmos and ISRO. In June 1993, the United States threatened to impose sanctions against Russian companies that did business with Glavkosmos. The two countries finally agreed that Russia would cease transferring rocket engine technology (the engines themselves were not at issue) to India.

As noted, on September 10, 1997, the *Washington Times* published a story that Russian and Chinese entities, including the Russian Space Agency, were selling missile technology to Iran. In July 1998, Russia announced that it had identified nine entities that might be engaged in illegal export activities. The United States imposed sanctions against seven of them on July 28 and three more on January 12, 1999. The State Department said the United States would not increase the quota on geostationary launches that Russia could conduct under the 1996 agreement unless Russian entities ceased cooperating with Iran's ballistic missile program (see CRS Report 98-299). The launches are conducted primarily by a U.S.-Russian joint venture composed of Lockheed Martin and Russia's Khrunichev and Energia, companies that were not among those sanctioned. Lockheed Martin was anxious

to have the quota raised to 20 and eventually eliminated. On July 13, 1999, the White House agreed to raise the quota to 20. The agreement that set the quotas was due to expire on December 31, 2000, but the White House eliminated the quota on December 1 (*Wall Street Journal,* December 1, 2000, p. A4). That action was taken even though Russia had informed the United States that, as of December 1, 2000, it was withdrawing from a 1995 agreement to stop selling conventional arms to Iran.

Ukraine. Ukraine also offers commercial launch services, chiefly as part of the Sea Launch joint venture among Boeing, Ukraine's Yuzhnoye, Russia's Energomash, and Norway's Kvaerner. The Sea Launch vehicle consists of a Ukranian two-stage Zenit rocket with a Russian third stage. The vehicle is launched from a mobile ocean oil rig built by Kvaerner. The rig is stationed in Long Beach, CA, where the launch vehicle and spacecraft are mated, and then towed into the ocean where the launch takes place. The United States and Ukraine signed a bilateral trade agreement in February 1996, that would have expired in 2001, but President Clinton terminated it on June 6, 2000, in recognition of "Ukraine's steadfast commitment to international nonproliferation norms." The first successful commercial launch was in October 1999. In 1998, Boeing agreed to pay $10 million for not abiding by export regulations in its dealings with Russia and Ukraine.

Separately, Ukraine signed an agreement with the U.S. company Globalstar to launch its satellites on Zenit from Baikonur. The first attempt failed in September 1998, destroying 12 Globalstar satellites. Globalstar switched to Russian Soyuz launch vehicles (marketed through Starsem) for subsequent launches.

India. India conducted its first successful orbital space launch in 1980. Its ASLV and PSLV launch vehicles can place relatively small satellites in low Earth orbit. India conducted its first commercial launch (of German and South Korean satellites) using the ASLV to low Earth orbit in May 1999. India is developing a larger vehicle (GSLV) capable of reaching geostationary orbit. The first GSLV test launch was completed in April 2001. The GSLV uses Russian cryogenic engines that were the subject of a dispute between the United States and Russia (discussed earlier). India has been seeking opportunities to launch satellites on a commercial basis, and Taiwan had planned to launch its Rocsat 2 remote sensing satellite on an Indian vehicle. Rocsat 2 is being built by Europe's Astrium, but contains U.S. components. According to *Space News* (July 16, 2001, p. 1,18), the United States will not grant an export license for the U.S. components because of economic sanctions imposed against India following nuclear weapons tests in 1998. Hence, *Space News* reports that Taiwan has selected a U.S. launch vehicle instead.

Japan. Japan successfully conducted the first launch of its H-2 launch vehicle in 1994, the first all-Japanese rocket capable of putting satellites in geostationary orbit. Previous rockets used for this purpose were based on U.S. technology and a 1969 U.S.-Japan agreement prohibited Japan from launching for third parties without U.S. consent. With the H-2, Japan was freed from that constraint. In 1990, a joint venture, Rocket Systems Corp. (RSC), was created to develop and market the H-2; the Japanese government provides the development funding and purchases launches for its own needs. H-2 was not cost effective, and encountered technical problems that led the Japanese government to abandon the program in 1999. A new version, H2A, successfully completed its first launch in August 2001. RSC signed contracts with two U.S. satellite builders, Hughes (now part of Boeing) and Loral, for 10 launches each between 2000 and 2005. Hughes canceled its contract in May

2000, however, and Loral lowered its agreement to eight. In 2002, the Japanese government announced that it will privatize production of the H2A by 2005. Mitsubishi Heavy Industries, one of the companies participating in RSC, reportedly will take over development and marketing from RSC. Development of an enhanced version of H2A is being considered. H-2 launches are conducted from Tanegashima, on an island south of Toyko. In June 1997, the Japanese government reached agreement with the fishing industry to allow more launches from Tanegashima. Fishermen must evacuate the area near the launch site during launches. The agreement extends from 90 to 190 the number of days per year that launches may be conducted, and permits up to eight launches a year instead of two.

LEGISLATION

H.R. 1931 (D. Weldon)/S. 1243 (Graham)

Spaceport Equality Act. H.R. 1931 introduced May 22, 2001; referred to Ways and Means Committee. S. 1243 introduced July 25, 2001; referred to Finance Committee.

H.R. 2177 (Calvert)

Invest in Space Now Act. Introduced June 14, 2001; referred to Ways and Means Committee.

H.R. 2443 (Lampson)

Space Tourism Promotion Act. Introduced July 10, 2001; referred to Committees on Science, and Ways & Means.

H.R. 2581 (Gilman)

Export Administration Act of 2001. Referred to House International Relations and House Rules. Reported by House International Relations Committee November 16, 2001 (H.Rept. 107-297, Part I). Reported by House Armed Services Committee March 8, 2002 (H.Rept. 107-297, Part II).

H.R. 4546 (Stump)/S. 2514 (Levin)

FY2003 National Defense Authorization Act. H.R. 4546 reported from House Armed Services Committee May 3, 2002 (H.Rept. 107-436); passed House May 9. S. 2514 reported from Senate Armed Services Committee May 15 (S.Rept. 107-151); passed Senate June 27.

H.R. 5010 (Lewis)

FY2003 DOD appropriations act. Reported from House Appropriations Committee June 25 (H.Rept. 107-532); passed House June 27. Reported from Senate Appropriations Committee July 18 (S.Rept. 107-213); passed Senate August 1, 2002.

S. 2797 (Mikulski)

FY2003 VA-HUD-IA appropriations act (includes NASA). Reported from Senate Appropriations Committee July 25 (S.Rept. 107-222).