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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 (EELVs), 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. P.L. 107-248 (H.R. 5010), the FY2003 DOD appropriations act, creates loan guarantees for companies building in-orbit commercial reusable space transportation systems, but they are not launch vehicles.

Since 1999, projections for launch services demand have declined dramatically, and NASA's efforts to develop a new RLV to replace the shuttle have faltered. Most recently, NASA announced plans to refocus its latest RLV development program, the Space Launch Initiative, towards building an Orbital Space Plane to take crews to and from the space station. It will be launched on an EELV rather than a new RLV. NASA also said it no longer had a near-term goal of lowering the cost of launching spacecraft, and will continue to rely on the shuttle until at least 2015, instead of 2012. DOD's new EELVs (Atlas 5 and Delta 4) were successfully launched in 2002, but the companies that built the vehicles reportedly are seeking additional funding from DOD to defray their costs in the wake of diminished commercial demand.

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 China is 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 December 26, 2002, the State Department charged Hughes Electronics and Boeing Satellite Systems (which had been the satellite manufacturing unit of Hughes Electronics prior to Boeing's purchase of it in January 2000), with 123 counts of export violations. The charges stem from investigations in the late 1990s into whether China obtained militarily useful information while Hughes and another company (Loral) assisted in the investigation of two Chinese launch failures of U.S.-made satellites.

On November 13, 2002, the Bush Administration submitted an amended NASA FY2003 budget request that reflects significant changes to the space shuttle and Space Launch Initiative (SLI) programs. Instead of focusing on development of a "2nd generation" reusable launch vehicle (RLV) to replace the space shuttle, SLI now will focus on developing an Orbital Space Plane (OSP) to take crews to and from the space station. The OSP will be launched on an EELV, not an RLV. NASA no longer has a near-term goal of reducing the cost of launching spacecraft. NASA plans to shift money into the shuttle program to ensure it can be safely used until at least 2015 (instead of 2012), or perhaps until 2020 or longer. NASA will continue technology development work on new RLVs, but not with the goal of choosing a design in the near future. The House and Senate appropriations committees marked up the original NASA FY2003 budget request (H.R. 5605/S. 2797). The $3.2 billion request for the space shuttle was approved by both committees, while SLI was cut by $30 million by the Senate committee, and $31 million in the House version. The 107th Congress did not complete action on that legislation, however.

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, 2002, NASA exercised the first option, extending the contract to 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 House and Senate Appropriations Committees approved that request in the FY2003 VA-HUD-IA appropriations bill (H.R. 5605/S. 2797). That bill did not clear Congress, however.

In November 2002, the Bush Administration submitted to Congress an amended FY2003 NASA budget request that answered some questions about the future of the shuttle. The shuttle is one element of NASA's "Integrated Space Transportation Program" (ISTP), and the November budget amendment reflected significant changes to the ISTP. NASA had planned to phase out the shuttle beginning 2012, replacing it with a new, lower-cost "2nd generation" reusable launch vehicle (RLV)—the shuttle is the 1st generation RLV—based on technologies developed through NASA's Space Launch Initiative (SLI). The debate over retaining shuttle versus building a new vehicle has waged for years. 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. NASA now has decided to retain the shuttle until at least 2015, and perhaps 2020 or longer, and plans to shift $470 million from the SLI program into the shuttle (FY2003-2007) to extend its lifetime. SLI is discussed in more detail below.

NASA has been engaged in a program of safety and supportability upgrades for the shuttle for many years to ensure its safe operation. 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. Then, in the FY2003 original budget submission, NASA reduced how much it planned to spend on both safety and supportability upgrades in the FY2002-2006 time period by 34%— from $1.836 billion to $1.220 billion. NASA Administrator O'Keefe insisted the proposed funding level will not compromise shuttle safety. However, the independent Aerospace Safety Advisory Panel (ASAP) concluded in March 2002 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."

In September 2002, NASA canceled its highest priority supportability upgrade, the Checkout and Launch Control System (CLCS) because of cost overruns and schedule delays. In its report on the FY2003 VA-HUD-IA appropriations bill (H.Rept. 107-740), the House Appropriations Committee expressed its frustration at NASA's inability to accurately evaluate risks and costs of the upgrade program. It directed NASA to report within 60 days of the law's enactment on steps being taken to correct deficiencies in the upgrade program. The bill did not clear the 107th Congress. In the November amended budget request, NASA announced plans to create a new line item, "Future Shuttle Life Extension Program," that will incorporate funding previously identified for shuttle upgrades. Of the $470 million NASA plans to add to the shuttle program in the FY2003-2007 period, $236 million is allocated to the life extension program. What projects will be funded were not specified.

The amended budget request also signaled a change in NASA's projected annual shuttle launch rate. Historically, shuttles have been launched at a rate of 7-8 per year, but that was cut to 6 per year, and then to 4 per year, for budgetary reasons. In the amended budget request, NASA indicated that it would increase the flight rate to 5 per year beginning in 2006 to support the space station program.

One remaining question concerns shuttle "privatization," which also has been discussed for many years. As noted, in 1996, NASA selected a "single prime contractor"—United Space Alliance (USA)—for the shuttle in what was described as a first step towards shuttle privatization, although the precise meaning of that term remains unclear. The Bush Administration said it would move forward with privatization, but later changed the terminology to "competitive sourcing." 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. According to media reports, a study by RAND, commissioned by NASA, was not encouraging about the prospects for privatizing the shuttle. In the November budget amendment, NASA said it was "examining options for competing shuttle operations" and still hopes to move to a new arrangement in FY2004, but, if not, can extend the contract with USA for another two years.

DOD's Evolved Expendable Launch Vehicle (EELV) Program

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 (see below).

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. Two EELVS were developed in joint government-private sector programs: Boeing's Delta IV and Lockheed Martin's Atlas V. Both vehicles were successful

in their first launch attempts to 2002. The goal of the EELV program 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 first Atlas 5 was successfully launched in August 2002; the first Delta 4 launch is expected in late 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.

NASA's new plan to develop an Orbital Space Plane to take crews to and from the space station launched via EELVs would require the EELVs to be "human-rated." That is, their level of reliability would have to be acceptable for taking humans, rather than just cargo, into space. How much it will cost to human-rate the EELVs and who will pay for it has not been announced. The added reliability could make EELVs stronger competitors in the global commercial launch services market.

For FY2003, DOD requested $58 million for R&D and $159 million for procurement. The FY2003 DOD appropriations act (P.L. 107-248)) added $8 million for EELV procurement. The FY2003 DOD authorization act (P.L. 107-314) added $14.5 million for procurement. Both acts fully fund the R&D request.

NASA's Efforts to Develop New Reusable Launch Vehicles (RLVs)

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.

X-33 and X-34. 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 and X-34. X-33 was a joint program with Lockheed

Martin to build a subscale prototype of a large RLV based on single-stage-to-orbit (SSTO) technology. 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. X-34 was a small RLV "testbed" to demonstrate reusable two-stage-to-orbit technologies, which was being built under a traditional contract with Orbital Sciences Corporation. (Initially, X-34 also was a government-industry cooperative effort with Orbital and Rockwell International, but those companies withdrew from the cooperative agreement. NASA then signed a contract with Orbital for a scaled-back program.) NASA terminated X-33 and X-34 in March 2001. NASA spent approximately $1.2 billion on X-33, and Lockheed Martin said that it spent $356 million of its own funding. 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. X-34 was terminated for similar reasons. NASA spent $205 million on X-34.

Space Launch Initiative (SLI). Recognizing the problems in the X-33 and X-034 programs, NASA restructured its RLV program in 2000 (as part of its FY2001 budget request) and initiated the Space Launch Initiative (SLI). As described in the next section, NASA now is proposing to restructure that program. Congress has not yet approved the new plan, so the following text describes SLI as it currently exists. Under SLI, NASA is working with the private sector and universities to develop new technologies to 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 the private sector will do so. The goal of the program 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."

SLI is focused on meeting NASA's future needs, primarily servicing the International Space Station. Part of the SLI program is development of "NASA Unique" capabilities, meaning those to support human spaceflight, which to date is a uniquely NASA activity. 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.

SLI is budgeted at $4.8 billion from FY2001-2006 . For FY2001, NASA requested and received $290 million. For FY2002, NASA requested $475 million and received $465 million. The original FY2003 budget request was $759.2 million. The Senate Appropriations Committee cut the request by $30 million in the FY2003 VA-HUD-IA appropriations bill(S.2797); the House Appropriations Committee cut it by $31 million (H.R.5605).

November 2002 SLI Restructuring Proposal. The SLI program has been under scrutiny. 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. A September 2002 GAO report highlighted the challenges facing the SLI program (GAO-02-1020). 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.

NASA Administrator O'Keefe and the Bush Administration apparently agree. The November amended FY2003 budget request would significantly change the SLI program. Mr. O'Keefe was quoted as calling the SLI goal of sharply reducing launch costs "a bumper sticker" and that he knew of no technology that could achieve that goal. The Administration's budget amendment documentation states that a new RLV lacks economic justification because the commercial launch market is too uncertain, and it is premature to base new requirements on future DOD or NASA missions. It also says that although the SLI program had estimated the cost of a new RLV at $10 billion (not including the funding spent on SLI), a new estimate by the SLI program office was $20 billion, and four independent estimates sponsored by NASA suggested $30-35 billion. Therefore NASA concluded "the economic case for a new RLV is in doubt for the foreseeable future."

If the amended budget request is approved by Congress, SLI funding for FY2003-2007 would be reduced by $2.133 billion—from $3.899 billion to $1.766 billion. Although the SLI terminology would continue, the thrust of the program would change to development of an Orbital Space Plane for taking crews to and from the space station. The space plane would be launched on an EELV, rather than a new reusable vehicle. In addition, NASA's ongoing technology efforts to develop 3rd generation RLV technology would be combined with remaining 2nd generation technology development into a "Next Generation" RLV technology program. This would shift the $661 million allocated for 3rd generation technology (an existing line item in the NASA budget, which includes hypersonics, an area in which DOD is interested) into the new SLI. Thus, SLI would consist of two components: Orbital Space Plane (OSP), and Next Generation Launch Technology (NGLT).

The OSP builds on work being conducted under the "NASA Unique" portion of the SLI program. In the budget amendment, $882 million would be shifted into the OSP program from other SLI activities. Added to funding already planned for NASA Unique technology, the total for OSP for FY2003-2007 would be $2.405 billion. The remainder of the $2.133 billion that is being shifted away from SLI will go to the space shuttle program ($470 million, discussed earlier), the space station program ($706 million, see CRS Issue Brief IB93017), and to Biological and Physical Research ($75 million, for research that will benefit from the higher shuttle flight rate proposed in the budget amendment). Despite being part of SLI, OSP is not a launch vehicle, and will not be discussed further in this report.

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 is discussed in the next section.

U.S. Commercial Launch Services Industry

Congressional Interest

The 107th Congress debated issues involving satellite exports (discussed below) and the domestic launch services industry. These issues are expected to be of interest to the 108th Congress as well. 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. In the 107th Congress, H.R. 2177 (Calvert) would have created tax incentives, while H.R. 2443 (Lampson) would have provided loan guarantees for developing transportation systems needed for space tourism, and tax incentives for space tourism companies. There was no action on those bills. Congress did add Title IX to the FY2003 DOD appropriations act (P.L. 107-248), which creates a loan guarantee program for companies developing commercial, reusable, in-orbit space transportation systems. Such systems would move satellites from one orbit to another, but not place them in orbit. Hence they are not launch vehicles and are not discussed further in this report. Bills to make spaceports eligible for tax exempt bonds also were introduced in the 107th Congress (H.R. 1931/S. 1243); there was no action on them.

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. 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 government reacted a civil settlement with Loral on January 9, 2002 wherein Loral agreed to pay a $14 million civil fine, and spend $6 million on strengthening its export compliance program. Although the *Wall Street Journal* reported on August 31, 2001 that a similar settlement was expected with Hughes, on December 26, 2002, the State Department charged Hughes Electronics and Boeing Satellite Systems with 123 export violations. In a statement, Boeing asserted that its acquisition agreement with Hughes stipulates that Hughes is responsible for resolving these matters, which occurred prior to Boeing's purchase.

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-Present. 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.

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.

The 107th Congress considered, but did not pass, legislation on the agency jurisdiction question. Title VII of H.R.2581, as reported from the House International Relations Committee on November 16, 2001 (H.Rept. 107-297, Part I), would have returned jurisdiction over commercial communications satellite exports to the Commerce Department. The House Armed Services Committee, however, struck Title VII when it reported its version of the bill on March 8, 2002 (H.Rept. 107-297, Part II), thereby retaining jurisdiction at the State Department. There was no further action.

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. W. 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).

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, is taking 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

P.L. 107-248 (H.R. 5010)

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. Conference report (H.Rept. 107-732) filed October 9; passed House October 10. Signed into law October 23, 2002.

P.L. 107-314 (H.R. 4546)

FY2003 National Defense Authorization Act. H.R. 4546 reported from House Armed Services Committee May 3 (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. Conference report (H.Rept. 107-772) passed House November 12, Senate November 13. Signed into law December 2, 2002.

H.R. 5605 (Walsh)/S. 2797 (Mikulski)

FY2003 VA-HUD-IA appropriations act (includes NASA). Reported from Senate Appropriations Committee July 25, 2002 (S.Rept. 107-222). Reported from House Appropriations Committee October 10, 2002 (H.Rept. 107-740). No further action.