2012

Commercial Space

Diane Howard
Embry-Riddle Aeronautical University, howard19@erau.edu

SPACE SECURITY INDEX

2012

www.spacesecurity.org

SPACE SECURITY INDEX

2012

SPACESECURITY.ORG

Library and Archives Canada Cataloguing in Publications Data
Space Security Index 2012

ISBN: 978-1-895722-92-5

Edited by Cesar Jaramillo

Design and layout: Creative Services, University of Waterloo,
Waterloo, Ontario, Canada

Cover image: This unusual image was photographed through the Cupola on the International Space Station by one of the Expedition 30 crew members. Taken December 29, 2011. Image Credit: NASA

Printed in Canada

Printer: Pandora Print Shop, Kitchener, Ontario

First published September 2012

Please direct inquires to:
Cesar Jaramillo
Project Ploughshares
57 Erb Street West
Waterloo, Ontario
Canada N2L 6C2
Telephone: 519-888-6541, ext. 7708
Fax: 519-888-0018
Email: cjaramillo@ploughshares.ca

TABLE OF CONTENTS

CHAPTER FIVE

Commercial Space

This chapter assesses space security indicators and developments in the commercial space sector, which includes manufacturers of space hardware such as rockets and satellite components, providers of space-based information such as telecommunications and remote sensing, and service operators for space launches. Also covered in this chapter are the developments related to the nascent space tourism industry, as well as the interactions between commercial operators and the public sector.

The commercial space sector has experienced dramatic growth over the past decade, largely as a result of rapidly increasing revenues associated with satellite services provided by companies that own and operate satellites, as well as the ground support centers that control them. This growth has been driven by, among other factors, the reality that space-based services such as satellite-based navigation, once the exclusive purview of governments, are now widely available for private customers. In 2011 alone, the world satellite industry had revenues in excess of $177-billion.[1] Companies that manufacture satellites and ground equipment have also contributed significantly to the growth of the commercial space sector. This includes both direct contractors that design and build large systems and vehicles, smaller subcontractors responsible for system components, and software providers.

This chapter assesses developments associated with access to space via commercial launch services. In the early 2000s overcapacity in the launch market and a reduction in commercial demand combined to depress the cost of commercial space launches. More recently, an energized satellite communication market and launch industry consolidation have resulted in stabilization and an increase in launch pricing. Revenues from 23 commercial launch events in 2011 were close to $2-billion.[2]

This chapter also examines the relationships between governments and the commercial space sector, including the government as partner and the government as regulator, and the growing reliance of the military on commercial services. Governments play a central role in commercial space activities by supporting research and development, subsidizing certain space industries, and adopting enabling policies and regulations. Indeed, the space launch and manufacturing sectors rely heavily on government contracts. The retirement of the space shuttle in the United States, for instance, will likely open up new opportunities for the commercial sector to provide launch services for human spaceflight. Conversely, because space technology is often dual-use, governments have sometimes taken actions such as the imposition of export controls, which impact the growth of the commercial market. There is also evidence that commercial actors are engaging governments on space governance issues, in particular space traffic management and space situational awareness.

Space Security Impact

The role that the commercial space sector plays in the provision of launch, communications, imagery, and manufacturing services, as well as its relationship with government, civil, and military programs, make this sector an important determinant of space security. A healthy space industry can lead to decreasing costs for space access and use, and may increase the accessibility of space technology for a wider range of space actors. This has a positive impact on space security by increasing the number of actors that can access and use space or space-based applications, thereby creating a wider pool of stakeholders with a vested interest in the maintenance of space security. Increased commercial competition in the research and development of new applications can also lead to the further diversification of capabilities to access and use space.

Commercial space efforts have the potential to increase the level of transnational cooperation and interdependence in the space sector, thereby enhancing transparency and confidence among international partners. Additionally, the development of the space industry could influence, and be influenced by, international space governance. To thrive, sustainable commercial markets must have the freedom to innovate, but they also require a framework of laws and regulations on issues of property, standards, and liabilities.

Issues of ownership and property may also pose a challenge to the growth of the industry. For example, while the non-appropriation clause of the Outer Space Treaty is generally understood to prohibit ownership claims in space, this clause also raises questions about the allocation and use of space resources, which are utilized by a variety of space actors, but are technically owned by no one.

Growth in space commerce has already led to greater competition for scarce space resources such as orbital slots and radio frequencies. To date, the ITU and national regulators have been able to manage inter- and intra-industry tensions. However, strong demand for additional frequency allocations and demands of emerging nations for new orbital slots will provide new governance challenges for domestic and international regulators. The growing dependence of certain segments of the commercial space industry on military clients could also have an adverse impact on space security, by making commercial space assets the potential target of military attacks.

Indicator 5.1: Growth in commercial space industry

Commercial space revenues have steadily increased since the mid-1990s, when the industry first started to grow significantly. The satellite industry is made up of four major segments: ground equipment, satellite services, launch industry, and satellite manufacturing. During 2011 satellite services accounted for approximately 61 percent of total worldwide space industry revenues[3] and 4 percent of overall global telecommunications industry revenues.[4] Between 2010 and 2011 launch industry segment remained steady with 3 percent of total revenues. Satellite manufacturing increased slightly in 2011 to 7 percent from 6 percent in the previous year; satellite services grew from 60 percent to 61 percent.[5] Growth in services such as telecommunications has been largely driven by commercial rather than government demand; this trend is mirrored in other sectors.

The telecommunications industry has long been a driver of commercial uses of space. The first commercial satellite was the Telstar-1, launched by NASA in July 1962 for telecommunications giant AT&T.[6] Satellite industry revenues were first reported in 1978, when Communication Satellite Corporation claimed 1976 operating revenues of almost $154-million.[7] By 1980 it is estimated that the worldwide commercial space sector already accounted for revenues of $2.1-billion.[8] Individual consumers are becoming important stakeholders in space with their demand for telecommunications services, particularly Direct Broadcasting Services, but also global satellite positioning and commercial remote sensing images.

Today's space telecommunications sector emerged from what were previously government-operated bodies that were deregulated and privatized in the 1990s. For example, the International Maritime Satellite Organisation (Inmarsat) and International Telecommunications Satellite Organization (Intelsat) were privatized in 1999 and 2001, respectively.[9] PanAmSat, New Skies, GE Americom, Loral Skynet, Eutelsat, Iridium, EchoStar, and Globalstar were some of the prominent companies to emerge during this time. Major companies today include SES Global, Intelsat, Eutelsat, Telesat, and Inmarsat.

Although satellite manufacturers continue to experience pressure to lower prices, strong demand for broadcasting, broadband, and mobile satellite services and a strong replacement market drive an increase in orders that is projected to continue.[10] Of the 133 payloads carried into orbit in 2011, 35 provide commercial services and the remaining 98 perform civil government, nonprofit, or military missions.[11] The commercial launch market continues to be dominated by Russia and Europe, followed by the United States.

The shape of the commercial space industry has been shifting as it becomes more global. Although it is still dominated by Europe, Russia, and the United States., countries such as India and China are starting to become involved. Developing countries are the prime focus of these efforts.[12] India has been positioning itself to compete for a portion of the commercial launch service market by offering lower-cost launches[13] and it also intends to compete in the satellite manufacturing industry.[14] For the first time in 2007 China both manufactured and launched a satellite for another country, Nigeria's Nigcomsat-1.[15] Moreover, because it uses no U.S. components, China has marketed manufactured satellites as free of ITAR (International Traffic in Arms Regulations) restrictions, reportedly at prices below industry standard.[16]

2011 Development

Despite predictions of downturn, satellite industry positioned for continued growth

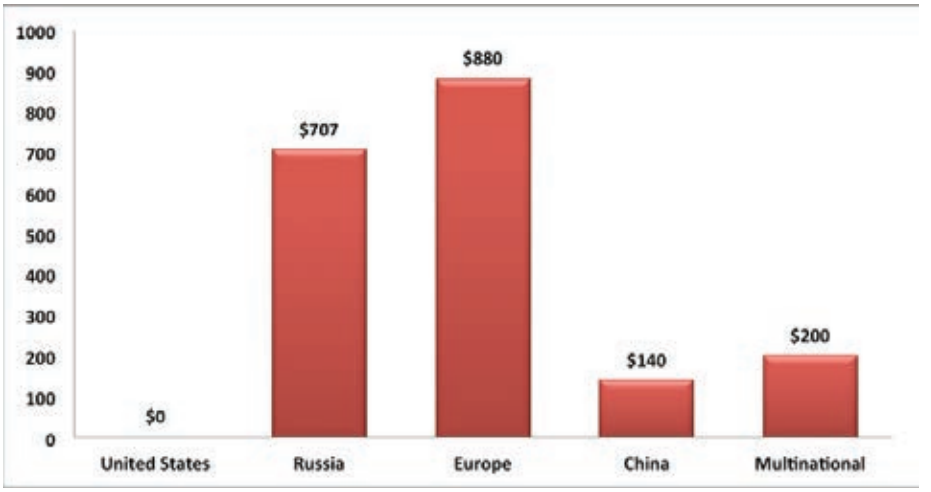
Because of the market's cyclical nature and the global recession, a downturn had been predicted for satellite markets, but substantial orders for commercial geostationary-orbiting telecommunications satellites kept the market lively.[17]

On 6 February 2012 Euroconsult, a leading consulting and analysis firm specializing in the space sector, announced that the prospects for the satellite industry are expected to remain favorable over the next decade in a variety of areas.[18] In its report *Satellite Communications & Broadcasting Markets Survey*, Euroconsult predicts satellite bandwidth used by traditional Fixed Satellite Services (FSS) will be worth approximately $15-billion by 2020.[19] However, the report also forecasts stagnating government spending, which is expected to persist through the middle of the decade.[20]

According to a public statement by Euroconsult CEO, Pacôme Revillon, "while we have seen slowing growth rates in leased capacity, FSS operators' revenue growth has continued to outperform the global economy, and operating margins remain high for most operators. In the near term, the difficult economic environment could weigh on the market."[21] Revillon added that "connectivity needs and the growth of digital TV in emerging regions, combined with the launch of new generation high throughput satellite systems should continue to drive growth. The value of satellite capacity leasing should consequently grow at 7% over the next ten years."[22]

Euroconsult's report predicts that 1,145 satellites will be built for launch between 2011 and 2020—a 51 percent increase over the previous decade.[23] Seventy percent of this activity can be attributed to government demand. These launches are expected to generate revenues worth $196-billion. As well, Euroconsult predicts that 203 commercial communications satellites, with a market value of $50-billion, will be launched into Geostationary Earth Orbit (GEO) over the next decade.[24]

Figure 5.1: Approximate commercial launch revenue by country in 2011 (in U.S.$ millions)[25]



The report is consistent with findings from early 2011 that "disproved analysts' warnings that the cyclical industry was headed for a downturn"[26] and confirmed that the telecommunications industry had managed to maintain nearly the same level of orders for commercial GEO orbiting satellites in 2010 as for 2009 (26 in 2010; 30 the year before).[27] For instance, in 2011 earth imagery supplier DigitalGlobe reported growth exceeding its ability to keep up with it.[28] GPS and direct-to-home (DTH) satellite television also produced strong revenues, continuing to fuel overall industry growth as they have since 2005.[29] Eutelsat, Intelsat, SES, and Telesat all reported top-line growth compared with the year before, although only Eutelsat showed a double-digit increase.[30]

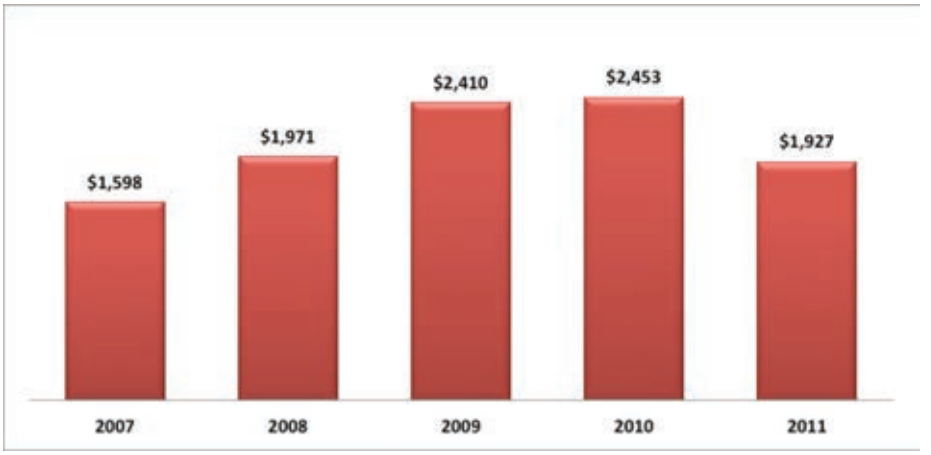
2011 Development

Inmarsat develops business by securing financing from U.S. Export-Import Bank for Global Xpress system, while expanding maritime operations

On 12 May 2011 mobile satellite services operator Inmarsat announced a loan agreement with the U.S. Export-Import Bank that will provide up to $700-million to build and insure three large Ka-band satellites designed to provide more bandwidth to its customer base as part of its Global Xpress satellite system.[31] A four-year drawdown will be followed by an 8.5-year payback in equal installments at an undisclosed fixed interest rate.[32]

Although Inmarsat is based in the U.K., eligibility for U.S. export-credit support was based on the fact that all three satellites for the Global Xpress system are being built by Boeing Space and Intelligence Systems, which is based in El Segundo, California.[33] In addition to carrying Ka-band payloads, all three Global Xpress satellites are expected to carry a complementary high-capacity overlay to allow higher bandwidth links to individual hotspots, several of which will be in the ocean.[34] The Ka-band payloads will use both civil and military frequencies.[35]

Figure 5.2: Worldwide commercial launch revenue. 2007-2011 (in U.S.$ millions)[36]



On 1 August 2011 Inmarsat announced that Inmarsat SA, one of its subsidiaries, had signed an agreement with International Launch Services to launch its three Global Xpress satellites.[37] The satellites are expected to be launched in 2013 and 2014 in separate Proton liftoffs from the Baikonur Cosmodrome in Kazakhstan.[38] The spacecraft will be stationed approximately 120 degrees apart in geostationary orbit 36,000 km above the equator, and will provide mobile broadband service for maritime, aeronautical, and land-based users.[39] Inmarsat estimated the total cost of its investment in the Global Xpress system, including launches, at $1.2-billion.[40]

In addition Inmarsat purchased Ship Equip International, a provider of communications services to maritime vessels with very-small-aperture terminal (VSAT) onboard antennas via Ku-band satellite.[41] Inmarsat aims to convert Ship Equip customers to its Global Express service. Concerns regarding signal attenuation for Ka-band mirror those expressed prior to the adoption of satellite broadband in the United States, which were addressed by adjusting power levels on the satellite beam and using adaptive coding modulation. Inmarsat is building upon the fact that prospective Global Express customers can continue to use their existing L-band satellite hardware, already used by most of Inmarsat's existing customers, and add Global Express gear to that system. The reported cost of the acquisition was $159.5-million.[42]

2011 Development

High throughput satellites (HTS) drive growth

Changes in satellite manufacturing have placed high throughput satellites in the forefront of technologies helping to grow the satellite industry.[43] Not simply larger and more powerful than their predecessors, HTS offer high total bandwidth throughput or capacity. Increased capacity is needed to meet bandwidth demand resulting from online, on-demand, streaming, or downloadable[44] sites such as YouTube, Netflix, and Hulu.

HTS combines greater spectrum availability, by using Ka-band and higher frequency bands, with the use of spot beams.[45] Much like cellular networks, spot beams enable frequency re-use. While HTS is not limited to Ka-band, the increased use of this spectrum motivated the international satellite industry to lobby for its effective management.[46] Eutelsat went live with its KA-SAT HTS in May 2011.[47]

2011 Development

Eutelsat leases Chinese satellite to preserve orbital slot

A Western satellite operator leased a Chinese-built satellite for the first time in 2011.[48] On 13 May Paris-based satellite operator Eutelsat announced that it had leased Chinese satellite Sinosat3/Chinasat 5C, which was launched in May 2007.[49] Sinosat 3/Chinasat 5C, which has 24 36-megahertz Ku-band transponders, is based on China's DFH-3 satellite frame and is designed to operate for 15 years.[50]

The company's announcement came shortly before, according to ITU regulations, its rights over the orbital slot over Europe were set to expire in June 2011. The satellite, referred to by the ITU as F-Sat-Ku-E-1.6E, was moved from Asia to one of Eutelsat's orbital slots over Europe, which it had reserved in 2004 through the French National Frequencies Agency.[51] Eutelsat had decided "to operate the [Chinese] satellite at 1.6 degrees East."[52] Since other national administrations have registered satellites and frequencies near the orbital position in question, another operator could have occupied the slot if Eutelsat had missed the deadline. The satellite was renamed Eutelsat 3A.

Details about the cost of the lease were provided on 29 July 2011 by Chief Financial Officer Catherine Guillouard. Eutelsat is paying 15-million euros ($21.5 million) to lease the satellite, plus a finance charge of less than 1 million euros.[53]

On 28 July 2011 Eutelsat announced that it had ordered a large satellite from Astrium, which will be placed in the slot currently used by Eutelsat 3A.[54] The new satellite, Eutelsat 3B, will carry a mixed C-, Ku-, and Ka-band payload and is expected to be launched in early 2014 into the 3 degrees east slot.[55]

2011 Development

Commercial launch market continues to expand

In 2011 China performed two commercial launches.[56] The first, in August, was the launch of a communications satellite developed by China for Pakistan.[57] In October the second launched a French satellite built by Thales Alenia Space for Eutelsat Communication. These launches herald China's intention to reenter the global launch industry, with a goal of five launches for 2012, or approximately 15 percent of the 20 to 30 commercial launches historically performed worldwide in a given year.[58]

The first mission for the Europeanized Soyuz-2 took place in October, launching two Galileo space navigation satellites.[59] This was the first time the Soyuz had launched from Kourou in French Guiana. In December the French Pléiades 1A high-resolution Earth observation satellite launched aboard a Soyuz rocket from the Guiana Space Centre.[60]

2011 Development

LightSquared telecommunications plan interferes with GPS signals in the United States

On 24 January 2011 the U.S. Federal Communications Commission (FCC) conditionally approved the U.S. telecommunications company LightSquared's plan to deploy 40,000 high-power transmitters for providing broadband service to customers, despite awareness that they would interfere with nearby GPS signals.[61]

The FCC granted its approval to LightSquared on the condition that it would work with the U.S. Global Positioning System Industry Council and U.S. military, which operates GPS, "to determine the extent of interference and develop mitigation measures."[62] Tests were to

be completed by 31 May 2011, with a final report presented to the FCC in mid-June.[63] The report stated that "although the results vary among devices, transmissions in the 10 MHz band at the top of LightSquared's downlink frequencies—the band nearest to the GPS frequencies—will adversely affect the performance of a significant number of legacy GPS receivers."[64] On 14 February 2012 the FCC issued a statement saying that it would revoke LightSquared's conditional license.[65] (See Chapter 1 for further details on this development.)

Space Security Impact

The pool of stakeholders with a direct interest in preserving space as a peaceful domain has increased in recent years as a result of the continued overall growth in the commercial space industry. This constitutes a positive development for space security. Moreover, cooperative efforts and the resulting cost-effectiveness will likely encourage greater space access and socioeconomic development for both established and emerging spacefaring states. Development of new products and services lessens dependence upon one facet of commercial activity, thus helping to insulate against fluctuations in specific markets. However, as commercial space activity increases, issues of congestion, competition, and spectrum management become of greater concern.

Indicator 5.2: Commercial sector support for increased access to space products and services

Space Launches

Russian, European, and U.S. companies remain world leaders in the commercial launch sector, with Russia launching the most satellites annually, both commercial and in total. Generally launch revenues are attributed to the country in which the primary vehicle manufacturer is based. However, Sea Launch is designated "multinational" and so a clear division of revenues among participating countries is harder to establish.

Commercial space access grew significantly in the 1980s. At that time NASA viewed the provision of commercial launches more as a means to offset operating expenses than as a viable commercial venture. European and Russian companies chose to pursue commercial launches via standard rocket technology, which allowed them to undercut U.S. competitors during the period when the United States was only offering launches through its Space Shuttle.

Increasing demand for launch services and the ban of commercial payloads on the Space Shuttle following the 1986 Challenger Shuttle disaster encouraged further commercial launch competition. The Ariane launcher, developed by the French in the 1980s, captured over 50 percent of the commercial launch market during the period 1988-1997.[66] The Chinese Long March and the Russian Proton rocket entered the market in the early and mid-1990s. In May 1999 India's Augmented Polar Satellite Launch Vehicle performed the country's first LEO commercial launch, placing German and South Korean satellites in orbit.[67] Today Ariane, Proton, and Zenit rockets dominate the commercial launch market.

Top commercial launch providers include Boeing Launch Services and Lockheed Martin Commercial Launch Services (vehicles procured through United Launch Alliance) and Orbital Sciences Corporation in the United States; Arianespace in Europe; ISC Kosmotras, Polyot (with partners), and ZAO Puskovie Uslugi in Russia; Antrix in India; China Great Wall Industry Corporation in China; and international consortia Sea Launch, International Launch Services, Eurockot Launch Services GmbH, and Starsem. Sea Launch—comprising Boeing (U.S.), Aker Kvaerner (Norway), RSC-Energiya (Russia), and SDO Yuzhnoye/PO

Yuzhmash (Ukraine)—operates from a mobile sea-based platform located on the equator in the Pacific Ocean. ILS was established as a partnership among Khrunichev State Research and Production Space Center (Russia), Lockheed Martin Commercial Launch Services (United States), and RSC-Energiya (Russia). In 2006 Lockheed sold its share to U.S. Space Transport Inc. Eurockot is a joint venture between EADS Space Transportation and Khrunichev, while Starsem is a joint venture between the Russian Federal Space Agency, TsSKB-Progress, EADS Space Transportation, and Arianespace. Commercial launch vehicle builders such as Space Exploration Technologies (SpaceX) have become increasingly active in research and development and are seeking to compete by providing cheaper, reusable launch vehicle systems such as the Falcon 9.

In addition to a proliferation of rocket designs, the launch sector has also seen innovations in launch techniques. For example, since the early 1990s companies such as the U.K.'s Surrey Satellite Technology Ltd. have used piggyback launches, in which a small satellite is attached to a larger one. It is now also common to use small launchers such as the Cosmos rocket and India's PSLV to deploy clusters of smaller satellites.

Commercial Earth Imagery

While at one point only national governments could access remote sensing imagery; today any individual or organization with access to the Internet can use these services through Google Maps, Google Earth, and Yahoo Maps programs.[68] Currently several companies in Canada, France, Germany, Israel, Russia, and the United States are providing commercial remote sensing imagery. The resolution of the imagery has become progressively more refined and affordable. In addition to optical photo images, synthetic aperture radar images up to one meter in resolution are coming on the market and a growing consumer base is driving up revenues. However, the potentially sensitive nature of the data has raised security concerns.

Commercial Satellite Navigation

Initially intended for military use, satellite navigation has emerged as a key civilian and commercial service. The U.S. government first promised international civilian use of its planned Global Positioning System in 1983, following the downing of Korean Airlines Flight 007 over Soviet territory and in 1991 pledged that it would be freely available to the international community beginning in 1993.[69] While GPS civilian signals have dominated the commercial market, new competition may emerge from the EU's Galileo system, which is specifically designed for civilian and commercial use, and Russia's GLONASS.[70] China's regional Beidou system will also be available for commercial use.[71] (For further information on satellite navigations systems see Chapters 4 and 6.)

The commercial satellite positioning industry initially focused on niche markets such as surveying and civil aviation, but has since grown to include automotive navigation, agricultural guidance, and construction.[72] Sales of ground-based equipment provide core revenues for the commercial satellite positioning industry. Commercial users first outpaced military buyers in the mid-1990s.[73] The commercial GPS market continues to grow with the introduction of new receivers that integrate the GPS function into other devices, such as cell phones.[74]

Commercial Space Transportation

An embryonic private spaceflight industry continues to emerge, seeking to capitalize on new concepts for advanced, reliable, reusable, and relatively affordable technologies for launch to near-space and LEO. In December 2004 the U.S. Congress passed the "Commercial

Space Launch Amendments Act of 2004." Intended to "promote the development of the emerging commercial human space flight industry," the Act established the authority of the Federal Aviation Administration (FAA) over suborbital space tourism in the United States, allowing it to issue permits to private spacecraft operators to send customers into space.[75] In 2006 the ESA announced the "Survey of European Privately-funded Vehicles for Commercial Human Spaceflight" to support the emergence of a European commercial space transportation industry.[76]

The market for commercial space transportation remains small, but has attracted a great deal of interest. In September-October 2009 Canadian Guy Laliberté became the seventh and latest private citizen to fly in space with Space Adventures, which sells seats on the Russian Soyuz.[77] Prices for this opportunity are increasing, with Charles Simonyi paying $25-million for his trip in 2007 and $35-million for a second trip in March 2009.[78]

In June 2004 SpaceShipOne, developed by The Spaceship Company (a joint venture between Scaled Composites and the Virgin Group), became the first private manned spacecraft, but only conducted suborbital flights.[79] It was followed by SpaceShipTwo, unveiled in December 2009 and expected to carry passengers on suborbital flights. Although a specific date for the first private flights on SpaceShipTwo has not yet been confirmed, Virgin Galactic, a subsidiary of the Virgin Group, has already started taking bookings for suborbital flights at a cost of $200,000 per seat.[80] While the industry has faced various challenges—including a lack of international legal safety standards, high launch costs, and export regulations[81]—important liability standards have emerged. In 2006 the FAA released a set of rules governing private human spaceflight requirements for crew and participants.[82] Final rules were also issued for FAA launch vehicle safety approvals.[83]

Insurance

Insurance affects both the cost and risk of access to space. Insurance rates also influence the ease with which startup companies and new technologies enter the market.[84] Although governments play an important role in the insurance sector, insofar as they generally maintain a certain level of indemnification for commercial launchers, the commercial sector assumes most of the insurance burden. There are two types of coverage: launch insurance, which typically includes the first year in orbit, and in-orbit insurance for subsequent years. Most risk is associated with launch and the first year in orbit. When covering launches, insurance underwriters and brokers discriminate among launch vehicles and satellite design so that the most reliable designs subsidize the insurance costs of the less reliable hardware.[85]

Following a decade of tumultuous rates due to tight supply of insurance and a series of industry losses, many companies abandoned insurance altogether, but recently there has been a softening of the launch insurance market.[86] Terms have also become more restricted. Insurers do not generally quote premiums earlier than 12 months prior to a scheduled launch and in-orbit rates are usually limited to one-year terms. It is possible that insurance costs may go higher in the future, owing to the risk caused by the significant increase in space debris in recent years.[87]

With the advent of space tourism, the space insurance industry may expand to cover human spaceflight. In the United States, the FAA requires commercial human spacecraft operators to purchase third-party liability insurance, although additional coverage is optional. Each of the first two space tourists purchased policies for training, transportation, and time spent in space.[88]

2011 Development

Various companies continue to develop services for the commercial human spaceflight and space tourism markets

Virgin Galactic continued testing Space Ship Two and carrier White Knight Two, completing a sixth hot-fire test of a full-scale flight design rocket motor in March 2011, followed on 22 April 2011 with the longest test flight to date.[89] The milestone test, which took place over the Mojave Air and Space Port, lasted 14 minutes and 31 seconds.[90] Virgin Galactic also announced the selection of its first commercial astronaut pilot, USAF test pilot Keith Colmer, from a field of more than 500 applicants.[91]

Virgin Galactic entered into commercial contracts with Southwest Research Institute to allow scientists to conduct experiments during suborbital flights.[92] Although these are the first contracts of this kind for the company, it sees potential in offering researchers more frequent and less costly flights into space. Southwest Research Institute has also purchased space for scientists and experiments on XCOR Aerospace's two-seat Lynx space plane.[93]

Stratolaunch Systems chose Scaled Composites, a subsidiary of Northrop Grumman and the developer of SpaceShip One and White Knight (forerunners to the Virgin Galactic fleet), to develop an air launch system and the largest aircraft yet constructed.[94] The firm hopes that this Paul G. Allen project will lower the cost of access to space while increasing safety.

2011 Development

AISSata-1 improves AIS (Automatic Identification System) tracking

Norway launched its experimental AISSat-1 satellite to improve safety at sea.[95] The launch took place from India in September. Using a payload developed by Kongsberg Seatex AS and a Canadian satellite platform, space-based AIS such as AISSata-1 extends ship tracking beyond the current line of sight or 40 nautical miles of the shore-based AIS network.[96]

2011 Development

Full control regained over Intelsat's Galaxy 15 satellite

In January 2011 Intelsat was able to recover and move its Galaxy 15 satellite after its batteries drained completely and it experienced a full system shutdown.[97] Subsequently, ground commands directed a full reset maneuver, returning the satellite to sun-pointing status and allowing control to resume. This outcome matched Intelsat's original prediction, although it took longer to occur than anticipated. Serious signal interference and service interruption were avoided.[98] (For a detailed account of the Galaxy 15 malfunction, see *Space Security 2011,* Chapters 1, 2, and 5.)

2011 Development

Plans advance for on-orbit servicing of satellites

On 15 March 2011 Canada-based MacDonald Dettwiler and Associates Corporation (MDA) announced that it had entered into an agreement with Intelsat for the on-orbit servicing of Intelsat's satellites via a space-based service vehicle to be developed and provided by MDA.[99] Under the agreement, Intelsat would be the anchor tenant for MDA's Space Infrastructure Servicing (SIS) vehicle, expected to be in service as early as 2015.[100] Intelsat was to provide flight operations support for the life of the mission and invest approximately $280-million in the inaugural mission.[101]

The SIS vehicle was envisioned to act as a service station for commercial and government satellites, providing fuel, repositioning, and performing maintenance using robotics and docking technologies already in use.[102] The service vehicle, which would be fully robotic and controlled from the ground, would carry up to 2,000 kg of fuel in addition to various robotic tools to service satellites and extend their useful life by one to five years.[103] According to MDA, the SIS vehicle would be used, in addition to refueling, "to perform critical maintenance and repair tasks, such as releasing jammed deployable arrays and stabilizing or towing smaller space objects or debris."[104]

On 16 January 2012, however, Intelsat and MDA announced the cancellation of the agreement.[105] According to an Intelsat executive, "at the completion of the investigation stage, we determined that the project would end. We remain very interested in refueling and SIS, and will continue to explore potential solutions to refueling."[106] The main reason for the cancellation was reportedly a lack of commitment from prospective government and commercial customers to use SIS in the future.[107]

In a similar move, U.S. Space and ATK started ViviSat, a company developed to promote the Mission Extension Vehicle (MEV). The plan is for MEV to offer services to operators, including rendezvous and docking without interruption to operations of the client satellite, long-term station-keeping and attitude control, relocation of satellites to different orbital slots or to different orbits, de-orbiting satellites at the end of life, and rescue and re-orbiting of stranded satellites.[108]

Space Security Impact

Increased access to space affects space security both positively and negatively. As more entities, both governmental and private, are able to reach space, the benefits of the resource spread, ideally in an equalizing manner. However, increased access to space also translates into a more congested environment, making more urgent effective regulatory mechanisms for the allocation of scarce resources. The increasing number of private citizens with a vested interest in space security may yield a positive impact on space security. However, such access may challenge space security, both in terms of the sustainability of the space environment and in the applicability of international law to the largely uncharted realm of space tourism. Finally, although effects seem positive, it is too early to assess the full impact of on-orbit satellite servicing, which aims to extend the operational life of active satellites.

Indicator 5.3: Interactions between public and private sectors on space activities

Government Support

Governments have played an integral role in the development of the commercial space sector. Many spacefaring states consider their space systems to be an extension of critical national infrastructure, and a growing number view their space systems as inextricably linked to national security. Full state ownership of space systems has now given way to a mixed system in which many commercial space actors receive significant government and military contracts and a variety of subsidies. Certain sectors, such as remote sensing or commercial launch industries, rely more heavily on government clients, while the satellite communications industry is commercially sustainable without government contracts. Due to the security concerns associated with commercial space technologies, governments still play an active role in the sector through regulation, including export controls and controls on certain applications, such as Earth imaging.

The U.S. Space Launch Cost Reduction Act of 1998 established a low-interest loan program to support the development of reusable vehicles.[109] In 2002 the USAF requested $1-billion in subsidies for development of Lockheed Martin's Atlas-5 and Boeing's Delta-4 vehicles, under the Evolved Expendable Launch Vehicle (EELV) program.[110] The 2005 Space Transportation Policy required the DoD to pay the fixed costs to support both companies (since merged into the United Launch Alliance) until the end of the decade, rather than force price-driven competition.[111] A 2006 report commissioned by the FAA indicated that a successful U.S. commercial launch industry is viewed as "beneficial to national interests."[112] Also in 2006 NASA announced the Commercial Orbital Transportation Services (COTS) program, designed to coordinate the transportation of crews and cargo to the International Space Station by private companies.[113]

The U.S. Commercial Remote Sensing Space Policy directs the U.S. government to "rely to the maximum practical extent on U.S. commercial remote sensing space capabilities for filling imagery and geospatial needs for military, intelligence, foreign policy, homeland security, and civil users" to "advance and protect U.S. national security and foreign policy interests by maintaining the nation's leadership in remote sensing space activities, and by sustaining and enhancing the U.S. remote sensing industry."[114]

The European Guaranteed Access to Space Program adopted in 2003 requires that ESA underwrite the development costs of the Ariane-5, ensuring its competitiveness in the international launch market.[115] The program explicitly recognizes a competitive European launch industry as a strategic asset and is intended to ensure sustained government funding for launcher design and development, infrastructure maintenance, and upkeep.[116] The 2007 European Space Policy "emphasizes the vital importance for Europe to maintain an independent, reliable and cost-effective access to space at affordable conditions…bearing in mind that a critical mass of launcher activities is a precondition for the viability of this sector."[117]

Russia's commercial space sector maintains a close relationship with its government, receiving contracts and subsidies for the development of the Angara launcher and launch site maintenance.[118] China's space industry is indistinguishable from its government, with public and private institutions closely intertwined.[119] The industries responsible for supporting China's space program fall under the auspices of the China Aerospace Science and Technology Corporation (CASC), which is directly linked to the government.

In many instances, governments are partnering with the private sector to subsidize the commercial development of systems also intended to meet national needs. For example, the U.S. National Geospatial-Intelligence Agency's (NGA) NextView program included subsidies for commercial remote sensing to meet military needs for high-resolution images, which are then for sale commercially at a lower resolution.[120] The commercial Radarsat-2 satellite was largely paid for by the Canadian Space Agency, which spent $445-million to pre-purchase data that is also sold commercially.[121] This arrangement is similar to that for Germany's TerrSar-X remote sensing satellite.[122]

Remote sensing is not the only instance of such partnering. The U.K.'s Skynet-5 secure military communications satellite is operated by a private company, which sells its excess capacity.[123] However, partnering with the commercial sector often involves mixing national security considerations with private commercial interests. For instance, in 2008 the Canadian government intervened to block the sale of MacDonald, Dettwiler and Associates, maker of the Radarsat-2 satellite, to a U.S. firm, citing national interests.[124]

Export controls

National security concerns continue to play an important role in the commercial space industry, particularly through export controls. Trade restrictions aim to strike a balance between commercial development and the proliferation of sensitive technologies that could pose security threats. However, achieving that balance is not easy, particularly in an industry characterized by dual-use technology. Space launchers and intercontinental ballistic missiles use almost identical technology, and many civil and commercial satellites contain advanced capabilities with potential military applications. Dual-use concerns have led states to develop national and international export control regimes aimed at preventing proliferation.

The Missile Technology Control Regime, formed in 1987, is composed of 34 member states seeking to prevent the further proliferation of capabilities to deliver weapons of mass destruction by collaborating on a voluntary basis to coordinate the development and implementation of common export policy guidelines.[125] However, export practices differ among members. For example, although the U.S. "Iran Nonproliferation Act" of 2000 limited the transfer of ballistic missile technology to Iran, Russia's Federal Law on Export Control still allowed it.[126] Most states control the export of space-related goods through military and weapons-of-mass-destruction export control laws, such as the Export Control List in Canada, the Council Regulations (EC) 2432/2001 in the EU, Regulations of the People's Republic of China on Export Control of Missiles and Missile-related Items and Technologies, and the WMD Act in India.[127]

From the late 1980s to the late 1990s the United States had agreements with China, Russia, and Ukraine to enable the launch from foreign sites of U.S. satellites and satellites carrying U.S. components. In 1998 a U.S. investigation into several successive Chinese launch failures led to allegations that aerospace companies Hughes Electronics and Loral Space & Communications Ltd. were transferring sensitive U.S. technology to China. Concerns sparked the transfer of jurisdiction over satellite export licensing from the Commerce Department's Commerce Control List to the State Department's U.S. Munitions List (USML) in 1999.[128] In effect this placed satellite sales in the same category as weapons sales, making international collaborations more heavily regulated, expensive, and time consuming.

Exports of USML items are licensed under the ITAR regime, which adds several additional reporting and licensing requirements for U.S. satellite manufacturers. As a result of such stringent requirements, the case has been made that "the unintended impact of the regulation change has been that countries such as China, Pakistan, India, Russia, Canada, Australia, Brazil, France, the United Kingdom, Italy, Israel, the Republic of Korea, Ukraine, and Japan have grown their commercial space industries, while U.S. companies have seen dramatic losses in customers and market share."[129] Industries are maneuvering around ITAR restrictions by purchasing ITAR-free satellites and launch services. For instance, China was able to launch the Chinasat 6B telecommunications satellite, built by Thales Alenia Space, on its Long March launcher because the satellite was built without U.S. components. Thales Alenia Space is the only western company that has deliberately designed a product line to avoid U.S. trade restrictions on its satellite components.[130]

Finally, because certain commercial satellite imagery can serve military purposes, a number of states have implemented regulations on the sector. The 2003 U.S. Commercial Remote Sensing Policy set up a two-tiered licensing regime, limiting the sale of sensitive imagery.[131] In 2001 the French Ministry of Defense prohibited open sales of commercial Spot Image satellite imagery of Afghanistan.[132] Indian laws require the 'scrubbing' of commercial satellite images of sensitive Indian sites.[133] With the Remote Sensing Space Systems Act, which came

into force on 29 March 2007, Canada adopted a regulatory regime that gives the Canadian government "shutter control" over the collection and dissemination of commercial satellite imagery and priority access in the event of future major security crises.[134]

Commercial space systems as critical infrastructure

Space systems, including commercial systems, are increasingly considered to be critical national infrastructure and strategic assets. During the 1990s the U.S. military began employing commercial satellite systems for non-sensitive communications and imagery applications.

The U.S. DoD is the single largest customer for the satellite industry, although it accounts for less than 10 percent of the revenue of most large satellite operators.[135] By November 2003 it was estimated that the U.S. military was spending more than $400-million each year on commercial satellite services.[136] By 2006 this figure had jumped to more than $1-billion a year for commercial broadband satellite services alone.[137] For instance, three years after Operation Iraqi Freedom began, it was reported that more than 80 percent of satellite bandwidth utilized by DoD was provided by commercial broadband satellite operators.[138] A 2003 U.S. General Accounting Office report recommended that the U.S. military be more strategic in planning for and acquiring bandwidth by, inter alia, consolidating bandwidth needs among military actors to capitalize on bulk purchases.[139]

2011 Development

Hosted payloads gain traction

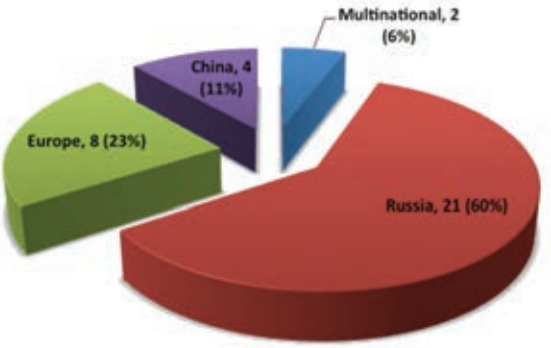
Hosted payloads are direct evidence of the increasing synergy between the public and private sectors. As more commercial and international satellites are able to take on a secondary payload and with the growing compatibility between commercial vehicles and DoD missions, hosted payloads are providing a cost-effective, flexible alternative for DoD capabilities deployment.[140] CHIRP (commercially hosted infrared payload), demonstrated in September 2011, is a good example as it supports next-generation infrared sensor system development, reduces technology risk, and is projected to achieve major savings.[141]

To facilitate the continued development of hosted payloads as a segment of business, seven major space companies formed the steering committee for a new organization, Hosted Payload Alliance.[142] The group is positioning itself to serve as a liaison between government and industry to discuss and resolve issues arising from hosted payloads on commercial satellites. Companies participating in the steering committee are Boeing Space and Intelligence Systems, Intelsat General Corp., Iridium Communications Inc., Lockheed Martin Space Systems, Orbital Sciences Corp., SES World Skies U.S. Government Solutions, and Space Systems/Loral.

The USAF is also expanding its use of hitching experimental government payloads to commercial satellites or launch vehicles.[143] The Space Test Program at Kirtland Air Force Base in New Mexico, which is responsible for setting up space launches for the experiments of a number of government agencies and has a stable budget of approximately $50-million, is considering hosted payloads as a viable option in launching its experiments.[144]

According to a request for information posted on the Federal Business Opportunities website, the USAF is interested in hosting multiple experiments on commercial missions planned for launch in 2012 or 2013.[145] Of the 73 experiments prioritized for launch by the Pentagon's Space Experiments Review Board, technical specifications have been provided for 15 that could be considered for commercial launches.[146]

Figure 5.3: Commercial payloads launched by country in 2011[147]



2011 Development

NASA awards contracts, funding to various commercial space companies

In January 2011 it was announced that NASA had increased its investment in the Commercial Orbital Transportation Services program, assigning cash payouts for the achievement of specific milestones related to logistical services being developed for the ISS.[148] SpaceX and Orbital Sciences, which will benefit from additional payouts for the development of cargo delivery systems, are set to split $300-million in COTS funding requested in the 2011 budget blueprint President Obama sent to lawmakers in February 2010.[149] The original SpaceX and Orbital COTS agreements are valued at $278-million and $170-million, respectively.[150]

At the time of the announcement SpaceX had already completed four milestones, worth $5-million each, that NASA established in December 2010. The milestones were: 1) a plan to test the effect of vibrations on pressurized cargo stowed inside the reusable spacecraft Dragon, 2) a demonstration of the test capability at the company's Hawthorne facility, 3) deploying Dragon's solar arrays and conducting thermal vacuum tests of some components, and 4) completing a ground simulation of the spacecraft's light detection and ranging (LIDAR) sensor, used for rendezvous and proximity operations with the ISS.[151]

SpaceX wanted to combine its second and third flight demonstrations after successfully completing the first. The third demo involves docking or berthing the Dragon capsule to the ISS for the first time. Russia, an ISS partner, emphasized that the decision to allow SpaceX's proposal was not NASA's alone to make.[152] Russia raised concerns related to the safety and reliability of the spacecraft. NASA countered by stating that all visiting vessels, including those owned by SpaceX and Orbital Sciences, would have to meet the same safety standards.

Orbital Sciences earned $20-million under the COTS agreement for completing a mission concept review related to the development of its Taurus 2 rocket and Cygnus spacecraft. In its COTS agreement with NASA, Orbital Sciences is slated to conduct a demonstration flight of Taurus 2 and Cygnus. Initially scheduled for 2011, the flight was delayed until 2012.[153]

On 5 January 2011 NASA announced that three companies participating in the Google Lunar X-Prize competition were among the six selected to participate in its Innovative Lunar Demonstration Data project.[154] The companies—Astrobotic Technology Inc. of Pittsburgh, Dynetics Inc. of Huntsville, Alabama, and Moon Express Inc. of Mountain View, California—will each receive $500,000 in data delivery orders for work on a commercial risk-reduction initiative for the development of robotic lander technologies.[155]

2011 Development

Australia invests in national broadband network

Australia is investing in a National Broadband Network in an effort to increase infrastructure connectivity.[156] On 6 May 2011 Gilat Satellite Networks Limited announced that it had been selected by Australian telecommunications company Optus Networks to provide a SkyEdge II VSAT network for the Australian Government's National Broadband Network Company's Interim Satellite Service.[157]

Gilat is to design, build, and operate the network for the National Broadband Network Company's Interim Satellite Service, which is expected to provide up to 6 Mb/s download and 1 Mb/s upload broadband services to all households and businesses through fiber, wireless, and satellite services. Under the terms of the contract, 11 SkyEdge II hubs and 20,000 SkyEdge II VSATs are to be deployed by Gilat over the next three years, with an option for more hubs and up to 48,000 VSATs.[158] The total contract value is estimated to be up to $120-million over five years.[159]

2011 Development

European Space Agency continues to scrutinize Arianespace finances

Despite pledges of new capital for Arianespace,[160] ESA continued its scrutiny of Arianespace's finances in 2011.[161] An audit was ordered by European governments as a condition of granting what was tantamount to a program of permanent financial aid.[162] The primary goal of the audit was to determine whether savings were possible for Arianespace and its contractors in rocket construction and operations. The results were to help ESA and its member states decide whether to continue with the status quo or allow Arianespace to relax or remove its geographic-return rule.[163] According to the rule, "the distribution of industrial contracts between the different countries by means of a programme is proportional to the financial contributions made by the individual countries to that programme."[164] This is a fundamental principle of ESA's industrial policy.

The audit concluded that, unless this rule were lifted, only marginal savings could be accomplished. The audit also determined that Arianespace's financial dilemma arose from conflicts of interests with companies that function as both suppliers to and shareholders of Arianespace. Other factors in Arianespace's financial difficulties include a global marketplace in which competitors' launchers benefit from their governments' financial support, the need to maintain competitive prices on the global market but which do not cover the production cost of the launchers, and the costs of production carried out in Europe and of the integration of components in French Guiana.[165]

Space Security Impact

The increased synergy between the public and private sectors has a positive impact on space security insofar as the concept of space security broadens to reflect the needs of the commercial sector as well as the national security of spacefaring states. However, the benefits of such partnerships could be offset by an increased reliance on commercial dual-use assets by the militaries of several countries. As this mutual dependence deepens, multiple-use spacecraft built by commercial operators could become military targets, resulting in an overall decrease in security. On the other hand, the proliferation of dual-use assets in space could make a military attack less useful and, therefore, less likely.