



Federal Aviation  
Administration

# COMMERCIAL SPACE TRANSPORTATION: 2011 YEAR IN REVIEW

January 2012

Sloan  
2012

HQ-121525-1100



### **About the Office of Commercial Space Transportation**

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-federal launch and reentry sites, as authorized by Executive Order 12465 and Title 51 United States Code, Subtitle V, Chapter 509 (formerly the Commercial Space Launch Act).

FAA/AST's mission is to ensure public health and safety and the safety of property while protecting the national security and foreign policy interests of the United States during commercial launch and reentry operations. In addition, FAA/AST is directed to encourage, facilitate, and promote commercial space launches and reentries. Additional information concerning commercial space transportation can be found on FAA/AST's web site at [http://www.faa.gov/about/office\\_org/headquarters\\_offices/ast/](http://www.faa.gov/about/office_org/headquarters_offices/ast/).

Cover: Art by John Sloan (2012)

#### **NOTICE**

Use of trade names or names of manufacturers in this document does not constitute an official endorsement of such products or manufacturers, either expressed or implied, by the Federal Aviation Administration.

# CONTENTS

|  |           |
|--|-----------|
| <b>Introduction</b> .....  | <b>1</b>  |
| <b>Executive Summary</b> .....                                     | <b>2</b>  |
| <b>2011 Launch Activity</b> .....                                  | <b>3</b>  |
| WORLDWIDE ORBITAL LAUNCH ACTIVITY .....                            | 3         |
| Worldwide Launch Revenues .....                                    | 5         |
| Worldwide Orbital Payload Summary .....                            | 5         |
| Commercial Launch Payload Summaries .....                          | 6         |
| Non-Commercial Launch Payload Summaries .....                      | 7         |
| U.S. AND FAA-LICENSED ORBITAL LAUNCH ACTIVITY .....                | 9         |
| FAA-Licensed Orbital Launch Summary .....                          | 9         |
| U.S. and FAA-Licensed Orbital Launch Activity in Detail .....      | 9         |
| FAA Reentry License Summary .....                                  | 12        |
| INTERNATIONAL ORBITAL LAUNCH ACTIVITIES .....                      | 12        |
| FAA SUBORBITAL FLIGHT SUMMARY .....                                | 15        |
| <b>2011 Space Transportation Trends</b> .....                      | <b>16</b> |
| FIVE-YEAR WORLDWIDE SPACE TRANSPORTATION TRENDS .....              | 16        |
| COMMERCIAL SATELLITE AND LAUNCH TRENDS .....                       | 18        |
| INTERNATIONALLY COMPETED LAUNCHES .....                            | 19        |
| <b>2012 Launch Activity Projection</b> .....                       | <b>20</b> |
| <b>Appendix I: 2011 Worldwide Orbital Launch Events</b> .....      | <b>22</b> |
| <b>Appendix II: 2012 Projected Worldwide Orbital Launch Events</b> | <b>26</b> |
| <b>Appendix III: Definitions</b> .....                             | <b>30</b> |

## INTRODUCTION

The *Commercial Space Transportation: 2011 Year in Review* summarizes U.S. and international launch activities for calendar year 2011. This report also provides a review and analysis of the past five years of commercial launch activity.

There were 84 orbital launch events worldwide in 2011, including commercial, civil, and military missions. Appendix I contains the details of these events. Appendix II details the first six-month projection of worldwide orbital launches for 2012.

The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) licensed one commercial orbital launch in 2011, compared to four licensed launches in 2010. The license was for the launch of Sea Launch AG's Zenit 3SL rocket in September.

Appendix III provides definitions for the terminology of this report.

## EXECUTIVE SUMMARY

Of the 84 worldwide orbital launch attempts in 2011, 18 (21 percent) were commercial. This is a decrease in commercial launches from 2010, when there were 23 commercial orbital launches worldwide out of a total of 74 launches (see Figure 1). Much of this decrease stems from the fact that none of the vehicles

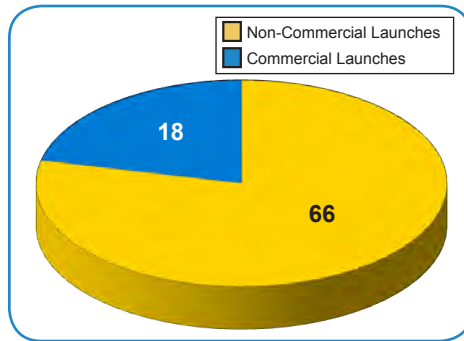


Figure 1. 2011 Total Worldwide Launch Activity

manufactured by the United States had any commercial launches in 2011. Four commercial launches planned for 2011 under NASA's Commercial Resupply Services (CRS) and Commercial Orbital Transportation Services (COTS) programs were delayed until 2012.

Russia had 56 percent of the international commercial launch market with 10 commercial launches in 2011. Sea Launch AG had two commercial launches accounting for 11 percent of

the commercial launch market. The return-to-flight launch from the Pacific Ocean was the only FAA/AST-licensed orbital launch this year. Sea Launch carried out its second launch out of Baikonur, Kazakhstan as part of the Land Launch program. Europe attained a 22 percent market share, conducting four commercial Ariane 5 launches. China had two commercial launches of its Long March 3B vehicle, attaining 11 percent of the international commercial market.

Of the 84 orbital launches attempted worldwide, 6 were failures, including 1 failed commercial launch. Four of the failures were Russian launches on three different launch vehicles:

- A Rockot launch vehicle failed to place the GEO IK-2 No. II remote sensing satellite in low Earth orbit (LEO) on February 1.
- A Proton M launch vehicle failed to put the Express AM4 into geosynchronous orbit (GEO) on August 17 (this was the commercial launch failure in 2011).
- A Soyuz launch vehicle failed to carry the Progress M-12M supply capsule to the International Space Station (ISS) on August 24.
- A Soyuz 2 1B launch vehicle failed to launch the Meridian 5 communications satellite to a Molniya orbit on December 23.

The United States and China each experienced one launch failure in 2011. A Taurus XL vehicle failed to launch NASA's Earth science satellite, Glory, and three university satellites on March 4. On August 18, a Long March 2C failed to place China's Shijian 11-04 experimental satellite into sun-synchronous orbit (SSO).

Two suborbital flights were conducted under FAA permits in 2011. Both were conducted by Blue Origin, using the PM-2 vehicle.

# 2011 LAUNCH ACTIVITY

## WORLDWIDE ORBITAL LAUNCH ACTIVITY

This section highlights worldwide launch activity in 2011. Launches, payloads, and revenue streams are on a country-by-country basis. Launch providers from the United States, Russia, Europe, China, Japan, India, Iran, and one multinational provider conducted a total of 84 launch events in 2011, 18 of which were commercial (see Tables 1 and 2 and Figures 2 and 3). The following is a summary of all the 2011 worldwide commercial launches by country:

|               | Commercial Launches | Non-Commercial Launches | Total Launches |
|---------------|---------------------|-------------------------|----------------|
| United States | 0                   | 18                      | 18             |
| Russia        | 10                  | 21                      | 31             |
| Europe        | 4                   | 3                       | 7              |
| China         | 2                   | 17                      | 19             |
| Japan         | 0                   | 3                       | 3              |
| India         | 0                   | 3                       | 3              |
| Iran          | 0                   | 1                       | 1              |
| Multinational | 2                   | 0                       | 2              |
| <b>TOTAL</b>  | <b>18</b>           | <b>66</b>               | <b>84</b>      |

Table 1. 2011 Worldwide Orbital Launch Events

- The United States had 18 launches, 3 more than in 2010, but no commercial launches.
- Russia led in both total orbital (31) and commercial launches (10). Russia also experienced the highest number of failures (4). One failure was for a commercial launch.
- Europe conducted seven launches in 2011, four of which were commercial launches. The first two Soyuz 2 launches from French Guiana happened in 2011.
- China had 19 launches, 2 of which were commercial. China did not conduct any commercial launches in 2010.
- The multinational Sea Launch Zenit 3SL launch vehicle returned to flight in September. The company had two commercial launches, one FAA-licensed launch from a platform in the Pacific Ocean and the other from Baikonur, Kazakhstan as part of the Land Launch program.

Appendix I shows all 84 orbital launches worldwide in 2011, including commercial, civil, and military missions.

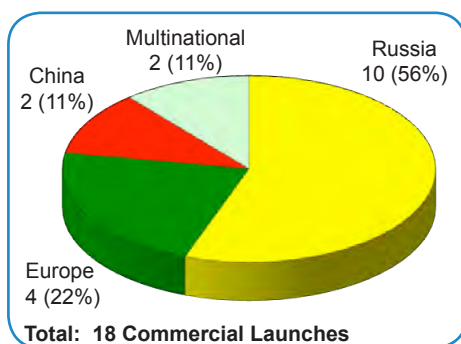


Figure 2. 2011 Worldwide Commercial Launch Activity

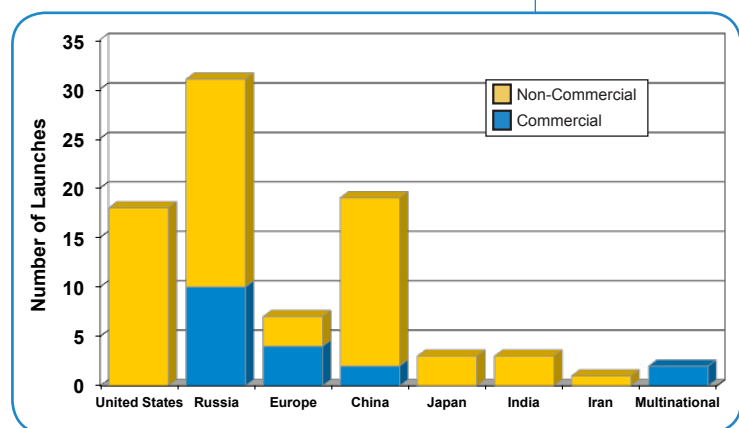


Figure 3. 2011 Total Worldwide Launch Activity

| Date      | Vehicle       | Launching Country/Region | Payload(s)   | Orbit  | Launch Outcome   |
|-----------|---------------|--------------------------|--|--|--|
| 22-Apr-11 | Ariane 5 ECA  | Europe                   | Yahsat 1A<br>Intelsat New Dawn   | GEO<br>GEO   | Success<br>Success   |
| 20-May-11 | Proton M      | Russia                   | Telstar 14R  | GEO  | Success  |
| 20-May-11 | Ariane 5 ECA  | Europe                   | Insat 4G/GSAT-8<br>ST 2  | GEO<br>GEO   | Success<br>Success   |
| 13-Jul-11 | Soyuz 2       | Russia                   | Globalstar 2nd Gen 07<br>Globalstar 2nd Gen 08<br>Globalstar 2nd Gen 09<br>Globalstar 2nd Gen 10<br>Globalstar 2nd Gen 11<br>Globalstar 2nd Gen 12 | NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO                 | Success<br>Success<br>Success<br>Success<br>Success<br>Success                       |
| 15-Jul-11 | Proton M      | Russia                   | SES-3<br>KazSat 2  | GEO<br>GEO   | Success<br>Success   |
| 06-Aug-11 | Ariane 5 ECA  | Europe                   | Astra 1N<br>BSAT-3c/JCSAT-110R   | GEO<br>GEO   | Success<br>Success   |
| 17-Aug-11 | Dnepr M       | Russia                   | Sich 2<br>NX<br>Nigeriasat 2<br>Edusat<br>RASAT<br>BPA 2<br>Aprizesat 5<br>Aprizesat 6   | NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO | Success<br>Success<br>Success<br>Success<br>Success<br>Success<br>Success<br>Success |
| 17-Aug-11 | Proton M      | Russia                   | Express AM4  | GEO  | Failure  |
| 21-Sep-11 | Ariane 5 ECA  | Europe                   | Arabsat 5C<br>SES-2  | GEO<br>GEO   | Success<br>Success   |
| 24-Sep-11 | Zenit 3SL     | Multinational            | Atlantic Bird 7  | GEO  | Success  |
| 29-Sep-11 | Proton M      | Russia                   | QuetzSat-1   | GEO  | Success  |
| 06-Oct-11 | Zenit 3SL     | Multinational            | Intelsat 18  | GEO  | Success  |
| 07-Oct-11 | Long March 3B | China                    | Eutelsat W3C   | GEO  | Success  |
| 19-Oct-11 | Proton M      | Russia                   | Viasat 1   | GEO  | Success  |
| 25-Nov-11 | Proton M      | Russia                   | Asiasat 7  | GEO  | Success  |
| 11-Dec-11 | Proton M      | Russia                   | Luch 5A<br>Amos 5  | GEO<br>GEO   | Success<br>Success   |
| 19-Dec-11 | Long March 3B | China                    | NigComSat 1R   | GEO  | Success  |
| 28-Dec-11 | Soyuz 2       | Russia                   | Globalstar 2nd Gen 13<br>Globalstar 2nd Gen 14<br>Globalstar 2nd Gen 15<br>Globalstar 2nd Gen 16<br>Globalstar 2nd Gen 17<br>Globalstar 2nd Gen 18 | NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO<br>NGSO                 | Success<br>Success<br>Success<br>Success<br>Success<br>Success                       |

Table 2. 2011 Worldwide Commercial Launch Events



## Worldwide Launch Revenues

Revenues from the 18 commercial launch events in 2011 amount to an estimated \$1.9 billion, a decrease of \$526 million from 2010 (see Figure 4). The following are the revenues by country:

- The United States did not generate any commercial launch revenue.
- Russian commercial launch revenues were approximately \$707 million.
- European revenues were approximately \$880 million.
- Chinese revenues were approximately \$140 million.
- Multinational revenues were approximately \$200 million.

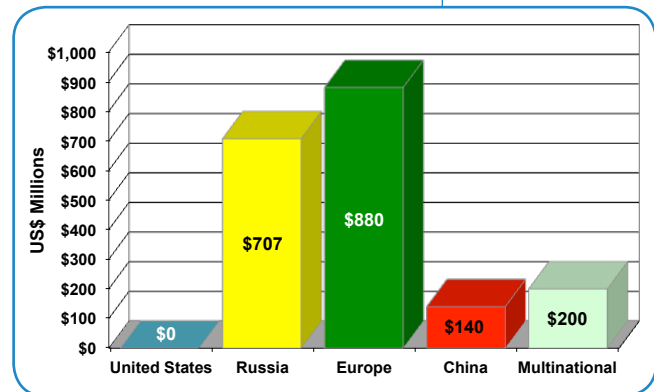


Figure 4. Approximate 2011 Commercial Launch Revenues

Payments for launch services typically are spread over one to two years before the launch. For the purposes of this report, revenue is in the year a customer's payload launches. Launch revenues go to the country of the primary vehicle manufacturer. The assessment of these revenues uses commercial launch price estimates for each launch vehicle, from publically available information.

Most launch vehicles today are manufactured, sold, and launched by the same organization entirely in one country or, in the case of Europe and the former Soviet Union,<sup>1</sup> within a particular economic region. At present, there is one launch service corporation, Sea Launch, that is characterized as multinational.

## Worldwide Orbital Payload Summary

|               | Commercial Payloads | Non-Commercial Payloads | Total Payloads |
|---------------|---------------------|-------------------------|----------------|
| United States | 0                   | 28                      | 28             |
| Russia        | 21                  | 32                      | 53             |
| Europe        | 8                   | 9                       | 17             |
| China         | 4                   | 17                      | 21             |
| Japan         | 0                   | 3                       | 3              |
| India         | 0                   | 8                       | 8              |
| Iran          | 0                   | 1                       | 1              |
| Multinational | 2                   | 0                       | 2              |
| <b>TOTAL</b>  | <b>35</b>           | <b>98</b>               | <b>133</b>     |

Table 3. Payloads Launched by Country in 2011

In 2011, 84 launches carried a total of 133 payloads into orbit (see Table 3 and Figures 5 and 6). Of the 133 payloads, 35 provide commercial services (see Figure 7 for these payloads by launch country). The remaining 98 payloads were used for non-commercial civil government, military, or non-profit purposes.

<sup>1</sup> International Launch Services (ILS) and Arianespace constitute an exception. ILS is a Russian-owned company incorporated in the U.S. and selling launches of the Russian Proton vehicles. Arianespace markets launches of a Russian-manufactured Soyuz 2 type launch vehicle from the Kourou launch site in French Guiana.

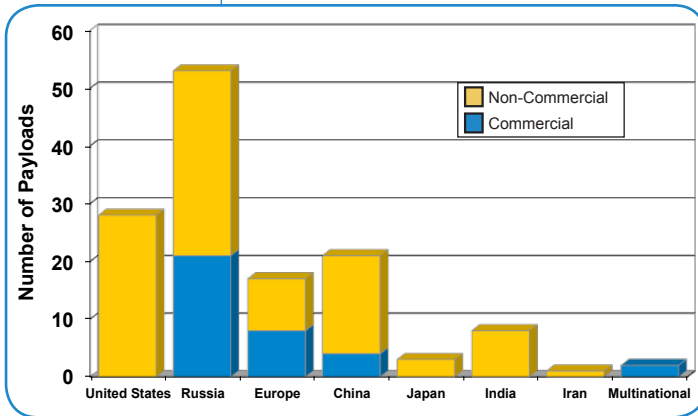


Figure 5. 2011 Total Worldwide Launch Activity by Payload

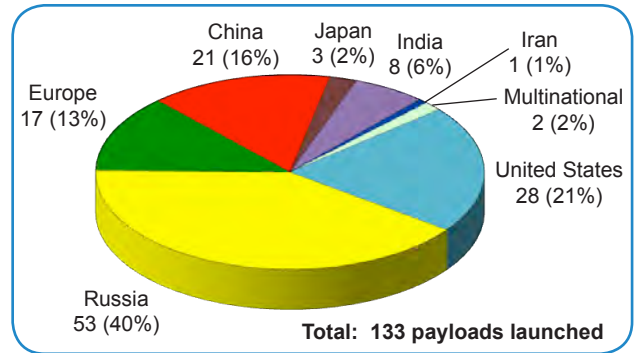


Figure 6. Total Payloads Launched by Country in 2011

### Commercial Launch Payload Summaries

Eighteen commercial launches carried a total of 41 commercial and non-commercial payloads into orbit. Thirty-five of the payloads were communications satellites; only two of those satellites were government communications satellites, and the rest were commercial communications satellites.

Eight payloads were for civil government purposes. Government payloads are often remote sensing or science satellites. See Table 4 for a summary of government payloads launched commercially.

| Launch Vehicle | Payload      | Service Type | Use            |
|----------------|--------------|--------------|----------------|
| Proton M       | KazSat 2     | Civil        | Communications |
| Dnepr          | Sich 2       | Civil        | Remote Sensing |
|                | NX           | Civil        | Remote Sensing |
|                | Nigeriasat 2 | Civil        | Remote Sensing |
|                | Edusat       | Civil        | Science        |
|                | RASAT        | Civil        | Science        |
|                | BPA 2        | Civil        | Development    |
| Proton M       | Luch 5A      | Civil        | Communications |

Table 4. Commercially Launched Government Civil Payloads

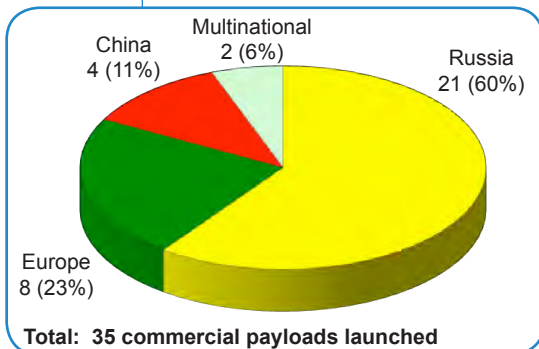


Figure 7. Commercial Payloads Launched by Country in 2011

Twenty of these 41 commercially launched payloads are non-geosynchronous orbit (NGSO) satellites, and 21 are GEO satellites. See Table 2 (p. 4) for which payloads are launched to NGSO or GEO orbit.

Seventeen of the 18 commercial launches were successful. On August 17, the Proton M launch vehicle failed to launch the Express AM4 Russian communications satellite to GEO.

## Non-Commercial Launch Payload Summaries

In 2011, there were 66 non-commercial launches carrying a total of 92 commercial and non-commercial payloads. Two of these payloads were commercial communications satellites: Chinasat 10 and Paksat 1R. The remaining 90 payloads were for civil government, military, or non-profit use (see Figure 8).

Table 5 provides a list of non-commercial payloads launched for civil government, military, or non-profit use, including:

- Forty-six payloads launched non-commercially for civil government purposes.
- Thirty-four payloads were for military use.
- Ten payloads launched non-commercially for non-profit missions.

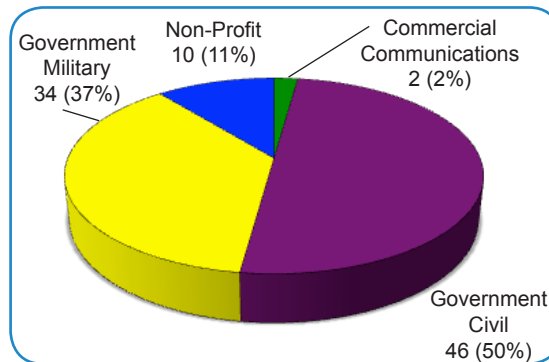


Figure 8. Payloads by Service Type Deployed By Non-Commercial Launches

| Country       | Service Type   | Payload(s)  |
|---------------|----------------|---|
| United States | Civil (10)     | 3 Space Shuttle missions (STS-133, 134, and 135); Glory; SAC-D/Aquarius; Juno; GRAIL A and B; NPP; and MSL  |
|               | Military (9)   | NRO L-27, L-34, L-49, and L-66; X-37B OTV 2; SBIRS GEO 1; ORS 1; Navstar GPS 2F-02; and TacSat 4  |
|               | Non-Profit (9) | Kysat 1; Hermes; Explorer 1 (PRIME); RAX; M-Cubed; AS-1; Explorer 1 (PRIME) Unit 2; DICE 1 and 2  |
| Russia        | Civil (12)     | Electro-L N1; Progress M-09M, -10M, -11M, 12M, -13M; Soyuz TMA-02M, -03M, -21, -22; Spektr R; and Phobos-Grunt                                    |
|               | Military (11)  | Cosmos 2472 and 2473; Glonass KI-1; Glonass M42, M43, M44, M45, and M46; Meridian 4 and 5; and GEO IK-2 No. II                                    |
| Europe        | Civil (4)      | ATV2; Galileo 1 and 2; and Pleiades HR 1  |
|               | Military (5)   | ELISA 1 through 4; and SSOT   |
| China         | Civil (12)     | Shijian 11-02, -03, and -04; Tianlian-1B; HY-2A; Tiangong 1; Shenzhou 8; Chuang Xing 1-03; Ziyuan 1-2C; Yinghuo-1; Shiyao Wexing 4; and Tianxun 1 |
|               | Military (6)   | Beidou 2 IGS 3, 4, and 5; Chinasat 1A; Yaogan 12 and 13   |
| Japan         | Civil (1)      | HTV-2   |
|               | Military (2)   | IGS-4C (Optical) and IGS-4B (Radar)   |
| India         | Civil (7)      | X-Sat; Resourcesat 2; GSAT 12; Jugnu; SRMSAT; Vesslesat 1; and Megha Tropiques  |
|               | Non-Profit (1) | Youthsat  |
| Iran          | Military (1)   | Rasad 1   |

Table 5. Payloads Launched Non-Commercially by Service Type

Sixty-one non-commercial launches were successful. The following five non-commercial launches failed:

- A Rockot launch vehicle carrying the GEO IK-2 No. II, a Russian SSO geodetic satellite, failed on February 1.
- A Taurus XL launch vehicle failed to launch NASA's Glory scientific satellite, along with the Kaysat 1, Hermes, and Explorer 1 (PRIME) satellites, on March 4.
- The Long March 2C launch carrying Shijian 11-04, a Chinese scientific SSO satellite, failed on August 18.
- A Soyuz launch vehicle failed to deliver the Progress M-12M cargo payload to the ISS on August 24.
- A Soyuz 2 launch vehicle failed to launch the Meridian 5 communications satellite on December 23.

## U.S. AND FAA-LICENSED ORBITAL LAUNCH ACTIVITY

### FAA-Licensed Orbital Launch Summary

There was one FAA-licensed launch in 2011: one of the total of two commercial launches conducted by multinational launch provider Sea Launch was a Zenit 3SL launch vehicle carrying the Atlantic Bird 7 communications satellite to GEO (see Table 6).

| Date      | Vehicle   | Primary Payload | Orbit | Launch Outcome |
|-----------|-----------|-----------------|-------|----------------|
| 24-Sep-11 | Zenit 3SL | Atlantic Bird 7 | GEO   | Success        |

Table 6. 2011 FAA-Licensed Orbital Launch Events

In 2011, FAA planned to license four commercial launches under NASA's COTS and CRS programs, but all four of those launches slipped to 2012.

Over the past five years, FAA has typically licensed four or five launches per year. However, in 2008, FAA licensed 11 launches, including 5 Sea Launch Zenit 3SL launches of commercial GEO communications satellites. Figures 9 and 10 summarize the number of FAA-licensed orbital launches and revenue from 2007-2011.

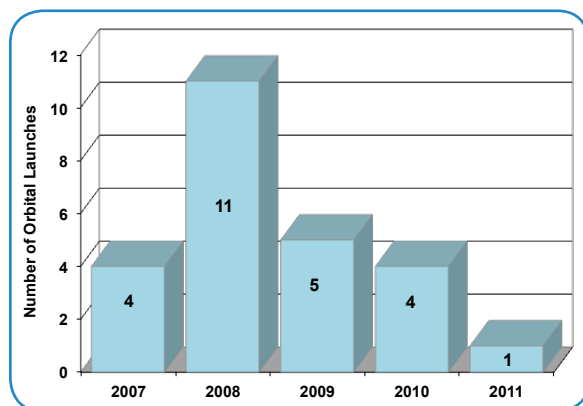


Figure 9. FAA-Licensed Orbital Launch Events, 2007-2011

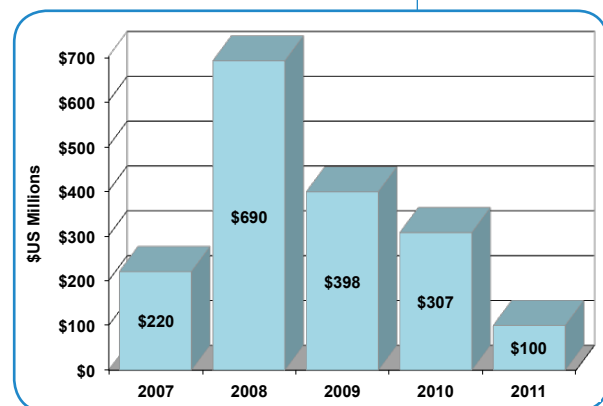


Figure 10. Estimated Revenue for FAA-Licensed Orbital Launch Events, 2007-2011

### U.S. and FAA-Licensed Orbital Launch Activity in Detail

U.S. launch vehicles provided 18 U.S. government launches in 2011. Nine of the launches were for NASA: three Space Shuttle missions and six science missions. The launch of one of the science missions, Glory, resulted in a failure. The U.S. Department of Defense (DoD) also had nine launches: four carried classified National Reconnaissance Office (NRO) payloads and five carried DoD or DoD-sponsored payloads.

See Table 7 for a detailed breakdown of U.S. and FAA-licensed launch activity during 2011 by vehicle.

| UNITED STATES                      |                |                  |                  |                   |                        |                    |                   |                   |                   |                   |                    | SEA LAUNCH          |
|------------------------------------|----------------|------------------|------------------|-------------------|------------------------|--------------------|-------------------|-------------------|-------------------|-------------------|--------------------|---------------------|
| Vehicle                            | Minotaur       | Minotaur IV      | Taurus XL        | Delta II          | Delta IV Medium+ (4,2) | Delta IV Heavy     | Atlas V 401       | Atlas V 501       | Atlas V 541       | Atlas V 551       | Shuttle            | Zenit 3SL           |
| 2011 Total Launches                | 2              | 1                | 1                | 3                 | 2                      | 1                  | 2                 | 1                 | 1                 | 1                 | 3                  | 1                   |
| 2011 Licensed Launches             | 0              | 0                | 0                | 0                 | 0                      | 0                  | 0                 | 0                 | 0                 | 0                 | 0                  | 1                   |
| Launch Reliability (2011)          | 2/2<br>100%    | 1/1<br>100%      | 0/1<br>0%        | 3/3<br>100%       | 2/2<br>100%            | 1/1<br>100%        | 2/2<br>100%       | 1/1<br>100%       | 1/1<br>100%       | 1/1<br>100%       | 3/3<br>100%        | 1/1<br>100%         |
| Launch Reliability (Last 10 Years) | 8/8<br>100%    | 3/3<br>100%      | 1/3<br>33%       | 20/20<br>100%     | 7/7<br>100%            | 5/5<br>100%        | 12/12<br>100%     | 3/3<br>100%       | 1/1<br>100%       | 2/2<br>100%       | 34/34<br>100%      | 23/24<br>(96%)      |
| Year of First Launch               | 2000           | 2010             | 2004             | 1995              | 2002                   | 2004               | 2002              | 2010              | 2011              | 2006              | 1981               | 1999                |
| Active Launch Sites                | VAFB, Wallops  | VAFB, Kodiak     | CCAFS, VAFB      | CCAFS, VAFB       | CCAFS, VAFB            | CCAFS, VAFB        | CCAFS, VAFB       | CCAFS, VAFB       | CCAFS             | CCAFS             | KSC                | Sea Launch Platform |
| LEO kg (lbs)                       | 640<br>(1,411) | 1,735<br>(3,822) | 1,588<br>(3,500) | 6,100<br>(13,440) | 10,430<br>(22,974)     | 22,560<br>(49,740) | 9,797<br>(21,598) | 8,123<br>(17,908) | --                | --                | 23,435<br>(51,557) | 15,876<br>(35,000)  |
| GTO kg (lbs)                       | --             | --               | 517<br>(1,140)   | 1,270<br>(2,800)  | 5,845<br>(12,874)      | 12,980<br>(28,620) | 4,750<br>(10,470) | 3,775<br>(8,320)  | 7,980<br>(17,593) | 8,670<br>(19,114) | 5,663<br>(12,459)  | 6,100<br>(13,448)   |

Table 7. U.S. and FAA-Licensed Launch Vehicle Performance in 2011

The following is a list of U.S.-based launch service providers, highlighting their launch activity in 2011. It includes all companies that launch from the United States or under the regulatory oversight of the FAA/AST.

**Orbital Sciences Corporation**

Orbital provides the Minotaur, Pegasus, and Taurus vehicles for orbital launch.

Orbital performed four launches in 2011, using the Minotaur I, Minotaur IV, and Taurus XL vehicles. In February, a Minotaur I launched NRO L-66 from Vandenberg Air Force Base (VAFB). In March, a Taurus XL attempted to launch NASA’s Earth science satellite, Glory, into orbit from VAFB; this launch attempt resulted in a failure. In June, another Minotaur I successfully launched ORS 1. In September, a Minotaur IV launched a technology development satellite, TacSat 4.

### **United Launch Alliance**

United Launch Alliance (ULA) conducts launches for the U.S. government launch market. ULA manufactures and operates Boeing-heritage Delta and Lockheed Martin-heritage Atlas launch vehicles. ULA is a 50-50 joint partnership between Boeing and Lockheed Martin.

In 2011, ULA conducted 11 non-commercial launches:

- Three Delta II launches placed these payloads into orbit: SAC-D/Aquarius, GRAIL A and B, and NPP.
- Three Delta IV launches placed these payloads into orbit: NRO L-49, NRO L-27, and Navstar GPS 2F-02.
- Five Atlas V launches placed these payloads into orbit: X-37B OTV 2, NRO L-34, SBIRS GEO 1, Juno, and MSL.

### **United Space Alliance**

United Space Alliance (USA) is the launch services company for non-commercial NASA Space Shuttle missions. Like ULA, USA is jointly owned by Boeing and Lockheed Martin.

USA conducted three successful Space Shuttle launches from the Kennedy Space Center in 2011. Space Shuttles Atlantis, Endeavour, and Discovery assisted in completing the construction of the ISS. These launches concluded the Space Shuttle program, and the Space Shuttle fleet is now retired.

The five Space Shuttle vehicles—Atlantis, Challenger, Columbia, Discovery, and Endeavour—have completed a total of 135 missions.

- Thirty-seven of these missions flew to the ISS and nine to the Russian Mir space station.
- The Shuttle orbiters hosted more than 2,000 scientific experiments and deployed a total of 180 payloads, including satellites and missions to Venus, Jupiter, and the Sun.
- The Shuttles deployed 20 commercial satellites and returned 52 payloads from space.
- Seven spacecraft were retrieved, repaired, and redeployed, including the Hubble Space Telescope.
- Two missions involved accidents, leading to the loss of the Challenger and Columbia orbiters and their crews.

### **Sea Launch**

The only FAA-licensed commercial orbital launch in 2011 was conducted by multinational launch provider Sea Launch. Its Zenit 3SL launch vehicle inserted the Atlantic Bird 7 communications satellite into GEO. The vehicle launched from Sea Launch's Odyssey platform in the Pacific Ocean. It was the first launch

conducted by Sea Launch after company reorganization and emerging from Chapter 11 bankruptcy protection procedure as a Swiss-based Russian majority-owned company. The total price of the launch is estimated at \$100 million. 2011 also saw one successful launch of the Land Launch system from Baikonur, Kazakhstan, operated by Sea Launch. It deployed the Intelsat 18 commercial GEO communications satellite.

### FAA Reentry License Summary

In 2011, there were no reentries conducted under an FAA reentry license. The NASA COTS and CRS missions in 2012 expect to use FAA reentry licenses.

### INTERNATIONAL ORBITAL LAUNCH ACTIVITIES

The following section highlights non-U.S. launch activity on a country-by-country basis.

#### Russia

In 2011, there were 31 Russian launches. Twenty-seven of these launches were successful, and four failed. Ten launches were commercial, and 21 were non-commercial launches. Of the non-commercial launches, nine were missions to the ISS, nine were for military purposes, and three were civil government missions. Table 8 and the lists below present a detailed breakdown of 2011 Russian launch activity by vehicle.









| RUSSIA                             |   |   |   |  |   |   |   |   |
|------------------------------------|---|---|---|--|---|---|---|---|
| Vehicle                            |  |  |  |  |  |  |  |  |
| 2011 Total Launches                | 1   | 1   | 1   | 2  | 9   | 7   | 1   | 9   |
| Launch Reliability (2011)          | 1/1<br>100%   | 0/1<br>0%   | 1/1<br>100%   | 2/2<br>100%  | 8/9<br>89%  | 6/7<br>86%  | 1/1<br>100%   | 8/9<br>89%  |
| Launch Reliability (Last 10 Years) | 4/4<br>100%   | 12/14<br>86%  | 2/2<br>100%   | 2/2<br>100%  | 95/97<br>98%  | 15/16<br>94%  | 3/3<br>100%   | 51/56<br>91%  |
| Year of First Launch               | 2010  | 1994  | 2007  | 2011   | 1963  | 2004  | 2009  | 2000  |
| Active Launch Sites                | Baikonur  | Baikonur, Plesetsk  | Baikonur  | Baikonur   | Baikonur, Plesetsk  | Baikonur, Plesetsk  | Plesetsk  | Baikonur  |
| LEO kg (lbs)                       | 4,100<br>(9,030)  | 1,850<br>(4,075)  | 12,030<br>(26,500)  | --   | 6,708<br>(14,758)   | 7,800<br>(17,100)   | 6,700<br>(14,740)   | 21,000<br>(46,305)  |
| GTO kg (lbs)                       | --  | --  | --  | 2,500<br>(5,500)   | 1,350<br>(2,975)  | 1,700<br>(3,800)  | --  | 5,500<br>(12,125)   |

Table 8. Russian Launch Vehicle Activity in 2011



The 10 commercial missions included:

- ILS launched seven Proton M vehicles, carrying a total of nine satellites. The Proton M carrying the Express AM-4 failed.
- ISC Kosmostras launched one Dnepr rocket, carrying a total of eight satellites.
- Two Soyuz 2 launches deployed 12 Globalstar 2 satellites.

The following nine launches were dedicated ISS missions:

- Five Soyuz rockets carrying Progress spacecraft. The Soyuz mission in August failed.
- Four Soyuz vehicles carrying manned Soyuz spacecraft ferried individuals to and from the ISS.

Russia executed nine additional launches for military purposes:

- A Rockot vehicle failed to launch GEO IK-2 No. II.
- Five Soyuz 2 rockets launched Glonass K1-1, Meridian 4, Glonass M42, Glonass M46, and Meridian 5. The launch of Meridian 5 was unsuccessful.
- A Soyuz U launched Cosmos 2472.
- Two Proton M vehicles launched Cosmos 2473 and Glonass M43 through M45.

Russia executed three launches for civil purposes:

- Two Zenit 3F launches carried Electro-L 1 and Spetkr R satellites.
- A Zenit 2M launched the co-manifested Phobos-Grunt (a mission to return ground samples from Mars' moon Phobos) and Yinghuo 1 satellites. The launch vehicle performed successfully, although the payloads subsequently failed to leave their initial Earth orbit.

## **Europe**

Europe conducted seven launches in 2011:

- Four Ariane 5 launch vehicles launched eight GEO commercial satellites. All four commercial Ariane 5 launches were dual manifests of GEO communications satellites.
- An Ariane 5 ES-ATV launched ATV 2 to the ISS.
- A Soyuz 2, carrying two Galileo satellites, launched from the European launch complex in Kourou, French Guiana. This was the first Soyuz 2 launch from that complex.
- The second Soyuz 2 launch from Kourou carried the Pleiades HR 1 remote sensing mission, four ELISA satellites for the French Ministry of Defense, and SSOT for the Government of Chile.

## **China**

China conducted 19 orbital launches in 2011 (4 more than in 2010), of which 2 were commercial. All but one of the launches were successful. Nine of the launches were to GEO. Eleven launched from the Xichang launch site, seven from Jiuquan, and one from the Taiyuan launch site.

- A Long March 2C rocket failed to place an experimental satellite, Shijian 11-04, into orbit.
- Two Long March vehicles carried commercial payloads: Eutelsat 1R and NigComSat 1R.
- Long March vehicles launched four communications missions, including one satellite for Pakistan and one in a dual manifest with a scientific payload.
- Three navigation satellites were launched.
- Four remote sensing payloads were deployed.
- Long March rockets placed five development and scientific payloads into orbit, including one in a dual manifest with a communications satellite.

## **Japan**

Japan had one successful H IIB launch and two successful launches of the H IIA rocket in 2011.

- H IIB launched an HTV 2 transport mission to the ISS.
- Two H IIA vehicles launched two IGS intelligence satellites.

## **India**

The Indian Space Research Organization (ISRO) performed three PSLV launches in 2011. All launches were non-commercial.

- The GSAT-12 communications satellite was inserted into GEO in July.
- Two PSLV launches deployed seven scientific, remote sensing, and communications satellites in LEO and SSO in April and October.

## **Iran**

Iran's Safir 2 rocket launched Rasad, a remote sensing satellite, on June 15.

## **Multinational**

Multinational launch provider Sea Launch AG had two commercial launches in 2011. In September, Zenit 3SL deployed Atlantic Bird 7. This launch was performed under an FAA commercial launch license (see Page 9). In October, Zenit 3SLB, a launch vehicle operated by Sea Launch, successfully launched Intelsat 18 from Baikonur, Kazakhstan.

Table 9 summarizes 2011 launch activities for Europe, China, Japan, India, and Iran, and the multinational category represented by Sea Launch AG.
















|                                    | EUROPE  |   |   | CHINA   |   |   |   |   |   |  | JAPAN   |   | INDIA   | IRAN  | LAND LAUNCH   |
|------------------------------------|---|---|---|---|---|---|---|---|---|--|---|---|---|---|---|
|                                    |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Vehicle                            | Ariane 5 ECA  | Ariane 5 ES-ATV   | Soyuz 2   | Long March 2C   | Long March 2D   | Long March 2F   | Long March 3A   | Long March 3B   | Long March 3C   | Long March 4B  | H IIA   | H IIB   | PSLV  | Safir 2   | Zenit 3SLB  |
| Country/Region                     | Europe  | Europe  | Europe  | China   | China   | China   | China   | China   | China   | China  | Japan   | Japan   | India   | Iran  | Ukraine   |
| 2011 Total Launches                | 4   | 1   | 2   | 3   | 2   | 2   | 3   | 5   | 1   | 3  | 2   | 1   | 3   | 1   | 1   |
| Launch Reliability (2011)          | 4/4<br>100%   | 1/1<br>100%   | 2/2<br>100%   | 2/3<br>67%  | 2/2<br>100%   | 2/2<br>100%   | 3/3<br>100%   | 5/5<br>100%   | 1/1<br>100%   | 3/3<br>100%  | 2/2<br>100%   | 1/1<br>100%   | 3/3<br>100%   | 1/1<br>100%   | 1/1<br>100%   |
| Launch Reliability (Last 10 Years) | 32/33<br>97%  | 2/2<br>100%   | 2/2<br>100%   | 14/15<br>93%  | 12/12<br>100%   | 8/8<br>100%   | 16/16<br>100%   | 13/13<br>100%   | 7/7<br>100%   | 14/14<br>100%  | 19/20<br>95%  | 2/2<br>100%   | 15/15<br>100%   | 2/2<br>100%   | 5/5<br>100%   |
| Year of First Launch               | 2002  | 2008  | 2011  | 1975  | 1992  | 1999  | 1994  | 1996  | 2008  | 1999   | 2001  | 2009  | 1993  | 2009  | 2008  |
| Active Launch Sites                | Kourou  | Kourou  | Kourou  | Jiuquan, Taiyuan, Xichang   | Jiuquan   | Jiuquan   | Taiyuan, Xichang  | Xichang   | Xichang   | Taiyuan  | Tanegashima   | Tanegashima   | Satish Dhawan   | Semnan Providence   | Baikonur  |
| LEO kg (lbs)                       | 17,250<br>(37,950)  | 21,000<br>(46,297)  | 7,800<br>(17,100)   | 3,200<br>(7,048)  | 3,500<br>(7,700)  | 8,400<br>(18,500)   | 7,200<br>(15,859)   | 13,562<br>(29,900)  | 3,700<br>(8,200)  | 2,500<br>(5,512)   | 11,730<br>(25,860)  | 19,000<br>(42,000)  | 3,700<br>(8,150)  | 27<br>(60)  | --  |
| GTO kg (lbs)                       | 10,500<br>(23,127)  | 8,000<br>(17,637)   | 1,700<br>(3,800)  | 1,000<br>(2,203)  | 1,250<br>(2,750)  | --  | 2,500<br>(5,506)  | 4,491<br>(9,900)  | --  | 1,500<br>(3,300)   | 5,800<br>(12,800)   | 8,000<br>(17,600)   | 800<br>(1,760)  | --  | 3,600<br>(7,937)  |

Table 9. European, Chinese, Japanese, Indian, Iranian, and Multinational Launch Vehicle Activity in 2011

## FAA SUBORBITAL FLIGHT SUMMARY

Two suborbital flights were conducted under the authority of FAA experimental permits in 2011: Blue Origin launched the PM-2 vehicle twice, on May 6 and on August 24. While there were no FAA-permitted suborbital launches in 2010 and 2009, five launches occurred in 2008 and nine in 2007. Unlike FAA-licensed flights, permitted flights are limited to reusable suborbital launch vehicles and intended for technology development, testing for crew, or testing before obtaining a license. Vehicles cannot carry property or people for compensation or hire. The first permit flights were in 2006, after the U.S. Congress granted authority in 2004.

## 2011 SPACE TRANSPORTATION TRENDS

### FIVE-YEAR WORLDWIDE SPACE TRANSPORTATION TRENDS

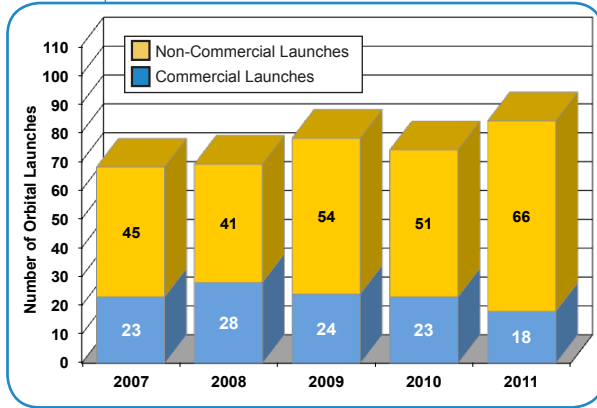


Figure 11. Five-Year Summary (2007-2011) of Commercial and Non-Commercial Launch Events

A total of 373 orbital launches have been conducted in the past five years. Between 2007 and 2011, there has been an average of 75 orbital launches per year worldwide (see Figure 11). Commercial launches suffered between one and two failures per year in 2007 through 2011, as shown in Figure 12. During the past five years, there has been at least one launch failure each year. (The definition of a launch failure is in Appendix II.) Six launches failed in 2011, the largest number in the last five years. The largest number of launch failures (8) in the past

15 years occurred in 1999. The 2011 launch failures included four Russian launches (including one commercial), one Chinese Long March vehicle launch, and one U.S. Taurus XL launch vehicle. Figure 12 presents a five-year trend of orbital launch successes and failures.

Russia and the United States have conducted the most orbital launches, followed by China and Europe (see Figure 13). There were 116 commercial orbital launches from 2007 to 2011. The number of launches rose from 23 in 2007 to a high of 28 in 2008 and dropped to 18 in 2011 (see Figures 14 and 15). The following is a breakdown of commercial orbital launches by country from 2007 to 2011:

- Russia had the most commercial launches with 56.
- Europe followed with 26 commercial launches.
- The United States had 17 commercial launches.
- Multinational Sea Launch performed 13 commercial launches.
- China had three, and India had one commercial launch.

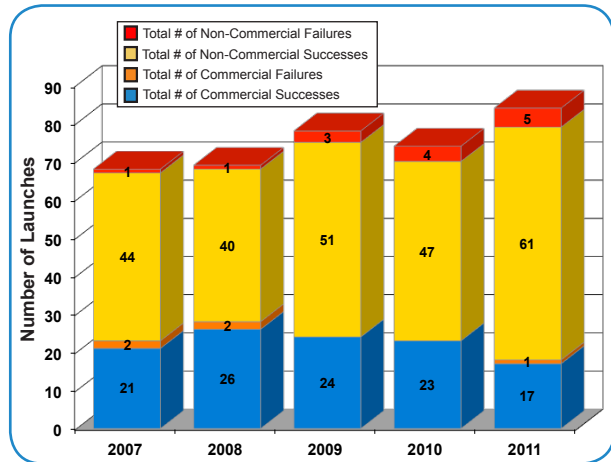


Figure 12. Five-Year Summary (2007-2011) of Orbital Launch Events and Launch Failures

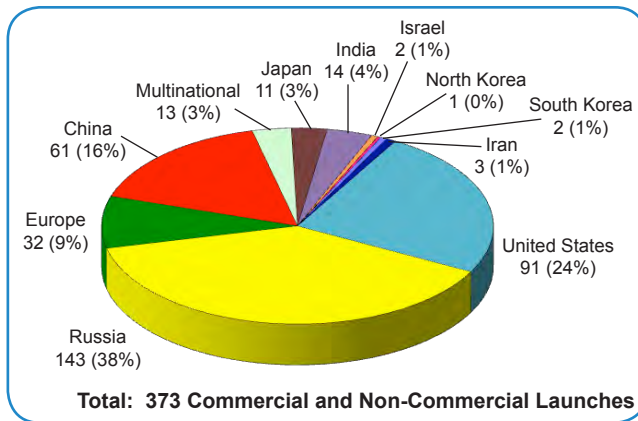


Figure 13. Five-Year Worldwide Total Orbital Launch Market Share (2007-2011)

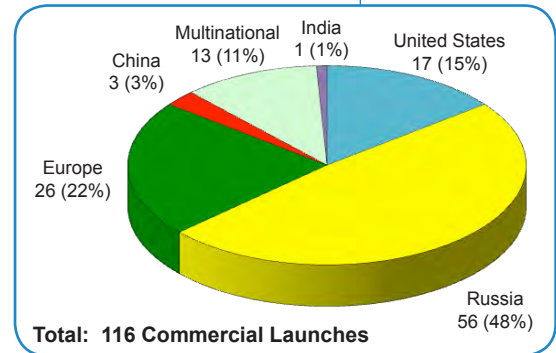


Figure 14. Five-Year Worldwide Commercial Orbital Launch Market Share (2007-2011)

The demand for commercial NGSO launches, which peaked in the late 1990s, was low in the four years before 2007. The number of commercial NGSO launches sharply increased in 2007 and 2008, and then increased again in 2010 after a slow year in 2009. These high levels are mostly driven by the launch of replacement satellites for the existing constellations, such as ORBCOMM and Globalstar, and by the launch of new constellations, such as SAR-Lupe and COSMO-SkyMed. In 2011, 2 of the 3 commercial NGSO launches deployed 12 more second-generation Globalstar satellites. See Figure 15 for commercial launches by orbit type for the last five years.

Figure 16 shows the number of payloads providing commercial services launched on commercial and non-commercial vehicles over the past five years. The number of commercial NGSO satellites launched per year fluctuates significantly year to year. This is because several commercial NGSO satellites are often launched together (multi-manifested) on the same launch vehicle. The launches of Globalstar (6 in 2010 and 12 in 2011), ORBCOMM (6 in 2008) and RapidEye constellation satellites (5 in 2008) explain why there are significantly more payloads launched in 2008, 2010, and 2011.

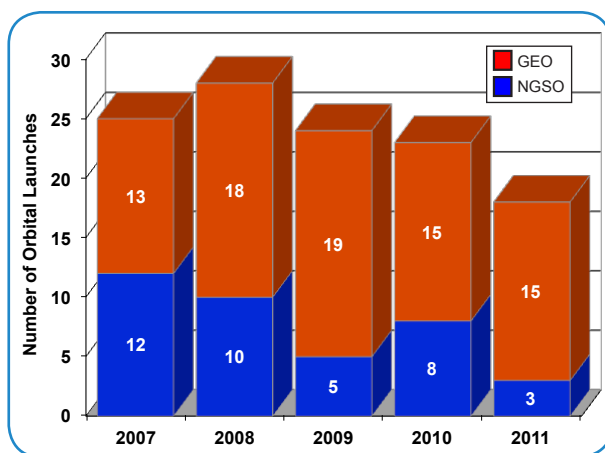


Figure 15. Five-Year Global Commercial Launch Events by Orbit (2007-2011)

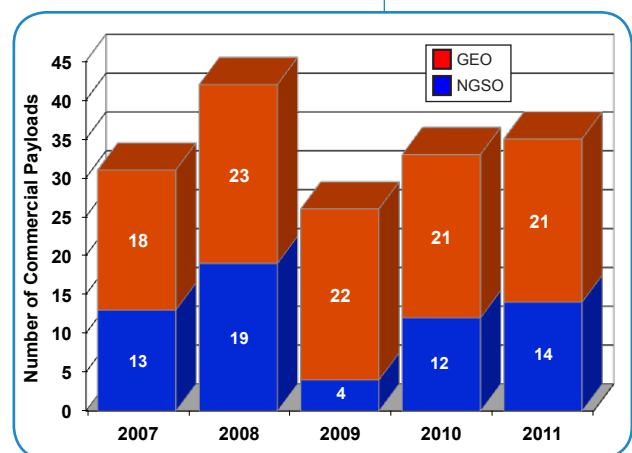


Figure 16. Five-Year Global Commercial Payloads by Orbit (2007-2011)

Commercial launch revenues steadily increased from 2006 to 2010. Revenues almost doubled between 2006 and 2010, from \$1.4 billion to about \$2.5 billion, and dropped to about \$1.9 billion in 2011 due to schedule changes that pushed several commercial launches to 2012 (see Figure 17 and Table 10).

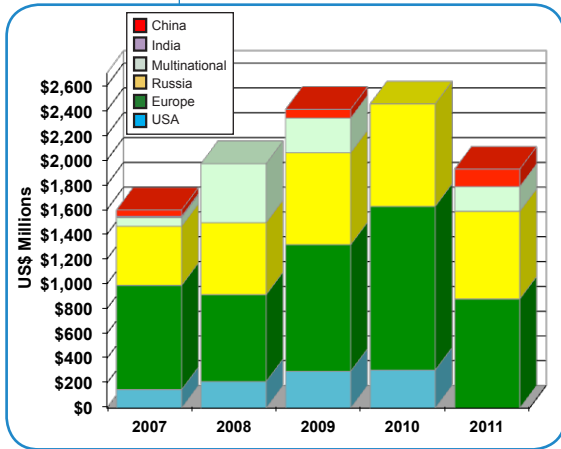


Figure 17. Approximate Launch Revenues for Commercial Launch Events (2007-2011)

|               | 2007           | 2008           | 2009           | 2010           | 2011           |
|---------------|----------------|----------------|----------------|----------------|----------------|
| United States | \$150          | \$215          | \$298          | \$307          | \$0            |
| Russia        | \$477          | \$581          | \$742          | \$826          | \$707          |
| Europe        | \$840          | \$700          | \$1,020        | \$1,320        | \$880          |
| China         | \$50           | \$0            | \$70           | \$0            | \$140          |
| India         | \$11           | \$0            | \$0            | \$0            | \$0            |
| Multinational | \$70           | \$475          | \$280          | \$0            | \$200          |
| <b>TOTAL</b>  | <b>\$1,598</b> | <b>\$1,971</b> | <b>\$2,410</b> | <b>\$2,453</b> | <b>\$1,927</b> |

Table 10. Estimated Commercial Launch Revenues, 2007-2011 (US\$ Millions)

## COMMERCIAL SATELLITE AND LAUNCH TRENDS

The commercial space transportation market is driven largely by the demand for launches of GEO telecommunications satellites and to a lesser (but growing) extent by a variety of NGSO satellites. Historically, the majority of commercial launches have been to GEO. Usually, GEO launches deploy larger payloads and require larger launch vehicles, thus generating more revenue than those to NGSO. More commercial launches to NGSO have taken place in recent years.

The supply of launch vehicle options continues to increase, despite only a marginal increase in demand for launches. Competition remains strong between United States, European, multinational, and Russian providers, while new entrants are joining, re-joining, or advancing toward the commercial market. For example, the Land Launch version of the Zenit, the Dnepr, the Soyuz (marketed and launched by Arianespace), and the Falcon 9 are all competing for commercial launches. The Japanese are marketing the H IIA commercially, and the Indians and Chinese, although limited by the U.S. export policies, are also targeting commercial launch customers.

## INTERNATIONALLY COMPETED LAUNCHES

The definitions of “commercial payload” and “commercial launch” are complex and open to interpretation (see Appendix II for definitions of these terms). Figure 18 shows trends for each country whose launch providers compete in the international marketplace. The chart reflects only launch service providers competing in the international marketplace for open-bid launch service contracts. From 2007 to 2011, there were 109 internationally competed launch events.

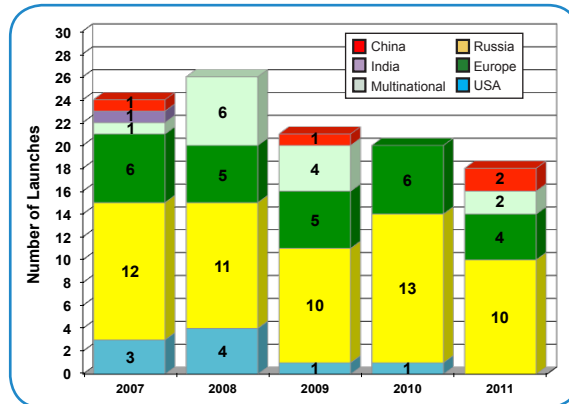


Figure 18. Five-Year Worldwide Internationally Competed Launch Events (2007-2011)

## 2012 LAUNCH ACTIVITY PROJECTION (FIRST SIX MONTHS OF 2012)

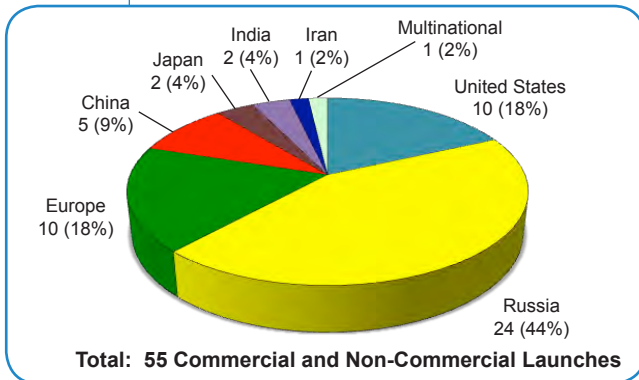


Figure 19. Total Projected Launches by Country: January - June 2012

Figure 19 shows the total number of projected orbital launches by each country and the relative percentage of launches for each country for the first six months of 2012. Launches are grouped by the country in which the primary vehicle manufacturer is based.

Figure 20 shows the total number of projected orbital launches of each launch vehicle in the first half of 2012.

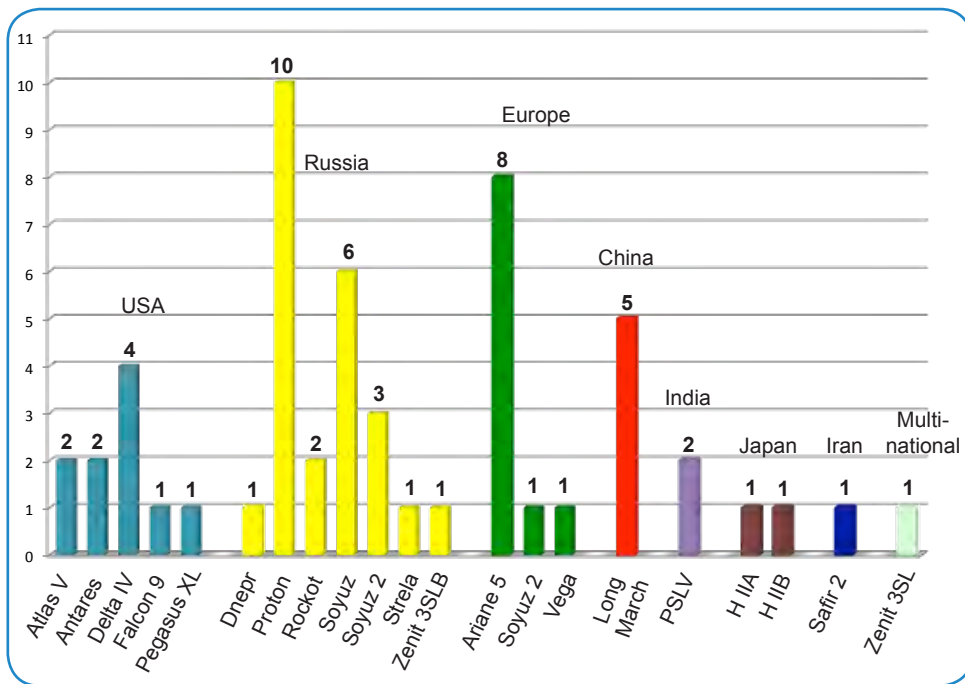


Figure 20. Total Projected Launch Vehicle Use: January - June 2012

Figure 21 shows all projected commercial orbital launch events for the first half of 2012. Figure 22 shows estimated commercial launch revenue from the projected commercial orbital launches in January through June 2012.

Figure 23 shows commercial against non-commercial projected orbital launch events from January through June 2012. Figure 24 shows projected commercial suborbital against commercial orbital launch events from January through June 2012.



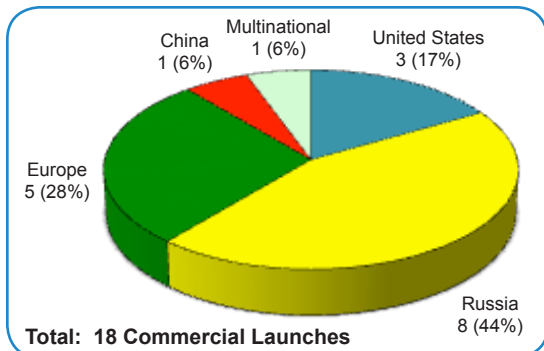


Figure 21. Projected Commercial Launch Events by Country: January - June 2012

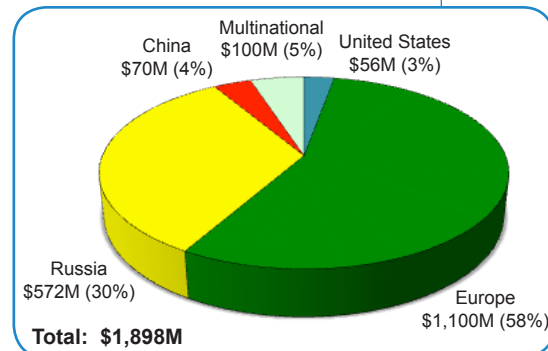


Figure 22. Estimated Commercial Launch Revenue: January - June 2012 (US\$ Millions)

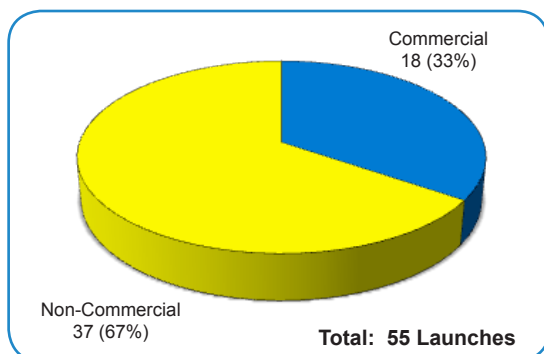


Figure 23. Projected Commercial vs. Non-Commercial Launch Events By Country: January - June 2012

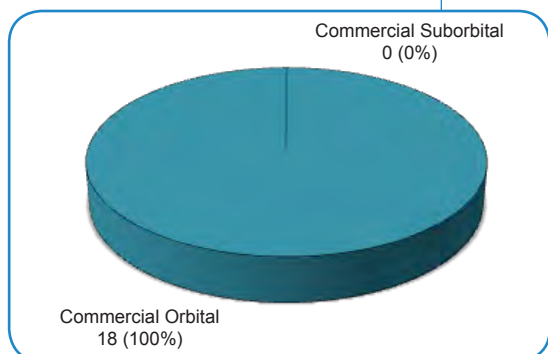


Figure 24. Projected Commercial Orbital vs. Commercial Suborbital Launch Events: January - June 2012

Figure 25 shows projected payload use (commercial and government) for payloads to launch from January through June 2012. Figure 26 shows the same projected payloads (commercial and government) by mass class. The total number of payloads launched may not equal the total number of launches, due to multiple manifesting (launching of multiple payloads by a single launch vehicle).

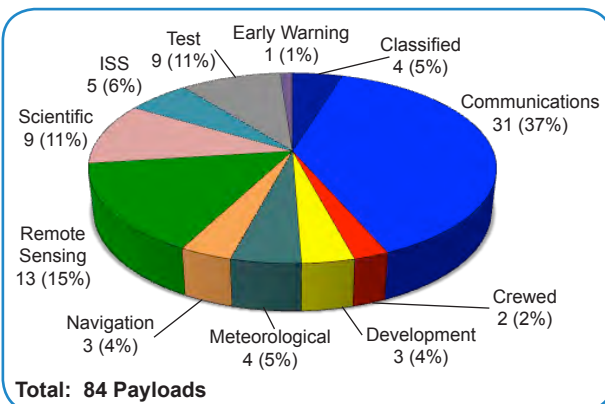


Figure 25. Projected Payload Use: January - June 2012

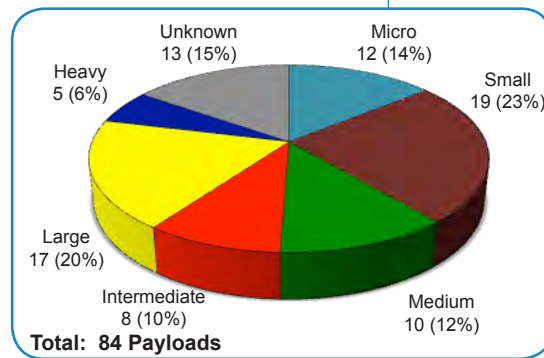


Figure 26. Projected Payload Mass Class: January - June 2012

There are no FAA-licensed commercial suborbital launch events or FAA experimental permit flights projected for the first half of 2012. However, there is a likelihood of at least a limited number of such launch events or flights to take place in the latter half of 2012.

## APPENDIX I: 2011 WORLDWIDE ORBITAL LAUNCH EVENTS

| Date      | Vehicle                 | Site            | Payload(s)           | Orbit | Operator                                      | Manufacturer                                  | Use            | Comm'l Price | L | M |
|-----------|-------------------------|-----------------|----------------------|-------|---|---|----------------|--------------|---|---|
| 20-Jan-11 | Delta IV Heavy          | VAFB            | NRO L-49             | SSO   | NRO   | Lockheed Martin                               | Classified     |              | S | S |
| 20-Jan-11 | Zenit 3F                | Baikonur        | Electro-L 1          | GEO   | Roshydromet                                   | NPO Lavotchkin                                | Meteorological |              | S | S |
| 22-Jan-11 | H IIB                   | Tanegashima     | Kounotori (HTV 2)    | LEO   | JAXA  | Mitsubishi Heavy Industries                   | ISS Cargo      |              | S | S |
| 28-Jan-11 | Soyuz                   | Baikonur        | Progress M-09M       | LEO   | Roscosmos                                     | RSC Energia                                   | ISS Cargo      |              | S | S |
| 01-Feb-11 | Rocket                  | Plesetsk        | GEO IK-2 No. II      | LEO   | Russian Space Forces                          | Reshetnev Company                             | Navigation     |              | F | F |
| 06-Feb-11 | Minotaur 1              | VAFB            | RPP (NRO L-66)       | SSO   | NRO   | Classified                                    | Classified     |              | S | S |
| 16-Feb-11 | Ariane 5 ES-ATV         | Kourou          | ATV 2                | LEO   | ESA   | EADS Astrium                                  | ISS Cargo      |              | S | S |
| 24-Feb-11 | Shuttle Discovery       | KSC             | STS 133 (ELC-4, PMM) | LEO   | NASA  | Rockwell International                        | Crewed         |              | S | S |
| 26-Feb-11 | Soyuz 2                 | Plesetsk        | Glonass K1-1         | MEO   | Russian Space Forces                          | Reshetnev Company                             | Navigation     |              | S | S |
| 04-Mar-11 | Taurus XL               | VAFB            | Glory                | SSO   | NASA  | Orbital Sciences Corp.                        | Scientific     |              | F | F |
|           |                         |                 | Kysat 1              | SSO   | Kentucky Space                                | Kentucky Space                                | Test           |              | F | F |
|           |                         |                 | Hermes               | SSO   | Colorado Space Grant Con.                     | Colorado Space Grant Con.                     | Communications |              | F | F |
|           |                         |                 | Explorer 1 (Prime)   | ELI   | Montana Space Grant Con.                      | Montana Space Grant Con.                      | Scientific     |              | F | F |
| 05-Mar-11 | Atlas V 501             | CCAFS           | X-37B OTV 2          | LEO   | USAF  | Boeing  | Classified     |              | S | S |
| 11-Mar-11 | Delta IV Medium+ (4, 2) | CCAFS           | NRO L-27             | GEO   | NRO   | Classified                                    | Communications |              | S | S |
| 04-Apr-11 | Soyuz                   | Baikonur        | Soyuz TMA-21         | LEO   | Roscosmos                                     | RSC Energia                                   | Crewed         |              | S | S |
| 10-Apr-11 | Long March 3A           | Xichang         | Beidou 2-IGS 3       | GEO   | People's Liberation Army                      | CAST  | Navigation     |              | S | S |
| 14-Apr-11 | Atlas V 401             | VAFB            | NRO L-34             | LEO   | NRO   | Classified                                    | Classified     |              | S | S |
| 20-Apr-11 | PSLV                    | Satish Dhawan   | Resourcesat 2        | SSO   | ISRO  | ISRO  | Remote Sensing |              | S | S |
|           |                         |                 | Youthsat             | SSO   | Bauman Moscow State Technical University      | ISRO  | Scientific     |              | S | S |
|           |                         |                 | X-Sat                | SSO   | Centre for Research in Satellite Technologies | Centre for Research in Satellite Technologies | Remote Sensing |              | S | S |
| 22-Apr-11 | V Ariane 5 ECA          | Kourou          | * Yahsat 1A          | GEO   | Yah Satellite Communications Company          | EADS Astrium                                  | Communications | \$220M       | S | S |
|           |                         |                 | * Intelsat New Dawn  | GEO   | Intelsat                                      | Orbital Sciences Corp.                        | Communications |              | S | S |
| 27-Apr-11 | Soyuz                   | Baikonur        | Progress M-10M       | LEO   | Roscosmos                                     | RSC Energia                                   | ISS Cargo      |              | S | S |
| 04-May-11 | Soyuz 2                 | Baikonur        | Meridian 4           | ELI   | Russian Space Forces                          | Reshetnev Company                             | Communications |              | S | S |
| 07-May-11 | Atlas V 401             | CCAFS           | SBIRS GEO 1          | GEO   | USAF  | Lockheed Martin                               | Early Warning  |              | S | S |
| 16-May-11 | Shuttle Endeavour       | KSC             | STS 134 (AMS, ELC-3) | LEO   | NASA  | Rockwell International                        | Crewed         |              | S | S |
| 20-May-11 | V Proton M              | Baikonur        | * Telstar 14R        | GEO   | Telesat                                       | Space Systems/Loral                           | Communications | \$85M        | S | S |
| 20-May-11 | V Ariane 5 ECA          | Kourou          | * Insat 4G/GSAT-8    | GEO   | ISRO  | ISRO  | Communications | \$220M       | S | S |
|           |                         |                 | * ST 2               | GEO   | Telecom/Chunghwa Telecom                      | Mitsubishi Electronic Corp.                   | Communications |              | S | S |
| 07-Jun-11 | Soyuz                   | Baikonur        | Soyuz TMA-02M        | LEO   | Roscosmos                                     | RSC Energia                                   | ISS Cargo      |              | S | S |
| 10-Jun-11 | Delta II 7320           | VAFB            | SAC-D/Aquarius       | SSO   | NASA/CONAE                                    | INVAP   | Remote Sensing |              | S | S |
| 15-Jun-11 | Safir 2                 | Semnan Province | Rasad                | LEO   | Iranian Aerospace Organization                | Iranian Space Agency                          | Remote Sensing |              | S | S |
| 20-Jun-11 | Long March 3B           | Xichang         | * Chinasat 10        | GEO   | China Direct Broadcasting Satellite Co., Ltd. | CAST  | Communications |              | S | S |
| 21-Jun-11 | Soyuz                   | Baikonur        | Progress M-11M       | LEO   | Roscosmos                                     | RSC Energia                                   | ISS Cargo      |              | S | S |

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.

+ Denotes FAA-licensed launch.

\* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.

All launch dates are based on local time at the launch site.

See Appendix III for definitions of payload orbits.

## APPENDIX I (CONTINUED)

| Date      | Vehicle                 | Site          | Payload(s)              | Orbit | Operator                             | Manufacturer  | Use            | Comm'l Price | L | M |
|-----------|-------------------------|---------------|-------------------------|-------|--------------------------------------|---|----------------|--------------|---|---|
| 27-Jun-11 | Soyuz U                 | Plesetsk      | Cosmos 2472             | LEO   | Russian Space Forces                 | RSC Energia   | Classified     |              | S | S |
| 29-Jun-11 | Minotaur I              | Wallops FF    | ORS 1                   | LEO   | USAF                                 | Goodrich ISR Systems                                | Classified     |              | S | S |
| 06-Jul-11 | Long March 2C           | Jiuquan       | Shijian 11-03           | SSO   | CAST                                 | Dongfanghong Satellite Co.                          | Scientific     |              | S | S |
| 08-Jul-11 | Shuttle Atlantis        | KSC           | STS 135 (MPLM, LMC)     | LEO   | NASA                                 | Rockwell International                              | Crewed         |              | S | S |
| 11-Jul-11 | Long March 3C           | Xichang       | Tianlian 1B             | GEO   | CAST                                 | CAST  | Communications |              | S | S |
| 13-Jul-11 | V Soyuz 2               | Baikonur      | * Globalstar 2nd Gen 07 | LEO   | Globalstar, Inc.                     | Thales Alenia Space                                 | Communications | \$50M        | S | S |
|           |                         |               | * Globalstar 2nd Gen 08 | LEO   | Globalstar, Inc.                     | Thales Alenia Space                                 | Communications |              | S | S |
|           |                         |               | * Globalstar 2nd Gen 09 | LEO   | Globalstar, Inc.                     | Thales Alenia Space                                 | Communications |              | S | S |
|           |                         |               | * Globalstar 2nd Gen 10 | LEO   | Globalstar, Inc.                     | Thales Alenia Space                                 | Communications |              | S | S |
|           |                         |               | * Globalstar 2nd Gen 11 | LEO   | Globalstar, Inc.                     | Thales Alenia Space                                 | Communications |              | S | S |
|           |                         |               | * Globalstar 2nd Gen 12 | LEO   | Globalstar, Inc.                     | Thales Alenia Space                                 | Communications |              | S | S |
| 15-Jul-11 | V Proton M              | Baikonur      | * SES-3                 | GEO   | SES World Skies                      | Orbital Sciences Corp.                              | Communications | \$85M        | S | S |
|           |                         |               | KazSat 2                | GEO   | JSC Kazsat                           | Khrunichev State Research & Production Space Center | Communications |              | S | S |
| 15-Jul-11 | PSLV                    | Satish Dhawan | GSAT 12                 | GEO   | ISRO                                 | ISRO  | Communications |              | S | S |
| 16-Jul-11 | Delta IV Medium+ (4, 2) | CCAFS         | Navstar GPS 2F-02       | MEO   | USAF                                 | Boeing  | Navigation     |              | S | S |
| 18-Jul-11 | Zenit 3F                | Baikonur      | Spektr R                | ELI   | Russian Academy of Sciences          | NPO Lavotchkin                                      | Scientific     |              | S | S |
| 26-Jul-11 | Long March 3A           | Xichang       | Beidou 2-IGS 4          | GEO   | People's Liberation Army             | CAST  | Navigation     |              | S | S |
| 29-Jul-11 | Long March 2C           | Jiuquan       | Shijian 11-02           | SSO   | CAST                                 | Dongfanghong Satellite Co.                          | Scientific     |              | S | S |
| 05-Aug-11 | Atlas V 551             | CCAFS         | Juno                    | EXT   | NASA/JPL                             | Lockheed Martin                                     | Scientific     |              | S | S |
| 06-Aug-11 | V Ariane 5 ECA          | Kourou        | * Astra 1N              | GEO   | SES Astra                            | EADS Astrium  | Communications | \$220M       | S | S |
|           |                         |               | * BSAT-3c/JCSAT-110R    | GEO   | Sky Perfect JCSAT Corp.              | Lockheed Martin                                     | Communications |              | S | S |
| 11-Aug-11 | Long March 3B           | Xichang       | * Paksat 1R             | GEO   | SUPARCO                              | China Great Wall Industry Corp.                     | Communications |              | S | S |
| 15-Aug-11 | Long March 4B           | Taiyuan       | Hai Yang 2A             | SSO   | China State Oceanic Administration   | Shanghai Institute of Satellite Engineering         | Remote Sensing |              | S | S |
| 17-Aug-11 | V Dnepr M               | Dombarovskiy  | Sich 2                  | SSO   | National Space Agency of Ukraine     | NPO Lavotchkin                                      | Remote Sensing | \$12M        | S | S |
|           |                         |               | NX                      | SSO   | NASRDA                               | Surrey Satellite Tech. Ltd.                         | Remote Sensing |              | S | S |
|           |                         |               | Nigeriasat 2            | SSO   | NASRDA                               | Surrey Satellite Tech. Ltd.                         | Remote Sensing |              | S | S |
|           |                         |               | Edusat                  | SSO   | Italian Space Agency                 | University of Rome                                  | Scientific     |              | S | S |
|           |                         |               | RASAT                   | SSO   | TUBITAK-UZAY                         | TUBITAK-UZAY  | Scientific     |              | S | S |
|           |                         |               | BPA 2                   | SSO   | Yuzhnoye                             | Hartron-Arkos                                       | Development    |              | S | S |
|           |                         |               | * Aprizesat 5           | LEO   | SpaceQuest, Ltd.                     | SpaceQuest, Ltd.                                    | Communications |              | S | S |
|           |                         |               | * Aprizesat 6           | LEO   | SpaceQuest, Ltd.                     | SpaceQuest, Ltd.                                    | Communications |              | S | S |
| 17-Aug-11 | V Proton M              | Baikonur      | * Express AM4           | GEO   | Russian Satellite Communications Co. | Reshetnev Company                                   | Communications | \$85M        | F | F |
| 18-Aug-11 | Long March 2C           | Jiuquan       | Shijian 11-04           | SSO   | CAST                                 | Dongfanghong Satellite Co.                          | Scientific     |              | F | F |
| 24-Aug-11 | Soyuz                   | Baikonur      | Progress M-12M          | LEO   | Roscosmos                            | RSC Energia   | ISS Cargo      |              | F | F |
| 10-Sep-11 | Delta II 7920H          | CCAFS         | GRAIL A                 | EXT   | NASA/JPL                             | Lockheed Martin                                     | Scientific     |              | S | S |
|           |                         |               | GRAIL B                 | EXT   | NASA/JPL                             | Lockheed Martin                                     | Scientific     |              | S | S |
| 18-Sep-11 | Long March 3B           | Xichang       | Chinasat 1A             | GEO   | People's Liberation Army             | CAST  | Communications |              | S | S |

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.

+ Denotes FAA-licensed launch.

\* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.

All launch dates are based on local time at the launch site.

See Appendix III for definitions of payload orbits.

## APPENDIX I (CONTINUED)

| Date      | Vehicle         | Site                | Payload(s)   | Orbit   | Operator   | Manufacturer  | Use  | Comm'l Price | L                               | M                               |
|-----------|-----------------|---------------------|--|---|--|---|--|--------------|---------------------------------|---------------------------------|
| 20-Sep-11 | Proton M        | Baikonur            | Cosmos 2473  | GEO   | Tass-Louch Telecom   | Reshetnev Company   | Communications   |              | S                               | S                               |
| 21-Sep-11 | V Ariane 5 ECA  | Kourou              | * Arabsat 5C<br>* SES 2  | GEO<br>GEO                                    | Arabsat<br>SES World Skies   | EADS Astrium<br>Orbital Sciences Corp.  | Communications<br>Communications   | \$220M       | S<br>S                          | S<br>S                          |
| 23-Sep-11 | H IIA           | Tanegashima         | IGS-4C (Optical)   | SSO   | Japan Defense Agency   | Mitsubishi Electronic Corp.   | Classified   |              | S                               | S                               |
| 24-Sep-11 | V + Zenit 3SL   | Sea Launch Platform | * Atlantic Bird 7  | GEO   | Eutelsat   | EADS Astrium  | Communications   | \$100M       | S                               | S                               |
| 27-Sep-11 | Minotaur IV     | Kodiak LC           | TacSat-4   | HEO   | USAF   | NRL/APL   | Development  |              | S                               | S                               |
| 29-Sep-11 | Long March 2F   | Jiuquan             | Tiangong 1   | LEO   | China Aerospace Corp.  | CAST  | Development  |              | S                               | S                               |
| 29-Sep-11 | V Proton M      | Baikonur            | * QuetzSat-1   | GEO   | QuetzSat   | Space Systems/Loral   | Communications   | \$85M        | S                               | S                               |
| 02-Oct-11 | Soyuz 2         | Plesetsk            | Glonass M42  | MEO   | Russian Space Forces   | Reshetnev Company   | Navigation   |              | S                               | S                               |
| 06-Oct-11 | V Zenit 3SLB    | Baikonur            | * Intelsat 18  | GEO   | Intelsat   | Orbital Sciences Corp.  | Communications   | \$100M       | S                               | S                               |
| 07-Oct-11 | V Long March 3B | Xichang             | * Eutelsat W3C   | GEO   | Eutelsat   | Thales Alenia Space   | Communications   | \$70M        | S                               | S                               |
| 12-Oct-11 | PSLV            | Satish Dhawan       | Megha Tropiques<br>Jugnu<br>SRMSAT<br>Vesselsat 1                                | LEO<br>LEO<br>SSO<br>LEO                      | CNES<br>IIT Kapur<br>SRM University<br>LuxSpace Sarl   | ISRO<br>IIT Kapur<br>SRM University<br>LuxSpace Sarl  | Scientific<br>Remote Sensing<br>Scientific<br>Communications   |              | S<br>S<br>S<br>S                | S<br>S<br>S<br>S                |
| 19-Oct-11 | V Proton M      | Baikonur            | * ViaSat 1   | GEO   | ViaSat   | Space Systems/Loral   | Communications   | \$85M        | S                               | S                               |
| 21-Oct-11 | Soyuz 2         | Kourou              | Galileo 1<br>Galileo 2   | MEO<br>MEO                                    | European Space Agency<br>European Space Agency   | OHB System<br>OHB Systems   | Navigation<br>Navigation   |              | S<br>S                          | S<br>S                          |
| 28-Oct-11 | Delta II 7920   | YAFB                | NPP<br>RAX 2<br>M-Cubed<br>AS-1<br>Explorer-1 (PRIME) Unit 2<br>DICE 1<br>DICE 2 | SSO<br>LEO<br>LEO<br>LEO<br>LEO<br>LEO<br>LEO | NASA/NOAA<br>University of Michigan<br>University of Michigan<br>Auburn University<br>Montana State University<br>Utah State University<br>Utah State University | Ball Aerospace<br>University of Michigan<br>University of Michigan<br>Auburn University<br>Montana State University<br>Utah State University<br>Utah State University | Meteorological<br>Scientific<br>Remote Sensing<br>Scientific<br>Scientific<br>Scientific<br>Scientific |              | S<br>S<br>S<br>S<br>S<br>S<br>S | S<br>S<br>S<br>S<br>S<br>S<br>S |
| 30-Oct-11 | Soyuz           | Baikonur            | Progress M-13M   | LEO   | Roscosmos  | RSC Energia   | ISS Cargo  |              | S                               | S                               |
| 31-Oct-11 | Long March 2F   | Jiuquan             | Shenzhou 8   | LEO   | China Aerospace Corp.  | CAST  | Development  |              | S                               | S                               |
| 04-Nov-11 | Proton M        | Baikonur            | Glonass M43<br>Glonass M44<br>Glonass M45  | MEO<br>MEO<br>MEO                             | Russian Space Forces<br>Russian Space Forces<br>Russian Space Forces   | Reshetnev Company<br>Reshetnev Company<br>Reshetnev Company   | Navigation<br>Navigation<br>Navigation   |              | S<br>S<br>S                     | S<br>S<br>S                     |
| 08-Nov-11 | Zenit 2M        | Baikonur            | Phobos-Grunt<br>Yinghuo  | EXT<br>EXT                                    | Roscosmos<br>China National Space Academy  | NPO Lavotchkin<br>Shanghai Institute of Satellite Engineering   | Scientific<br>Scientific   |              | S<br>S                          | F<br>F                          |
| 09-Nov-11 | Long March 4B   | Xichang             | Yaogan 12<br>Tianxun 1   | SSO<br>SSO                                    | People's Liberation Army<br>Nanjing University of Aeronautics & Astronautics   | Shanghai Academy of Space Technology<br>Nanjing University of Aeronautics & Astronautics  | Remote Sensing<br>Remote Sensing   |              | S<br>S                          | S<br>S                          |
| 14-Nov-11 | Soyuz           | Baikonur            | Soyuz TMA-22   | LEO   | Roscosmos  | RSC Energia   | Crewed   |              | S                               | S                               |
| 20-Nov-11 | Long March 2D   | Jiuquan             | Chuang Xing 1-03<br>Shiyan Wexing 4  | SSO<br>SSO                                    | Shanghai Academy of Space Technology<br>Dongfanghong Satellite Co.   | China Academy of Science<br>Harbin Institute of Technology  | Communications<br>Scientific   |              | S<br>S                          | S<br>S                          |
| 25-Nov-11 | V Proton M      | Baikonur            | * Asiasat 7  | GEO   | Asiasat  | Space Systems/Loral   | Communications   | \$85M        | S                               | S                               |

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.

+ Denotes FAA-licensed launch.

\* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.  
All launch dates are based on local time at the launch site.  
See Appendix III for definitions of payload orbits.

## APPENDIX I (CONTINUED)

| Date      | Vehicle         | Site        | Payload(s)              | Orbit | Operator                                    | Manufacturer                         | Use            | Comm'l |   |   |
|-----------|-----------------|-------------|-------------------------|-------|---|--------------------------------------|----------------|--------|---|---|
|           |                 |             |                         |       |   |                                      |                | Price  | L | M |
| 26-Nov-11 | Atlas V 541     | CCAFS       | Mars Science Laboratory | EXT   | NASA  | NASA/JPL                             | Scientific     |        | S | S |
| 28-Nov-11 | Soyuz 2         | Plesetsk    | Glonass M46             | MEO   | Russian Space Forces                        | Reshetnev Company                    | Navigation     |        | S | S |
| 29-Nov-11 | Long March 2D   | Jiuquan     | Yaogan 13               | SSO   | People's Liberation Army                    | Shanghai Academy of Space Technology | Classified     |        | S | S |
| 01-Dec-11 | Long March 3A   | Xichang     | Beidou 2-IGS 5          | GEO   | People's Liberation Army                    | CAST                                 | Navigation     |        | S | S |
| 11-Dec-11 | V Proton M      | Baikonur    | Luch 5A                 | GEO   | Roscosmos                                   | Reshetnev Company                    | Communications | \$85M  | S | S |
|           |                 |             | * Amos 5                | GEO   | SpaceCom Ltd.                               | Reshetnev Company                    | Communications |        | S | S |
| 12-Dec-11 | H IIA           | Tanegashima | IGS-4B (Radar)          | SSO   | Japan Defense Agency                        | Mitsubishi Electronic Corp.          | Classified     |        | S | S |
| 16-Dec-11 | Soyuz 2         | Kourou      | Pleiades HR 1           | LEO   | CNES  | EADS Astrium                         | Remote Sensing |        | S | S |
|           |                 |             | ELISA 1                 | LEO   | French MoD                                  | EADS Astrium                         | Classified     |        | S | S |
|           |                 |             | ELISA 2                 | LEO   | French MoD                                  | EADS Astrium                         | Classified     |        | S | S |
|           |                 |             | ELISA 3                 | LEO   | French MoD                                  | EADS Astrium                         | Classified     |        | S | S |
|           |                 |             | ELISA 4                 | LEO   | French MoD                                  | EADS Astrium                         | Classified     |        | S | S |
|           |                 |             | SSOT                    | SSO   | Government of Chile                         | EADS Astrium                         | Remote Sensing |        | S | S |
| 19-Dec-11 | V Long March 3B | Xichang     | * Nigcomsat 1R          | GEO   | Nigerian Communication Satellite Ltd.       | CAST                                 | Communications | \$70M  | S | S |
| 21-Dec-11 | Soyuz           | Baikonur    | Soyuz TMA-03M           | LEO   | Roscosmos                                   | RSC Energia                          | Crewed         |        | S | S |
| 22-Dec-11 | Long March 4B   | Xichang     | Ziyuan 1-2C             | SSO   | China State Bureau of Surveying and Mapping | CAST                                 | Remote Sensing |        | S | S |
| 23-Dec-11 | Soyuz 2         | Plesetsk    | Meridian 5              | ELI   | Russian Space Forces                        | Reshetnev Company                    | Communications |        | F | F |
| 28-Dec-11 | V Soyuz 2       | Baikonur    | * Globalstar 2nd Gen 13 | LEO   | Globalstar, Inc.                            | Thales Alenia Space                  | Communications | \$50M  | S | S |
|           |                 |             | * Globalstar 2nd Gen 14 | LEO   | Globalstar, Inc.                            | Thales Alenia Space                  | Communications |        | S | S |
|           |                 |             | * Globalstar 2nd Gen 15 | LEO   | Globalstar, Inc.                            | Thales Alenia Space                  | Communications |        | S | S |
|           |                 |             | * Globalstar 2nd Gen 16 | LEO   | Globalstar, Inc.                            | Thales Alenia Space                  | Communications |        | S | S |
|           |                 |             | * Globalstar 2nd Gen 17 | LEO   | Globalstar, Inc.                            | Thales Alenia Space                  | Communications |        | S | S |
|           |                 |             | * Globalstar 2nd Gen 18 | LEO   | Globalstar, Inc.                            | Thales Alenia Space                  | Communications |        | S | S |

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.

+ Denotes FAA-licensed launch.

\* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.  
All launch dates are based on local time at the launch site.  
See Appendix III for definitions of payload orbits.

## APPENDIX II: PROJECTED WORLDWIDE ORBITAL LAUNCH EVENTS FOR FIRST SIX MONTHS OF 2012

| Date      | Vehicle                     | Site              | Payload(s)   | Orbit   | Operator  | Manufacturer  | Use  | Comm'l Price |
|-----------|-----------------------------|-------------------|--|---|---|---|--|--------------|
| 10-Jan-12 | Long March 4B               | Taiyuan           | Ziyuan 3   | SSO   | China State Bureau of Surveying & Mapping   | CAST  | Remote Sensing   |              |
| 19-Jan-12 | Delta IV Medium +(5, 4)     | CCAFS             | WGS 4  | GEO   | USAF  | Boeing  | Communications   |              |
| 21-Jan-12 | V Proton M                  | Baikonur          | * SES 4  | GEO   | SES World Skies   | Space Systems/Loral   | Communications   | \$85M        |
| 24-Jan-12 | V Proton M                  | Baikonur          | * Sirius FM-6  | GEO   | Sirius Satellite Radio Inc.   | Space Systems/Loral   | Communications   | \$85M        |
| 25-Jan-12 | Soyuz                       | Baikonur          | Progress M-14M   | LEO   | Roscosmos   | RSC Energia   | ISS Cargo  |              |
| Jan-12    | Strela                      | Baikonur          | Kondor E   | LEO   | NPO Machinostroyeniya   | NPO Machinostroyeniya   | Remote Sensing   |              |
| Jan-12    | Long March 3A               | Xichang           | Feng Yun 2F  | GEO   | China Meteorological Administration   | Shanghai Institute of Satellite Engineering   | Meteorological   |              |
| 02-Feb-12 | V Soyuz 2                   | Baikonur          | * Globalstar 2nd Gen 19<br>* Globalstar 2nd Gen 20<br>* Globalstar 2nd Gen 21<br>* Globalstar 2nd Gen 22<br>* Globalstar 2nd Gen 23<br>* Globalstar 2nd Gen 24 | LEO<br>LEO<br>LEO<br>LEO<br>LEO<br>LEO        | Globalstar, Inc.<br>Globalstar, Inc.<br>Globalstar, Inc.<br>Globalstar, Inc.<br>Globalstar, Inc.<br>Globalstar, Inc.  | Thales Alenia Space<br>Thales Alenia Space<br>Thales Alenia Space<br>Thales Alenia Space<br>Thales Alenia Space<br>Thales Alenia Space  | Communications<br>Communications<br>Communications<br>Communications<br>Communications<br>Communications | \$50M        |
| 07-Feb-12 | Vega                        | Kourou            | LARES<br>PW-Sat 1<br>XaTcobeo<br>Robusta<br>e-Str@r<br>Goliat<br>ALMASAT   | LEO<br>LEO<br>LEO<br>LEO<br>LEO<br>LEO<br>SSO | Italian Space Agency<br>Warsaw Polytech<br>University of Vigo<br>University of Montpellier II<br>Polytech University of Turin<br>University of Bucharest<br>University of Bologna | Italian Space Agency<br>Warsaw Polytech<br>University of Vigo<br>University of Montpellier II<br>Polytech University of Turin<br>University of Bucharest<br>University of Bologna | Test<br>Test<br>Test<br>Test<br>Scientific<br>Remote Sensing<br>Test                                     |              |
| 10-Feb-12 | Proton M                    | Baikonur          | Cosmos (Oko)   | TBD   | Russian Space Forces  | Reshetnev Company   | Early Warning  |              |
| Feb-12    | Rocket                      | Baikonur          | Aeolus   | SSO   | European Space Agency   | EADS Astrium  | Scientific   |              |
| Feb-12    | Proton M                    | Baikonur          | Luch 5B<br>Yamal 300K  | GEO<br>GEO                                    | Roscosmos<br>Gazprom Space Systems  | Reshetnev Company<br>Reshetnev Company  | Communications<br>Communications   |              |
| 06-Mar-12 | V Proton M                  | Baikonur          | * Intelsat 22  | GEO   | Intelsat  | Boeing  | Communications   | \$85M        |
| 09-Mar-12 | Ariane 5 ES-ATV             | Kourou            | ATV 3  | LEO   | European Space Agency   | EADS Astrium  | ISS Cargo  |              |
| 14-Mar-12 | Pegasus XL                  | Kwajalein Island  | NuSTAR   | LEO   | NASA/JPL  | Orbital Sciences Corp.  | Scientific   |              |
| 28-Mar-12 | Delta IV M+                 | Vandenberg AFB    | DMSP 5D-3-F20  | SSO   | NOAA  | Lockheed Martin   | Meteorological   |              |
| 29-Mar-12 | Delta IV Medium-Plus (5, 2) | Vandenberg AFB    | NRO L-25   | SSO   | NRO   | Classified  | Classified   |              |
| 30-Mar-12 | Soyuz                       | Baikonur          | Soyuz TMA-04M  | LEO   | Roscosmos   | RSC Energia   | Crewed   |              |
| Mar-12    | Safir 2                     | Semnan Providence | Navid (Zafar)  | SSO   | Government of Iran  | Government of Iran  | Remote Sensing   |              |
| Mar-12    | Long March 2F               | Jiuquan           | Shenzhou 9   | LEO   | China Aerospace Corp.   | CAST  | Development  |              |
| Mar-12    | PSLV                        | Satish Dhawan     | Brite Austria 1<br>Brite Austria 2<br>Sapphire<br>NEOSSAT  | LEO<br>LEO<br>LEO<br>SSO                      | University of Vienna<br>University of Vienna<br>Canadian Ministry of Defense<br>Canadian Space Agency   | University of Vienna<br>University of Vienna<br>MDA<br>Dynacon Inc.   | Scientific<br>Scientific<br>Remote Sensing<br>Scientific   |              |
| Mar-12    | PSLV                        | Satish Dhawan     | Risat I<br>Venta I   | SSO<br>LEO                                    | ISRO<br>Government of Latvia  | ISRO<br>University of Bremen  | Remote Sensing<br>Remote Sensing   |              |

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.

+ Denotes FAA-licensed launch.

\* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.

All launch dates are as of December 31, 2011, and are based on local time at the launch site.

See Appendix III for definitions of payload orbits.

## APPENDIX II (CONTINUED)

| Date      | Vehicle         | Site                | Payload(s)                                       | Orbit      | Operator  | Manufacturer   | Use                              | Comm'l Price |
|-----------|-----------------|---------------------|--|------------|---|--|----------------------------------|--------------|
| 1Q-12     | V + Falcon 9    | CCAFS               | * Dragon COTS Demo 2/3                           | LEO        | SpaceX  | SpaceX   | Development                      | \$56M        |
| 1Q-12     | V + Antares     | Wallops FF          | * Antares Demo Flight<br>* Cygnus Mass Simulator | LEO<br>LEO | Orbital Sciences Corp.<br>Orbital Sciences Corp.        | Orbital Sciences Corp.<br>Orbital Sciences Corp.                         | Test                             | TBA          |
| 1Q-12     | V Long March 3B | Xichang             | * APSTAR 7                                       | GEO        | APT Satellite Co., Ltd.                                 | Thales Alenia Space  | Communications                   | \$70M        |
| 1Q-12     | V Ariane 5 ECA  | Kourou              | * Jupiter  | GEO        | Hughes Network Systems                                  | Space Systems/Loral  | Communications                   | \$220M       |
| 1Q-12     | V Ariane 5 ECA  | Kourou              | * GSAT 10  | GEO        | ISRO  | ISRO   | Communications                   | \$220M       |
| 1Q-12     | Proton M        | Baikonur            | * Telkom 3<br>* Express MD2                      | GEO<br>GEO | Telkom Indonesia<br>Russian Satellite Communication Co. | Reshetnev Company<br>Khronichev State Research & Production Space Center | Communications<br>Communications |              |
| 1Q-12     | V Dnepr IA      | Dombrovskiy         | * Kompasat 5                                     | LEO        | KARI  | KARI   | Remote Sensing                   | \$12M        |
| 1Q-12     | V Proton M      | Baikonur            | * Intelsat 23                                    | GEO        | Intelsat  | Orbital Sciences Corp.   | Communications                   | \$85M        |
| 1Q-12     | Rocket          | Plesetsk            | Cosmos (Military Gonet 1)                        | LEO        | Russian Space Forces                                    | Reshetnev Company  | Communications                   |              |
|           |                 |                     | Gonets M-03                                      | LEO        | SMOLSAT   | Reshetnev Company  | Communications                   |              |
|           |                 |                     | Gonets M-04                                      | LEO        | SMOLSAT   | Reshetnev Company  | Communications                   |              |
|           |                 |                     | MIR (Yubileyniy 2)                               | LEO        | Reshetnev Company                                       | Reshetnev Company  | Communications                   |              |
| 1Q-12     | V + Zenit 3SL   | Sea Launch Platform | * Intelsat 19                                    | GEO        | Intelsat  | Space Systems/Loral  | Communications                   | \$100M       |
| 1Q-12     | Soyuz           | Baikonur            | Kanopus B1<br>BelKa 2                            | SSO<br>SSO | VNIIEM<br>National Academy of Sciences of Belarus       | VNIIEM<br>RSC Energia  | Remote Sensing<br>Remote Sensing |              |
|           |                 |                     | Zond PP  | SSO        | Roscosmos   | NPO Lavotchkin   | Scientific                       |              |
|           |                 |                     | ADS-1B   | SSO        | COM DEV International                                   | Surrey Satellite Tech. Ltd.  | Remote Sensing                   |              |
|           |                 |                     | TET-1  | SSO        | DLR   | Kayser-Threde GmbH   | Test                             |              |
| 25-Apr-12 | Soyuz           | Baikonur            | Progress M-15M                                   | LEO        | Roscosmos   | RSC Energia  | ISS Cargo                        |              |
| 26-Apr-12 | Long March 2C   | Jiuquan             | Gokturk 2  | SSO        | Turkish Military  | TUBITAK-UZAY   | Classified                       |              |
| 27-Apr-12 | Atlas V 531     | CCAFS               | Advanced EHF 2                                   | GEO        | DoD   | Lockheed Martin  | Communications                   |              |
| Apr-12    | Zenit 3SLB      | Baikonur            | Lybid 1  | GEO        | Ukraine Space Agency                                    | NPO Yuzhnoye   | Communications                   |              |
| Apr-12    | Soyuz 2         | Baikonur            | Resurs P1  | SSO        | Roscosmos   | Khronichev State Research & Production Space Center                      | Remote Sensing                   |              |
| 01-May-12 | V + Antares     | Wallops FF          | * Cygnus COTS Demo                               | LEO        | Orbital Sciences Corp.                                  | Orbital Sciences Corp.   | Test                             | TBA          |
| 23-May-12 | Soyuz           | Baikonur            | MetOp B  | SSO        | Eumetsat  | EADS Astrium   | Meteorological                   |              |
| 30-May-12 | Soyuz           | Baikonur            | Soyuz TMA-05M                                    | LEO        | Roscosmos   | RSC Energia  | Crewed                           |              |
| May-12    | Proton M        | Baikonur            | MLM  | LEO        | Roscosmos   | Korolev NPO Energia  | ISS Cargo                        |              |
| 20-Jun-12 | Atlas V 401     | Vandenberg AFB      | NRO L-38   | TBD        | NRO   | Classified   | Classified                       |              |
| 26-Jun-12 | H IIB           | Tanegashima         | HTV 3  | LEO        | JAXA  | Mitsubishi Heavy Industries  | ISS Cargo                        |              |
| 28-Jun-12 | Delta IV Heavy  | CCAFS               | NRO L-15   | TBD        | NRO   | Classified   | Classified                       |              |
| Jun-12    | Ariane 5 ECA    | Kourou              | MSG 3  | GEO        | Eumetsat  | Thales Alenia Space  | Meteorological                   |              |
| Jun-12    | H IIA           | Tanegashima         | GCOM W1  | SSO        | JAXA  | TBA  | Scientific                       |              |
|           |                 |                     | Arirang 3 (Kompasat 3)                           | SSO        | KARI  | KARI/EADS Astrium  | Remote Sensing                   |              |
|           |                 |                     | SDS 4  | SSO        | JAXA  | JAXA   | Development                      |              |
|           |                 |                     | Horyu 2  | LEO        | Kyushu Institute of Technology                          | Kyushu Institute of Technology   | Scientific                       |              |

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.

+ Denotes FAA-licensed launch.

\* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.

All launch dates are as of December 31, 2011, and are based on local time at the launch site.

See Appendix III for definitions of payload orbits.

## APPENDIX II (CONTINUED)

| Date   | Vehicle        | Site     | Payload(s)         | Orbit | Operator                      | Manufacturer        | Use            | Comm'l Price |
|--------|----------------|----------|--------------------|-------|-------------------------------|---------------------|----------------|--------------|
| Jun-12 | Soyuz 2        | Kourou   | Galileo 3          | MEO   | European Space Agency         | EADS Astrium        | Navigation     |              |
|        |                |          | Galileo 4          | MEO   | European Space Agency         | EADS Astrium        | Navigation     |              |
| Jun-12 | Soyuz 2        | Plesetsk | Glonass KI-2       | MEO   | Russian Space Forces          | Reshetnev Company   | Navigation     |              |
| 2Q-12  | Ariane 5 ECA   | Kourou   | Vinasat 2          | GEO   | Vietnam Telecom International | Lockheed Martin     | Communications |              |
| 2Q-12  | V Ariane 5 ECA | Kourou   | * Intelsat 20      | GEO   | Intelsat                      | Space Systems/Loral | Communications | \$220M       |
| 2Q-12  | V Proton M     | Baikonur | * Intelsat 21      | GEO   | Intelsat                      | Boeing              | Communications | \$85M        |
| 2Q-12  | V Ariane 5 ECA | Kourou   | * Alphasat I-XL    | GEO   | Inmarsat                      | EADS Astrium        | Communications | \$220M       |
| 2Q-12  | V Ariane 5 ECA | Kourou   | * JCSAT 13         | GEO   | Sky Perfect JSAT Group        | Lockheed Martin     | Communications | \$220M       |
| 2Q-12  | V Proton M     | Baikonur | * Astra 4B (SES-5) | GEO   | SES World Skies               | Space Systems/Loral | Communications | \$85M        |

V Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed, or privately financed launch activity. For multiple manifested launches, certain secondary payloads whose launches were commercially procured may also constitute a commercial launch.

+ Denotes FAA-licensed launch.

\* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.

L and M refer to the outcome of the Launch and Mission: S=Success, P=Partial Success, F=Failure.

Notes: All prices are estimates.

All launch dates are as of December 31, 2011, and are based on local time at the launch site.

See Appendix III for definitions of payload orbits.



## ACRONYMS FOR APPENDIX I AND II

|             |  |
|-------------|--|
| AMS         | Alpha Magnetic Spectrometer                                      |
| CAST        | China Academy for Space Technology                               |
| CCAFS       | Cape Canaveral Air Force Station                                 |
| CNSA        | China National Space Administration                              |
| CONAE       | National Commission on Space Activities, Argentina               |
| COTS        | Commercial Orbital Transportation Services                       |
| CRS         | Commercial Resupply Services                                     |
| DoD         | Department of Defense  |
| ELC         | Express Logistics Carrier  |
| ESA         | European Space Agency  |
| GSFC        | Goddard Space Flight Center                                      |
| IAI         | Israel Aerospace Industries Ltd.                                 |
| ISRO        | Indian Space Research Organization                               |
| ISS         | International Space Station                                      |
| JAXA        | Japan Aerospace Exploration Agency                               |
| KARI        | Korean Advanced Institute of Science and Technology              |
| KSC         | NASA Kennedy Space Center  |
| LMC         | Lightweight Multi-purpose Carrier                                |
| MPLM        | Multi-purpose Pressurized Logistics Carrier                      |
| NASA        | National Aeronautics and Space Administration                    |
| NASRDA      | National Space Research and Development Agency, Nigeria          |
| NOAA        | United States National Oceanic and Atmospheric Administration    |
| NRO         | National Reconnaissance Office                                   |
| PMM         | Permanent Multi-purpose Module                                   |
| Russian MoD | Ministry of Defense of the Russian Federation                    |
| SAS         | Shanghai Academy of Space Technology, China                      |
| SBA         | Shanghai Bureau of Astronautics, China                           |
| SUPARCO     | Pakistan Space and Upper Atmosphere Research Commission          |
| ULA         | United Launch Alliance   |
| USA         | United Space Alliance  |
| USAF        | United States Air Force  |
| USEF        | Institute for Unmanned Space Experiment Free Flyer (USEF), Japan |
| VAFB        | Vandenberg Air Force Base  |

## APPENDIX III: DEFINITIONS

### COMMERCIAL SUBORBITAL OR ORBITAL LAUNCH

---

A commercial suborbital or orbital launch has one or more of the following characteristics:

- The launch is licensed by FAA/AST.
- The primary payload's launch contract was internationally competed (see definition of internationally competed below). A primary payload is generally defined as the payload with the greatest mass on a launch vehicle for a given launch.
- The launch is privately financed without government support.

### LAUNCH FAILURE

---

The payload did not reach a usable orbit (an orbit where some portion of the mission could be salvaged) or was destroyed as the result of a launch vehicle malfunction.

### INTERNATIONALLY COMPETED

---

An internationally competed launch contract is one in which the launch opportunity was available in principle to any capable launch service provider. An internationally competed launch is considered commercial.

### COMMERCIAL PAYLOAD

---

A commercial payload is described as having one or both of the following characteristics:

- The payload is operated by a private company.
- The payload is funded by the government, but provides satellite service partially or totally through a private or semi-private company. This distinction is usually applied to certain telecommunication satellites whose transponders are partially or totally leased to a variety of organizations, some or all of which generate revenues. Examples are Russia's Express and Ekran series of spacecraft. All other payloads are classified as noncommercial (government civil, government military, or non-profit).

### ORBITS

---

- **Geosynchronous Earth orbit (GSO):** A spacecraft in GSO is synchronized with the Earth's rotation, orbiting once every 24 hours, and appears to an observer on the ground to be stationary in the sky.
- **Geostationary Earth orbit (GEO):** GEO is a broad category used for any circular orbit at an altitude of 35,852 kilometers (22,277 miles) with a low inclination (over the equator).

- **Non-geosynchronous orbit (NGSO):** NGSO satellites are those in orbits other than GEO, including:
  - **Low Earth orbit (LEO):** lowest achievable orbit, about 2,400 kilometers,
  - **Medium Earth orbit (MEO):** 2,400 kilometers to GEO,
  - **Elliptical (ELI):** a highly elliptical orbit,
  - **External (EXT):** used for trajectories beyond GEO (such as interplanetary trajectories), and
  - **Sun-synchronous orbit (SSO):** an orbit that passes over the same part of the Earth at roughly the same time each day.

## PAYLOAD USE

---

- **Classified:** Any system whose purpose is officially deemed classified or cannot be officially verified.
- **Communications:** Any system designed to receive and transmit data for purposes of facilitating communications. This includes fixed satellite services, mobile satellite services, military communications, store-and-forward systems, asset tracking, and similar.
- **Crewed:** Any system designed primarily to transport humans into, through, or back from space.
- **Development:** Any system whose purpose is to advance hardware design as part of a research and development program.
- **ISS:** Any system designed primarily to transport cargo into, through, or back from the International Space Station (ISS).
- **Meteorological:** Any system designed to monitor the Earth's weather for forecasting and issuing weather watches and warnings.
- **Navigation:** Any system designed to provide signals for accurate timing, positioning, and navigation.
- **Remote Sensing:** Any civil and commercial system designed to gather data by means of optical (panchromatic, multispectral, or hyperspectral) or radar sensors.
- **Scientific:** Any system designed to gather data about astrophysics, astronomy, biology, cosmology, celestial bodies, physics, and the space environment. This designation also includes systems designed to monitor the Earth, except those systems designed specifically for meteorology.
- **Test:** Any system designed to provide telemetry and data on launch vehicle performance.
- **Unknown:** Any system whose mission is unknown.
- **Other:** Any system whose purpose does not fit in any of the provided categories.

## **PAYLOAD MASS CLASS**

---

Payloads are divided into the following mass classes based on mass on the ground (not in orbit):

- **Micro:** Up to 91 kg (200 lbs)
- **Small:** 92 to 907 kg (201 to 2,000 lbs)
- **Medium:** 908 to 2,268 kg (2,001 to 5,000 lbs)
- **Intermediate:** 2,269 to 4,536 kg (5,001 to 10,000 lbs)
- **Large:** 4,537 to 9,072 kg (10,001 to 20,000 lbs)
- **Heavy:** Greater than 9,072 kg (20,000 lbs)