3. INTENSITY: OUTPUTS FROM THE SPACE ECONOMY

The statistics on outputs offer an overview of the use of space infrastructures, i.e. products or services that are produced or provided by the space sector. Outputs also include the benefits to industries or countries deriving from the production of space products or the performance of space-related R&D. These include financial benefits (e.g. trade revenues) and indicators of present and future financial benefits (e.g. patents).

The indicators examined here incorporate: (1) revenues from the space industry; (2) space-related services; (3) international trade in space products; (4) space patents; and (5) space launch activity and payloads (i.e. a satellite or an instrument on a satellite). Two of these sections – international trade in space and space patents – draw upon official OECD statistics. Statistics on revenues, services and launches examine data and information from non-OECD sources, such as governments, industry associations and consulting firms.

3.1. REVENUES FROM THE SPACE INDUSTRY

The space industry covers many segments. Using mainly private sources, the statistics presented here provide orders of magnitude for three major manufacturing segments of the satellite industry: satellite manufacturing, ground equipment and the launch industry. Space-related services are covered in the next section.

Highlights

Worldwide satellite industry revenues remained steady from 2002 to 2005 at USD 35-36 billion, with an increase in 2006 for the manufacturing segment, which attained levels similar to 2000. (Figure 3.1a). A more global recovery over time is anticipated, based on the cyclical nature of space activities (*e.g.* renewal of satellite fleets), although the growing number of actors is forcing increased international competitiveness.

A breakdown of the total shows that while ground equipment grew over 2002-2005, the launch and satellite manufacturing areas shrunk until 2005 (Figure 3.1b). This trend is reflected in the rising percentage of the total revenues coming from the ground segment and proportional declines in both the launch and satellite manufacturing markets (Figure 3.1c).

The US share in revenues of world satellite manufacturers decreased (Figure 3.1e). An examination of European space-related manufacturing units shows a similar picture with sales relatively down since 2000, although picking up in 2006 (Figure 3.1f).Worldwide launch revenues in 2006 had not returned to the high levels of 2000, when the US and other players were vying for launch activity (Figure 3.1d).

Definition

The activities presented here focus exclusively on three segments of satellite industry manufacturing. First is the launch industry segment, which comprises launch services (by private companies for both government and private payloads), vehicle manufacturers and component and subsystem manufacturers. Given the difficulty of separating launch manufacturing from launch services data, both types were included together under the umbrella of launch industry revenues. Second is the satellite manufacturing segment which includes manufacturers of satellites and associated components and subsystems. Third is the ground equipment segment, which covers the manufacturing of mobile terminals, gateways, control stations, VSATs and DBS dishes, and handheld phones and other equipment. Eurospace data focus on the manufacturing of space hardware and software, ground stations, launch equipment and associated parts throughout Europe.

Methodology

The data come primarily from two US Satellite Industry Association (SIA) reports, which are based on surveys that target large companies operating in the three segments, focusing on their employment and revenue situations. The data are complemented with publicly available information to provide a more comprehensive overview of the segment and industry. The launch industry data include information from private companies on both their commercial and non-commercial payloads, but exclude government launches (*e.g.* the Space Shuttle or the International Space Station). The launch industry and satellite manufacturing data are counted on the year of the launch, and all data are presented in current US dollars (they are not adjusted for inflation).

Supplementary data include industry reports from Eurospace, which examine turnover of the European space industry. Eurospace draws on surveys complemented with additional data. The Eurospace data covers the development and production of spacecraft, launchers and related ground equipment.

Data comparability

As mentioned previously, it is a major challenge to obtain comparable international data on space activities, mainly because of statistical classification issues and the limits on the current definition of the industry. Although extensive, the data from private sources raise issues of double counting, especially with regard to revenue statistics (the input of one company may include the output of another one in its total). Some satellite manufacturing revenues may be also slightly misleading, since they reflect revenues when satellites are actually launched (*e.g.* SIA report), with 2005 figures reflecting mostly 2002 orders, a bad year for the industry. In fact in 2005, more than 20 satellites were ordered, so manufacturing revenues are sure to pick up in data from following years.

Data sources

- Satellite Industry Association (2006), *State of the Satellite Industry Report*, Futron Corporation, June.
- Satellite Industry Association/Futron (2007), *State of the Satellite Industry Report*, Futron Corporation, June.
- ASD-Eurospace (2007), *Facts and Charts: The European Space Industry in 2006*, June.

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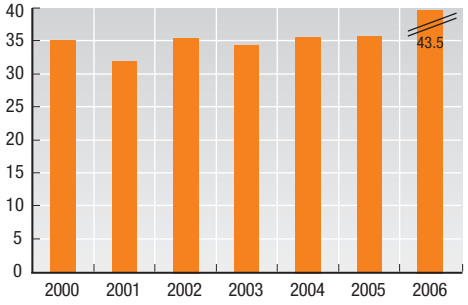
Figure 3.1a. **World satellite industry manufacturing revenues, 2000-2006**

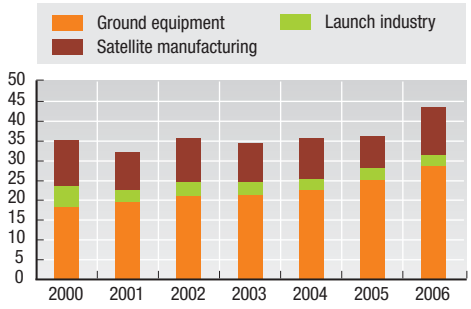
Billions of US dollars



Source: SIA (2007), *State of the Satellite Industry Report*, June.

Figure 3.1b. **World satellite industry manufacturing revenue by sector, 2000-2006**

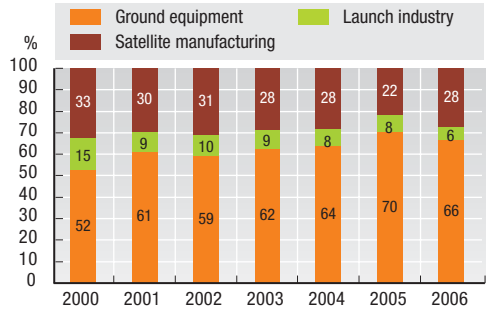
Billions of US dollars



Source: SIA (2007), *State of the Satellite Industry Report*, June.

Figure 3.1c. **World satellite industry manufacturing revenues by sector, 2000-2006**

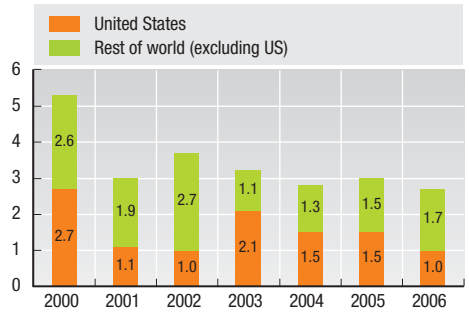
Percentage of worldwide manufacturing industry revenue



Source: SIA (2007), *State of the Satellite Industry Report*, June.

Figure 3.1d. **Worldwide launch industry[1] revenues, 2000-2006**

Billions of US dollars

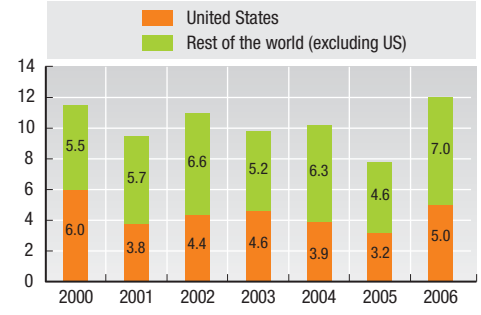


1. Includes both launch manufacturing and private launch services.Revenues based on year of launch and not when contract awarded.

Source: SIA (2007), *State of the Satellite Industry Report*, June.

Figure 3.1e. **Worldwide manufacturing of satellite revenues, 2000-2006**

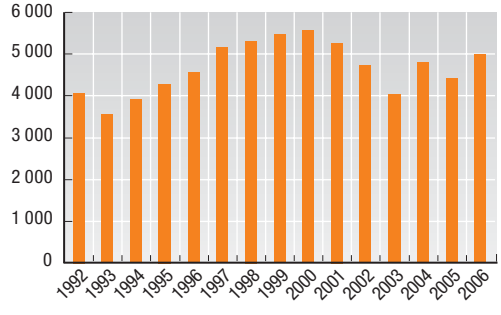
Billions of US dollars



Source: SIA (2007), *State of the Satellite Industry Report*, June.

Figure 3.1f. **Turnover by European space manufacturers, 1992-2006**

Millions of euros



Source: Eurospace (2007), *Facts and Figures*, June 2007.

3.2. SPACE-RELATED SERVICES

While the manufacturing and launch segments (the "upstream" segment) of the space sector have faced some challenges over the past five years (including a levelling-off in demand for launch services), space-related services markets (the "downstream" segment) continue to grow strongly.

Highlights

Space-related services revenues are not easy to gauge nationally and internationally, but worldwide estimates range from some USD 52.2 billion to 77.2 billion in revenues in 2005 (Figures 3.2aand 3.2c).

According to the US Satellite Industry Association (SIA), revenues from the world satellite services industry (mainly telecommunications and Earth observation services) were 83% higher in 2005 than five years earlier, and still growing in 2006. Telecommunications services, in particular direct broadcast satellite (DBS) services (*e.g.* satellite television), represent the bulk of commercial revenues with USD 48.5 billion in 2006 (Figure 3.2b). Further growth is expected due to expected satellite operators' consolidations and strong demand worldwide. Other space-related services, in Earth observation and navigation, are not generating as much revenue (Figure 3.2c), although governments, particularly defence departments, increasingly use satellite capacities, as demonstrated by their use of commercial satellite bandwidth (Figure 3.2d).

Several studies point to an increase in satellite services revenues in different markets over the next decade. For example, as a new generation of systems comes online, growth in the mobile satellite services market is expected to be more robust (Figure 3.2e). Concerning Earth observation, satellite imagery should benefit from increasing worldwide demand for geospatial products (*e.g.* weather forecasting) (Figure 3.2f).

Finally, revenue estimates for space-related services may be largely underestimated, as shown by the findings of the United Kingdom's recent space industry mapping exercise. It showed that companies making commercial use of space assets (capacities or products) were often neglected in existing industry surveys (Box 3.2).

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Definition

Space-related services use a specific satellite capacity, such as bandwidth or imagery, as inputs to provide a more global service to business, government or retail consumers. Those services are as diverse as space applications themselves. The services are traditionally divided into three large application domains: telecommunications, Earth observation (also called remote sensing) and navigation. Value chains often involve public agencies as investors and final users. As such, public authorities remain significant customers even in well-established commercial markets, such as telecommunications.

Methodology

As there are no official sources providing international estimates for space-related services, private sources have been used to provide at least some orders of magnitude. The activities presented here show the diversity of space-related services, and also the differing methodologies used to assess these markets.

Different definitions of specific products and services co-exist, and some reports from private sources tend to aggregate categories of services (*e.g.* SIA includes some remote sensing services in the category of fixed satellite services). In addition, companies may be

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involved in and gain revenues from various segments of a service's value chain. Hence, there are widely ranging results from US and European reports.

Due to their relative novelty and the lack of existing data, some space-related services are not covered here. This includes "space tourism" (*i.e.* paying for space adventure rides), which is just starting to develop.

Data comparability

Commercial satellite services markets are not only very diverse in nature, but also fragmented internationally into specific regional markets. Thus, an overarching global view of the space-related services sector is currently difficult to establish.

As in the case of space manufacturing, international data from private sources raise issues of double counting; and revisions to annual reports have introduced notable changes to estimated trends. For example, the 2006 SIA industry indicators report significantly revised its 2004 numbers, with DBS television revenues adjusted downward by USD 13 billion (almost 40% of the total).

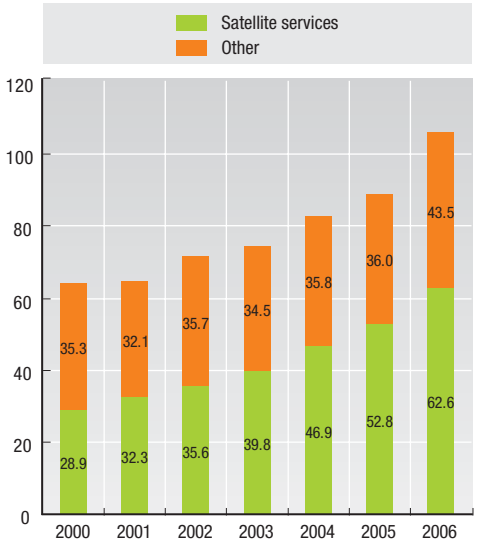
However, as demonstrated by the recent space industry mapping exercise in the United Kingdom, some services markets are still very much underestimated (Box 3.2). More work is needed to capture better space-related services and companies, which often have no direct links to the traditional space sector, but which nevertheless use space components.

Data sources

- BCC Research (2007), Remote Sensing Technologies and Global Markets, March.
- Bierett, R. (2007), Presentation for Telecom Info Days 2007, European Space Agency, ESTEC, April (using data from Euroconsult, 2006).
- BNSC (2006), BNSC Space Sector Mapping Study, April.
- National Space Society (2006), The Space Report, autumn.
- Northern Sky Research (2006), Government and Military Market for Commercial Satellite Services, March.
- Northern Sky Research (2006), Mobile Satellite Services, second edition.
- Satellite Industry Association (2007), State of the Satellite Industry, Futron Corporation, June

Figure 3.2a. **World satellite industry revenues for services and other[1], 2000-2006**

Billions of US dollars

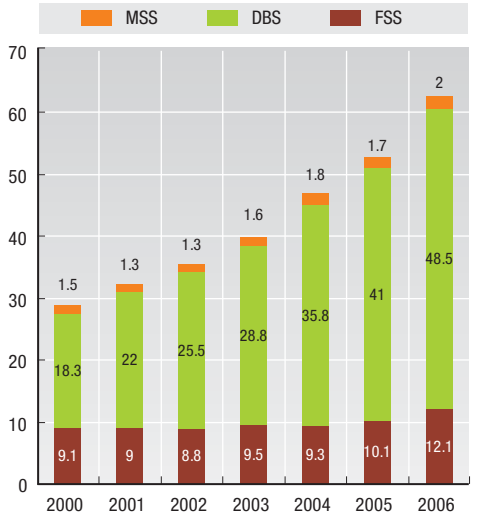


1. "Other" is ground equipment, launch industry and satellite manufacturing.

Source: SIA (2007), *State of the Satellite Industry Report*, June.

Figure 3.2b. **World satellite services revenue, 2000-2006**

Millions of US dollars



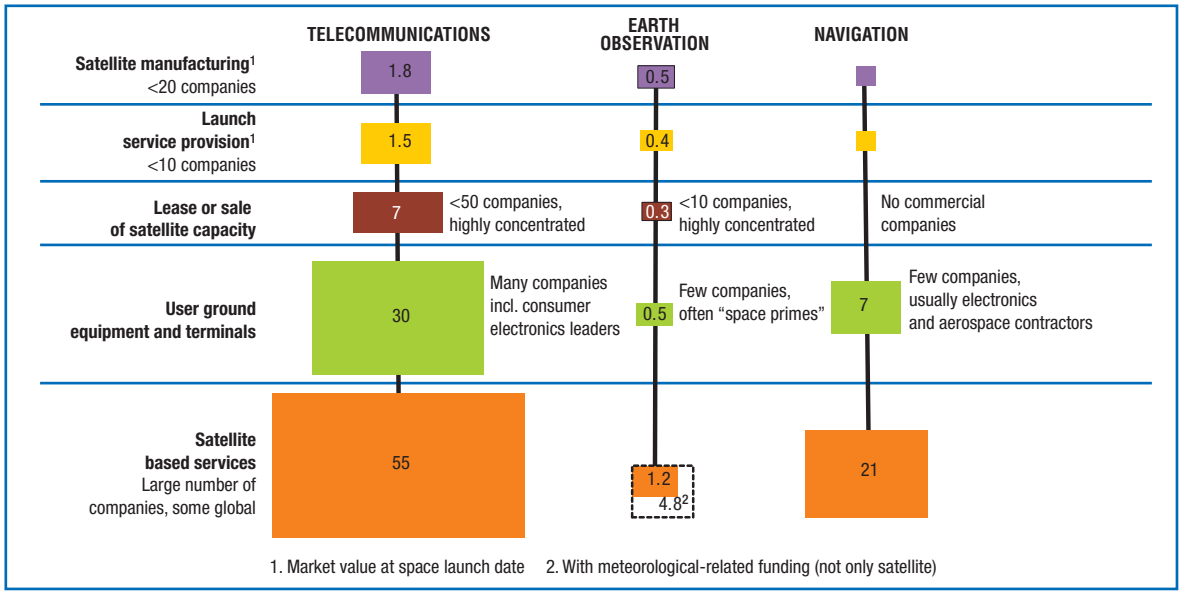
Notes: MSS (Mobile Satellite Services): Mobile telephone and mobile data.
DBS (Direct Broadcast Satellite): Direct to home television (DTH), Digital Audio Radio Service (DARS), and broadband.
FSS (Fixed Satellite Services): Very Small Aperture Terminal (VSAT) services, remote sensing, and transponders agreements.

Source: SIA (2007), *State of the Satellite Industry Report*, June.

3.2. SPACE-RELATED SERVICES

Figure 3.2c. **The three value chains in commercial satellite applications in 2005**

Revenues in billions of US dollars



1. Market value at space launch date.
2. With meteorological-related funding (not only satellite).

Source: R. Bierett (2007), *Presentation for Telecom Info Days 2007*, European Space Agency, ESTEC, April (data from Euroconsult, 2006).

Box 3.2. **Lessons learned in estimating space-related services revenues: The 2006 UK industry mapping study**

In 2005-2006, the British National Space Centre carried out an industry mapping study to help inform the UK Civil Space Strategy 2007-2010. A thorough study of the supply chains and networks of value added in the UK space sector helped identify a number of players that were not included in previous space industry surveys (*i.e.* BNSC's *Annual State and Health of the Space Sector* reports). It was found that there are many downstream application areas and markets in which space technologies are significant enablers and which represent large amounts of turnover. According to the research conducted, companies which sell satellite broadcast receivers as well as companies which resell satellite navigation transponders and satellite phones could / should be included if they make a partial use of space data in their business. In that context, the value-added figures from the *Annual State and Health of the Space Sector* report of GBP 2.2 billion are judged too small by at least 25%.

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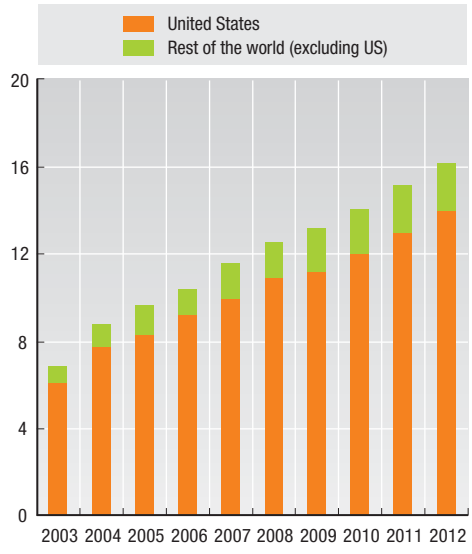
Figure 3.2d. **World government and military commercial satellite market total, 2003-2012**[1]



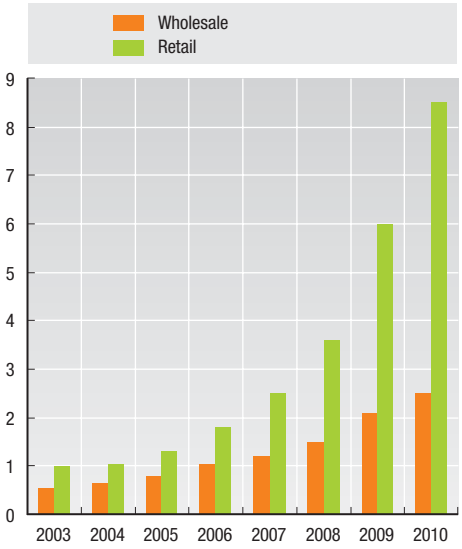
Bandwidth procured in gigabits per second

1. Estimated 2007-2012.

Source: Northern Sky Research (2006), *Government and Military Market for Commercial Satellite Services*, March.

Figure 3.2e. **World mobile satellite services market: Wholesale and retail revenues, 2003-2012**[1]

Billions of US dollars

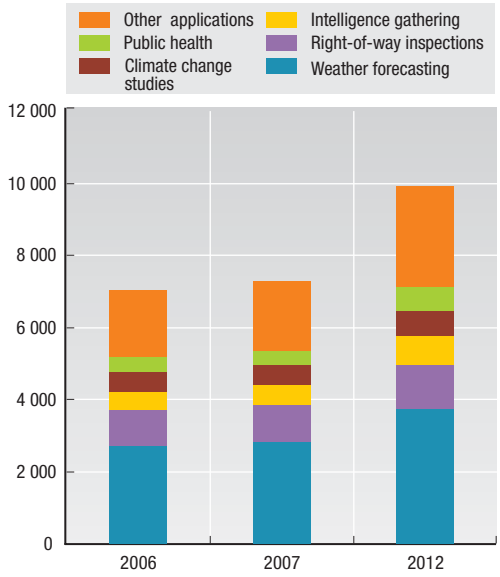


1. Estimated 2007-2012.

Source: Northern Sky Research (2006), *Mobile Satellite Services*, second edition.

Figure 3.2f. **Estimated global expenditures for remote sensing products by application, 2006-2012**[1]

Millions of US dollars[2]



1. Estimated 2007, 2012.
2. Includes more than just satellite imagery, *i.e.* aerial.

Source: BCC Research (2007), *Remote Sensing Technologies and Global Markets*, March.

3.3. INTERNATIONAL TRADE IN SPACE PRODUCTS

Although not many space products and services are fully commercial (*i.e.* most are strategic in nature and not freely traded), this section provides a partial overview of existing trade data by examining the exports of two commodity groups with significant space components from the International Trade in Commodity Statistics (ITCS) database, defined in detail below. Exports are those of OECD countries. Note that the United Nations refers to the database as the COMTRADE (Commodity Trade Statistics) database.

Highlights

Data for 2004 from OECD member countries reveal that exports of space products are dominated by a few major countries, with the G7 accounting for 91%, and the US, France and Germany alone accounting for 71% (Figure 3.3a).

Total space exports in 2004 fell by 13% compared with 2003, to USD 3.74 billion (Figure 3.3b). While exports of "*Spacecraft, including satellites, and suborbital and spacecraft launch vehicles*" (ITCS category HS880260) rose by USD 570 million, exports of the much larger category "*Parts of balloons, dirigibles, and spacecraft not elsewhere specified*" (HS880390), dropped by USD 1.135 billion leading to an overall decline from 2003 of USD 560 million.

Statistics from 1996 to 2004 also show that recent exports by OECD countries have fallen substantially from their high of 1998. It is important to note that a majority of exports since 1998 have been in the commodity code that includes non-space items ("*Parts of… spacecraft*") in addition to "*Spacecraft, including satellites…*". This trend parallels the cyclical downturn of the aerospace sector around 2001, mentioned previously.

An examination of G7 exports for 2004 reveals that they are focused on a few key markets (Table 3.3). In fact, 97% of the USD 3.395 billion space exports went to three of the 10 continents/regions and intra-G7 exports accounted for USD 1.98 billion (58%) of the total. Among non-OECD markets, Asia appears to be the most important with over 75% of the total.

Definitions

Trying to determine what exactly constitutes trade in space-related commodities can be complicated. Nevertheless, the two commodity codes employed clearly indicate "space-related" elements: (1) HS880260 ("*Spacecraft, including satellites, and suborbital and spacecraft launch vehicles*"); and (2) HS880390 ("*Parts of balloons, dirigibles, and spacecraft not elsewhere specified*"). The estimates from those commodity codes include therefore more items than just space products.

Methodology

Statistics on the quantity and markets for exports of OECD economies come from the ITCS database jointly managed by the OECD and the United Nations. It includes details on imports and exports for all UN member states. The OECD is responsible for the collection of statistics related to its member countries, and the UN for all others. Exports from these two commodity classifications are those of OECD countries to all countries of the world (both OECD and non-OECD member countries).

Comparability

The only case where export data on these commodities are not available is for the United Kingdom, which lacked the data for 1999, 2000, 2003 and 2004. As substitute measures of UK exports for these missing years, the values of imports of these two commodities by the rest of the world from the UK were used. All statistics are presented in current US dollars, by converting domestic currencies using annual trade-weighted aggregates of monthly exchange rates.

Data sources

- OECD / UN (2007), International Trade in Commodity Statistics (ITCS) database, April.

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Table 3.3. **G7 total exports of space products by country of destination,[1] 2004**

Millions of current US dollars of exports

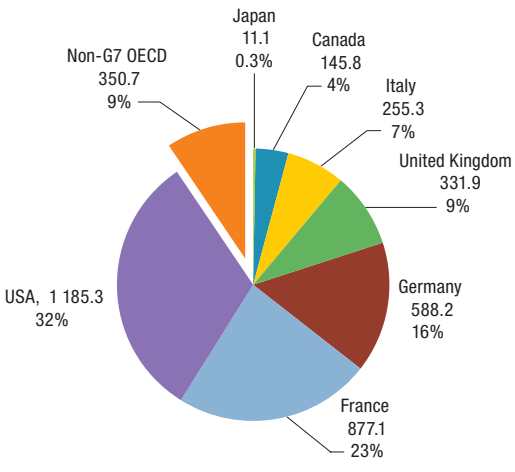
2004 G7 totals	Millions of US dollars	Percent
TOTAL	3 394.56	100.0%
By continent/region of destination:		
Europe	1 662.84	49.0%
Asia	1 236.36	36.4%
North America	395.36	11.6%
South America	45.78	1.3%
Middle East	21.47	0.6%
Africa	18.39	0.5%
Oceania	11.50	0.3%
Central America	2.94	0.1%
Unspecified	0.032	0.0%
Antarctica	0.000	0.0%
Of which:		
OECD countries	2 432.24	71.7%
Non-OECD countries	962.29	28.3%
Unspecified	0.00	0.0%
OECD countries	2 432.24	100.0%
Of which:		
G7 Countries	1 979.47	81.4%
Non-OECD countries	962.29	100.0%
of which:		
Asia (excluding Middle East)	724.26	75.3%
Europe	149.34	15.5%
Americas	48.73	5.1%
Middle East	21.47	2.2%
Africa	18.39	1.9%
Oceania	0.10	0.0%

1. Space products are: HS880260 (Spacecraft, etc.) and HS880390 (Parts of balloons, spacecraft, etc.).

Source: OECD/UN (2007), International Trade in Commodity Statistics (ITCS) database, April.

Figure 3.3a. **Amount and share of OECD space products exports, 2004**

Exports in millions of current US dollars and as a percentage of OECD total

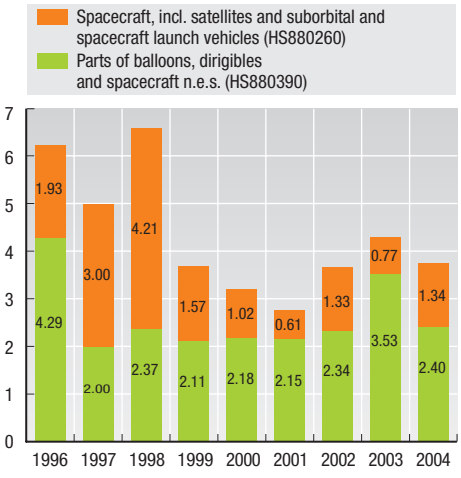


Source: OECD/UN (2007), International Trade in Commodity Statistics (ITCS) database, April.

StatLink http://dx.doi.org/10.1787/105381478683

Figure 3.3b. **OECD Exports of Space Products 1996-2004**

Exports in billions of current US dollars



Source: OECD/UN (2007), International Trade in Commodity Statistics (ITCS) database, April.

StatLink http://dx.doi.org/10.1787/105405043773

3.4. SPACE PATENTS

Over the years, OECD work has shown the reliability of patent data as an indicator of the technological innovation and economic health of a given sector. This is also true for the space sector and its derived applications. Surveys show that a large proportion of firms' inventions are patented and that a large proportion of patents become innovations with an economic use. Patents reveal inventions and innovations in small firms and in the engineering departments of large firms, which R&D indicators alone do not properly measure.

Highlights

Ever since the appearance of the first satellites and other systems at the dawn of the space age in the late 1950s, the space sector has been in the forefront of high tech innovation. More recently, the convergence of new information technologies and computer power has benefited both space systems and innovative "down-to-Earth" applications (*e.g.* communications, navigation, imagery). The number of space-related patents tripled between 1990 and 2000, both in Europe and the United States, but declined from 2001 on, due to a large degree to time-lag effects described below (Figures 3.4a and 3.4b).

Between 1980 and 2004, the OECD countries were responsible for 97% of all space-related applications to the European Patent Office (EPO) and nearly all the grants at the United States Patent and Trademark Office (USPTO) (Figures 3.4c and 3.4d). The US was the largest applicant with 47% of space patents at the EPO and 75% at the USPTO. France, Germany and Japan also accounted for a major portion of space-related patents at both offices. While the US tended to focus on "*Cosmonautics; vehicles or equipment thereof*" (category B64-related in the international classification) other countries (especially Japan) tended to focus on other more specialised patents (Figures 3.4e and 3.4f).

Definition

The space-related patents referred to in the figures primarily include all systems and applications included in the international statistical classification B64G: "*Cosmonautics; vehicles or equipment thereof*". This classification covers a large array of space-related systems and applications (including satellites; launchers; components; radio or other wave systems for navigation or tracking; simulators). In addition, a few other patent classifications were included, provided that the patent description contained certain key words.[1]

Methodology

For this analysis, space-related patents are defined using a mixture of International Patent Classification (IPC) codes and keywords. The principle IPC class used is "B64G" ("*Cosmonautics; vehicles or equipment thereof*") which covers technology related to developing and maintaining space-based systems, space exploration and peripheral equipment related to cosmonautics. The simplest type of patent indicator is derived by counting the number of patents that satisfy certain criteria. The criterion here was either that the statistical classification be "B64G" or another relevant patent classification containing certain keywords. In order to capture patents relating to applications relying on space-based technology, patent applications with the following IPC classes were chosen if the title of the patent application contained one or more of the following phrases: "GPS", "global position", "satellite", "remote sensing", "earth observation" and "geographic information system": *a)* G01S – Radio direc tion-finding; radio navigation; determining distance or velocity by use of radio waves; locating or presence-detecting by use of the reflection or re-radiation of radio waves. *b)* H01Q – Aerials. *c)* Radio transmission systems: H04B7/185/19 and /195 – Space-based or airborne stations, earth-synchronous stations and non-synchronous stations.

The data came from the OECD Patent Database, which provides links to all major patent databases such as those of the EPO and USPTO.

A key methodological issue is related to the visible downturn of patent applications since 2001. This is mainly due to delays and technical difficulties in updating patent databases and also the time-lag at the USPTO between the application of a patent and its granting. Thus, the downturn should not be misconstrued as a recession in terms of space-related patenting activities. Work is ongoing to see if space patents can be examined in greater detail to determine, for example, the linkages between patents and citations, licenses and other gauges to help quantify the relationship between patents and product development.

Data comparability

Patents presented here do not cover all space-related innovations, as many are protected by other types of intellectual property regimes, or by secrecy. The patenting activity of individual countries may also differ widely, depending on the patent institution considered. National data on countries' patenting activity can be broken down by region in order to investigate the geographical distribution of technological activities. The main methodological problem is how to assign individual patents to regions in a way that reflects the presence of inventive activity, as patents are usually assigned according to the address of the inventor or the firm that owns the patent.

Data sources

- OECD (2006), *OECD Patent Database*, September.

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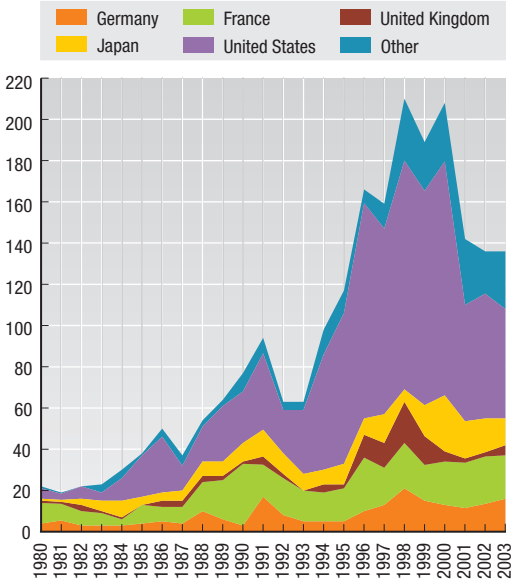
Figure 3.4a. **Breakdown of space-related patents at EPO, 1980-2003**[1]

Number of patents granted or pending by country of applicant



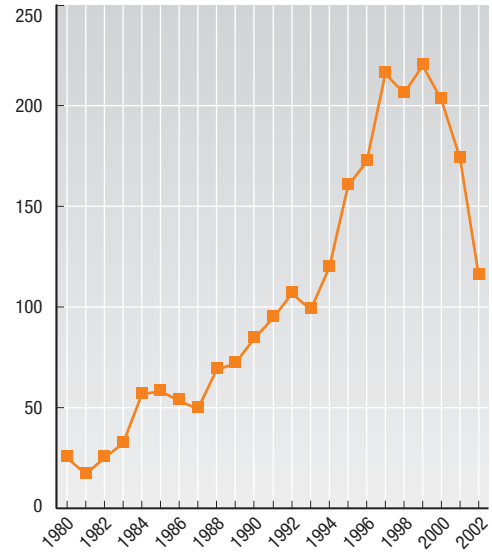
1. Please note the impact of time lag on last few years of data.

Source: OECD (2006), *OECD Patent Database*, September.

StatLink http://dx.doi.org/10.1787/105406846328

Figure 3.4b. **Breakdown of space-related patents granted at USPTO, 1980-2002**[1]

Number of patents granted per year to applicants from all countries



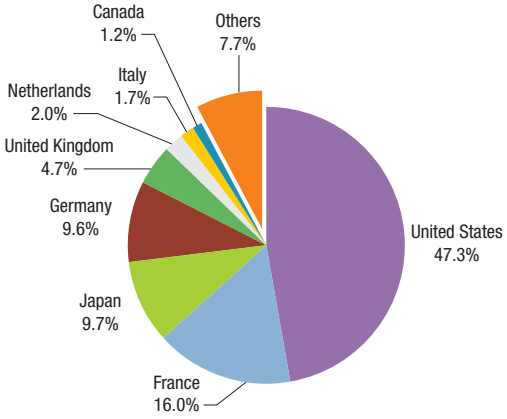
1. Please note the impact of time lag on last few years of data.

Source: OECD (2006), *OECD Patent Database*, September.

StatLink http://dx.doi.org/10.1787/105414700135

Figure 3.4c. **Breakdown of space-related patenting at EPO, 1980-2004**

Percent of all patents based on country of inventor

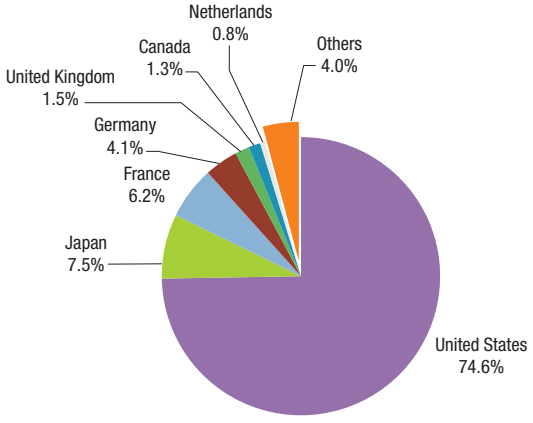


Source: OECD (2006), *OECD Patent Database*, September.

StatLink http://dx.doi.org/10.1787/105503285727

Figure 3.4d. **Breakdown of space-related patenting at USPTO 1980-2004**

Percentage of all patents based on country of inventor



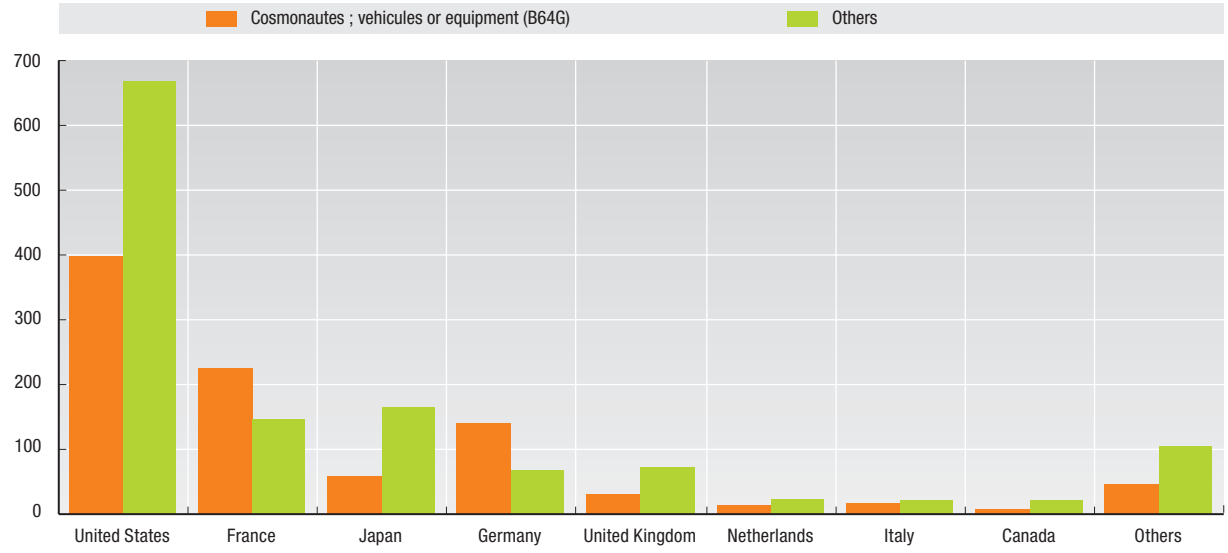
Source: OECD (2006), *OECD Patent Database*, September.

StatLink http://dx.doi.org/10.1787/105556480168

3.4. SPACE PATENTS

Figure 3.4e. **Breakdown of space-related patents by type and country at EPO, 1980-2004**

Number of patents granted or pending based on country of inventor

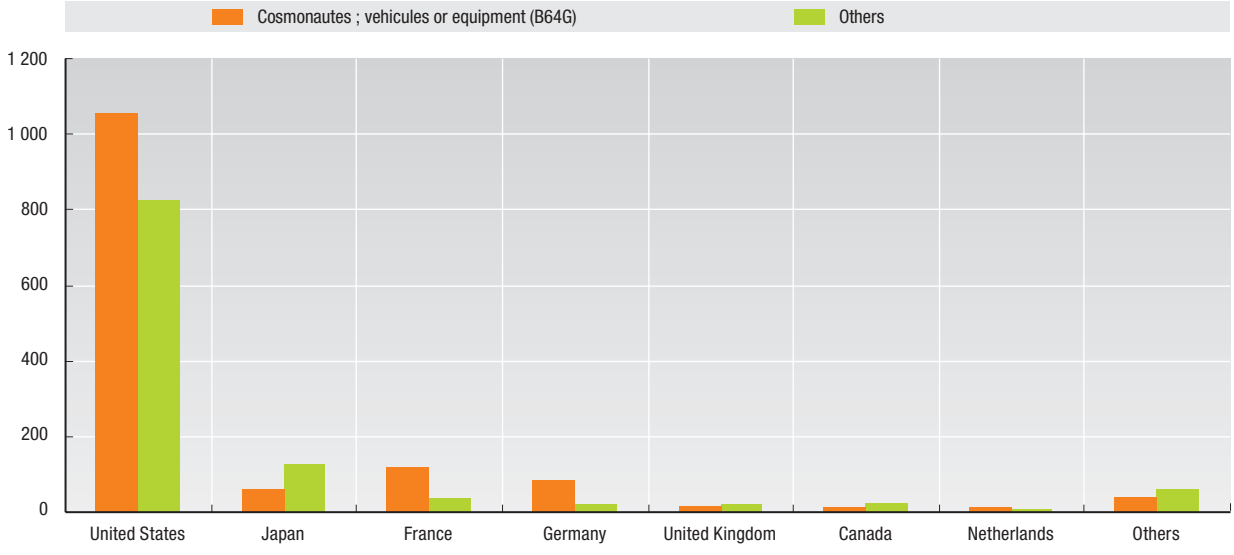


Source: OECD (2006), *OECD Patent Database*, September.

StatLink http://dx.doi.org/10.1787/105600723725

Figure 3.4f. **Breakdown of Space-related Patents by Type and Country at USPTO, 1980-2004**

Number of Patents Granted Based on Country of Inventor



Source: OECD (2006), *OECD Patent Database*, September.

StatLink http://dx.doi.org/10.1787/105657466582

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3.5. SPACE LAUNCH ACTIVITY

A dozen countries currently have an autonomous capability to launch satellites into orbit. The international space launch industry plays a pivotal role in enabling commercial and non-commercial actors to engage in civilian and military space activities.

Highlights

The number of launches has fallen off since the late 1990s (Figure 3.5a). Commercial launches have decreased largely due to the financial crisis faced by telecom operators in 2001. Not surprisingly, the same pattern is displayed in payload activity (Figure 3.5b). An examination of all launches by country from 2000 to 2006 reveals that, while all major launch providers (US, Russia and Europe) had fewer launches in 2006 than in 2000, some of the decline in the US and Europe was offset by gains by Russia and China (Figure 3.5c).

An examination of commercial launch events only over 1996-2000 and 2001-2006 reveals that gains by both Russia and the multinational firm Sea Launch happened at the expense of China and the US (Figures 3.5d and 3.5e). Revenues from commercial launches have tended to decline with declining launch activity (Figure 3.5f). The cyclical nature of satellite activities (*i.e.* the need to renew satellite fleets) and the growing number of countries with space programmes should contribute to more space launches over the next decade. International competition in commercial markets is likely to increase.

Definition

Space launch events can be broken down into two main types: commercial and non-commercial. A commercial launch event is one where the primary payload's launch is open to competition from any capable launch service provider. Hence, a commercial launch may be performed by either a government or private launch service provider. Conversely, a non-commercial launch event is any launch activity where the orbital transport service of the primary payload is not subject to competition.

Launch events from the Sea Launch venture refer to "multinational" launches that are done in international waters involving the partnership of organisations from four different countries (Norway, Russia, the Ukraine and the United States).

The payload may include one or more satellites, and may also be commercial or non-commercial. Commercial payloads refer to those where either: (1) the payload operator is a private firm; or (2) the payload is government-funded but it provides partial or total services through a semi- or totally private company. Non-commercial payloads can be of civil or military/government nature or not-for-profit (e.g. scientific exploration probes).

Methodology

The data included are mainly provided by the Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST). They include worldwide orbital and sub-orbital launch events that are conducted during a given calendar year (regardless of when the contract was signed). The data include all launch events and payloads, whether or not the launch or mission is considered to have succeeded.

Data comparability

The FAA data are subject to revision because of subsequent reclassification of commercial/non-commercial launches. Data on total launches were compared to data available from NASA's *Aeronautics and Space Report of the President, Fiscal Year 2004 Activities* which showed NASA having on average just two more launches per year (from 1997 to 2003) than FAA data. Other industry reports from different sources might vary in their definitions of commercial launches, but generally provide the same types of data on launch events.

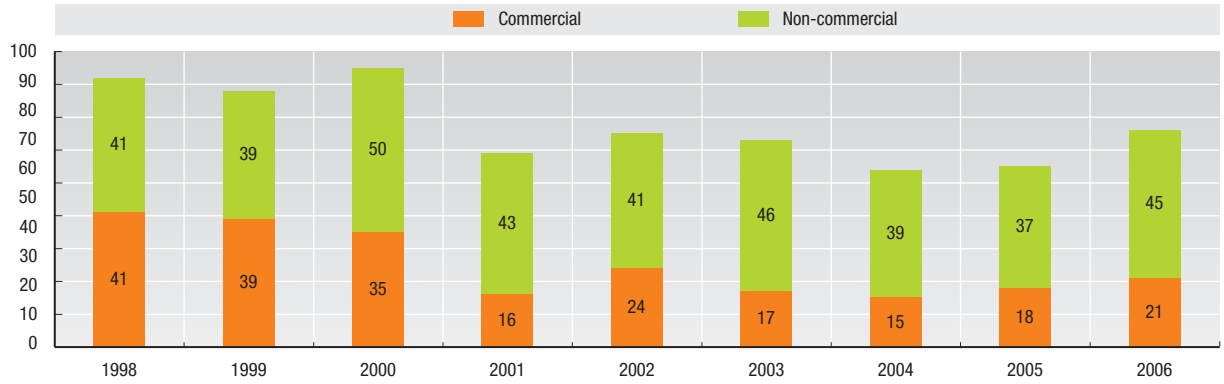
Data sources

- Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) (2007), *Commercial Space Transportation 2006: Year in Review*, January.

3.5. SPACE LAUNCH ACTIVITY

Figure 3.5a. **Total commercial and non-commercial launch events 1998-2006**

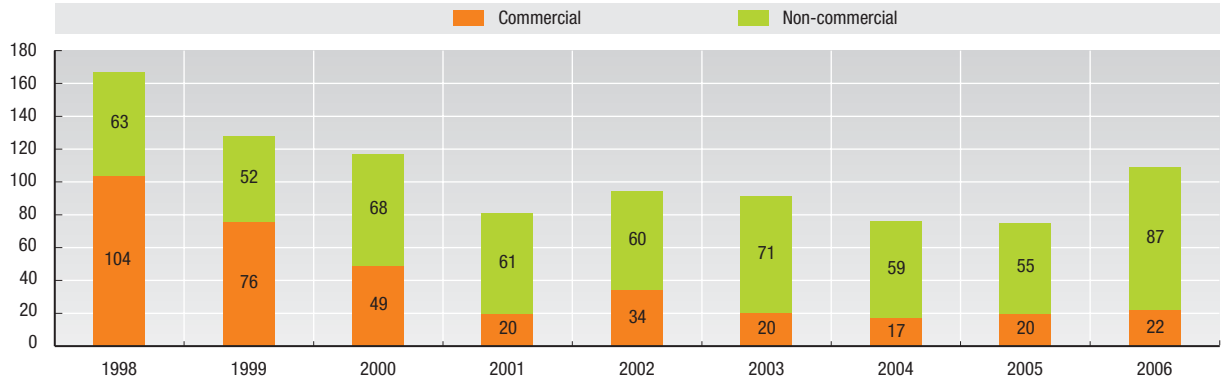
Number of launch events



Source: Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) (2007), *Commercial Space Transportation 2006: Year in Review*, January.

Figure 3.5b. **Total worldwide commercial and non-commercial payloads, 1998-2006**

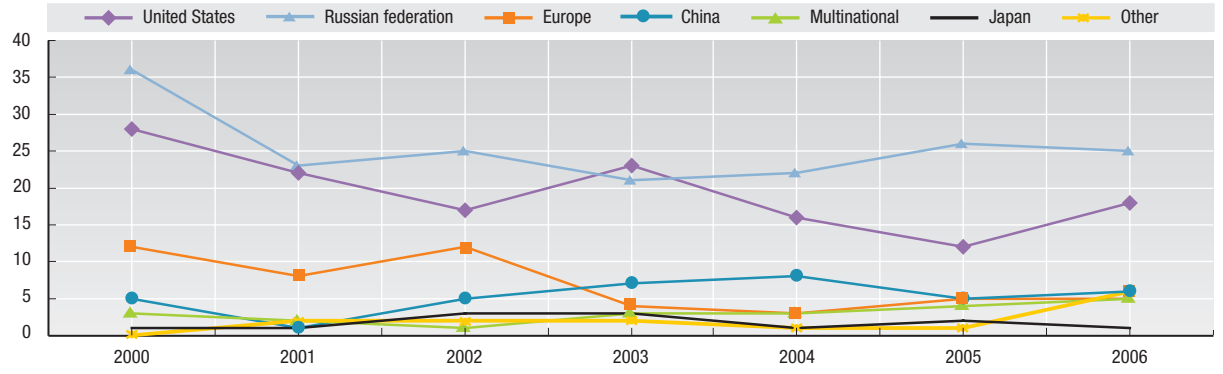
Number of payloads



Source: Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) (2007), *Commercial Space Transportation 2006: Year in Review*, January.

Figure 3.5c. **Total (commercial and non-commercial) launch events by country, 2000-2006**

Number of launch events



Source: Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) (2007), *Commercial Space Transportation 2006: Year in Review*, January.

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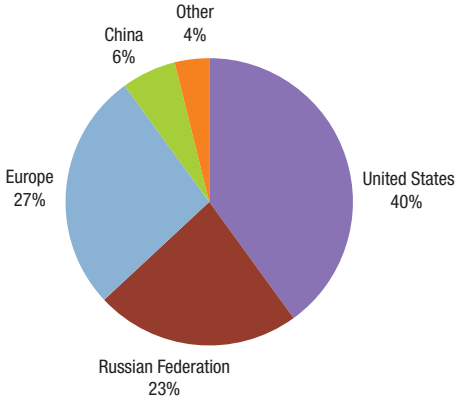
Figure 3.5d. **Breakdown of 177 worldwide commercial launch events, 1996-2000**

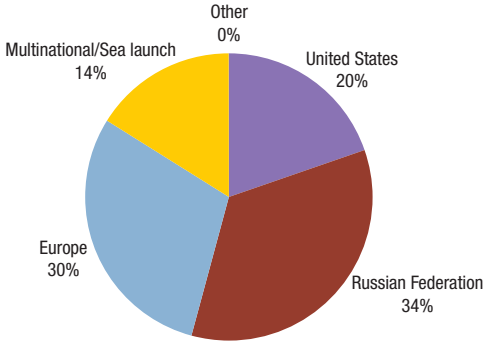
As a percentage of all launch events



Source: Associate Administrator for Commercial Space Transportation (AST), 2001.

Figure 3.5e. **Breakdown of 111 worldwide commercial launch events, 2001-2006**

As a percentage of all launch events



Source: Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) (2007), *Commercial Space Transportation 2006: Year in Review*, January.

Figure 3.5f. **Total worldwide commercial launch events and revenue, 1997-2006**

Number of launch events and launch revenues

Source: Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST) (2007), *Commercial Space Transportation 2006: Year in Review*, January.

3.6. SPACE EXPLORATION-RELATED ACTIVITIES

Countries with space programmes are increasingly investing in "down-to-Earth" space applications (*e.g.* telecommunications, Earth observation) for strategic and economic reasons. Nevertheless, space exploration remains a key driver for investments in innovative R&D and sciences, and it constitutes an intensive activity for major space agencies.

Highlights

Space exploration is probably the most visible face of space activities and constitutes an inherent mission of space agencies worldwide. Its achievements generate enthusiasm among the public and wide media interest, as shown by race to the Moon, Mars exploration by robots or the probe landing on Titan. Space sciences and planetary missions have developed markedly over the years. This trend is reflected in the current and planned robotic exploration missions of the solar system, in which the US, Europe and several Asian countries are active players (Table 3.6a).

In addition to robotic exploration, the development of a human presence in space has been a recurring theme since the 1950s for both political and prestige-related reasons. Currently only three countries – Russia, the US and China – have the autonomous capability to launch human beings into space; however, a total of 451 persons from 37 different countries have flown in Earth orbit as of late December 2006. Since the late 1990s, the feasibility of commercial human spaceflight endeavours is also being tested via "space tourism" ventures (Table 3.6b).

Definition

Space exploration is the physical exploration of outer-Earth objects, via robotic probes and human missions. More broadly, it also includes the scientific disciplines (*e.g.* astronomy, solar physics, astrophysics, planetary sciences), technologies and policies applied to space endeavours.

Methodology

Robotic missions presented here include active and planned orbiters (*i.e.* spacecraft whose purpose is to orbit a planet or an asteroid, usually to map the surface), planetary rovers (*i.e.* robots landing and roving on celestial bodies), and other exploration probes (*i.e.* spacecraft sent to fly by several celestial bodies). Planned missions may be cancelled, therefore only missions intended to be launched by 2008 have been included.Several dozen exploration probes have been launched over the years as national or international missions, targeting planets, moons, comets and asteroids in the solar system.

In the case of human spaceflight, several definitions for "astronaut" co-exist. The International Aeronautic Federation (IAF) calls anyone who has flown at an altitude of 100 kilometres an "astronaut". The US Air Force set the limit at fifty miles altitude (80.45 km), while other organisations consider that a person must have reached orbital velocity and remain in orbit (above 200 km) to be considered an "astronaut". The IAF definition has been used here.

Data comparability

The data presented are compiled from various sources. As there is no single information depository for international space exploration missions, the figures provided are estimates.

Data sources

- OECD IFP research (2007), including data from NASA Space Exploration website *http://solarsystem.nasa.gov*, accessed January; ESA Space Science website *www.esa.int*, accessed January; the online *Astronautic Encyclopediahttp://astronautix.com*, accessed January; and communications from French space experts C. Lardier and P. Coué.

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Table 3.6a. **Selected active and upcoming robotic exploratory probes, as of December 2006**[1]

Name of mission	Date of launch	Agency(ies)	Mission description
Lunar Reconnaissance Orbiter	2008	NASA (USA)	Lunar orbiter
Chang'e 1 ("Moon Goddess")	2007	CAST (China)	Lunar orbiter
Chandrayaan 1 (Hindi for "Moon Craft")	2007	ISRO (India)	Lunar orbiter
Selene	2007	JAXA, ISAS (Japan)	Lunar orbiter
Dawn	2007	NASA (USA)	Rendezvous and orbit asteroids Vesta (2011) and Ceres (2015).
Phoenix	2007	NASA (USA)	Lander to dig soil on northern plains of Mars and look for water-ice evidence (2008).
New Horizons	19 July 2006	NASA (USA)	On its way to Pluto and Kuiper belt (2015), flyby of Jupiter (2007).
Venus Express	9 Nov. 2005	ESA (Europe)	Venus orbiter
Mars Reconnaissance Orbiter	12 Aug. 2005	NASA (USA)	Mars orbiter
Messenger	2 Aug. 2004	NASA (USA)	On its way to Mercury (2011), flyby of Venus (2007).
Rosetta	2 March 2004	ESA (Europe)	On its way to Comet Churyumov-Gerasimenko (2014), flybys of Asteroid 2867 Steins (2008).
Opportunity	7 July 2003	NASA (USA)	Mars rover
Spirit	10 June 2003	NASA (USA)	Mars rover
Hayabusa ("Peregrine Falcon")	9 May 2003	JAXA, ISAS (Japan)	Landed and collected surface samples from the asteroid Itokawa (2005). Return to Earth planned for 2010.
Mars Express	6 Feb. 2003	ESA (Europe)	Mars orbiter
2001 Mars Odyssey	7 April 2001	NASA (USA)	Mars orbiter
Cassini	15 Oct. 1997	NASA, ESA, ASI (USA, Europe, Italy)	Saturn orbiter (the Huygens probe carried onboard landed on Titan in 2005).
Ulysses	6 Oct. 1990	NASA (USA)	Solar orbiter
Voyager 2	20 Aug. 1977	NASA (USA)	Exploration outside the solar system (currently +12 billion kilometres away from the Sun).
Voyager 1	5 Sept. 1977	NASA (USA)	Exploration outside the solar system (currently +15 billion kilometres away from the Sun).

1. In addition to those robotic exploration missions targeted at extraterrestrial bodies, more than a dozen space science satellites are in Earth orbit. Two large international space telescopes (NASA/ESA) are active as of Dec. 2006: the Hubble Space Telescope (launched in 1990) and SOHO, the Solar and Heliospheric Observatory (launched in 1995). Hubble's successor, the James Webb Space Telescope could be launched in 2013. The international CoRoT observatory, led by the French Space Agency (CNES) (launched in 2006), and NASA's Kepler observatory (to be launched in 2008) are designed in particular to search for Earth-like planets outside the solar system.

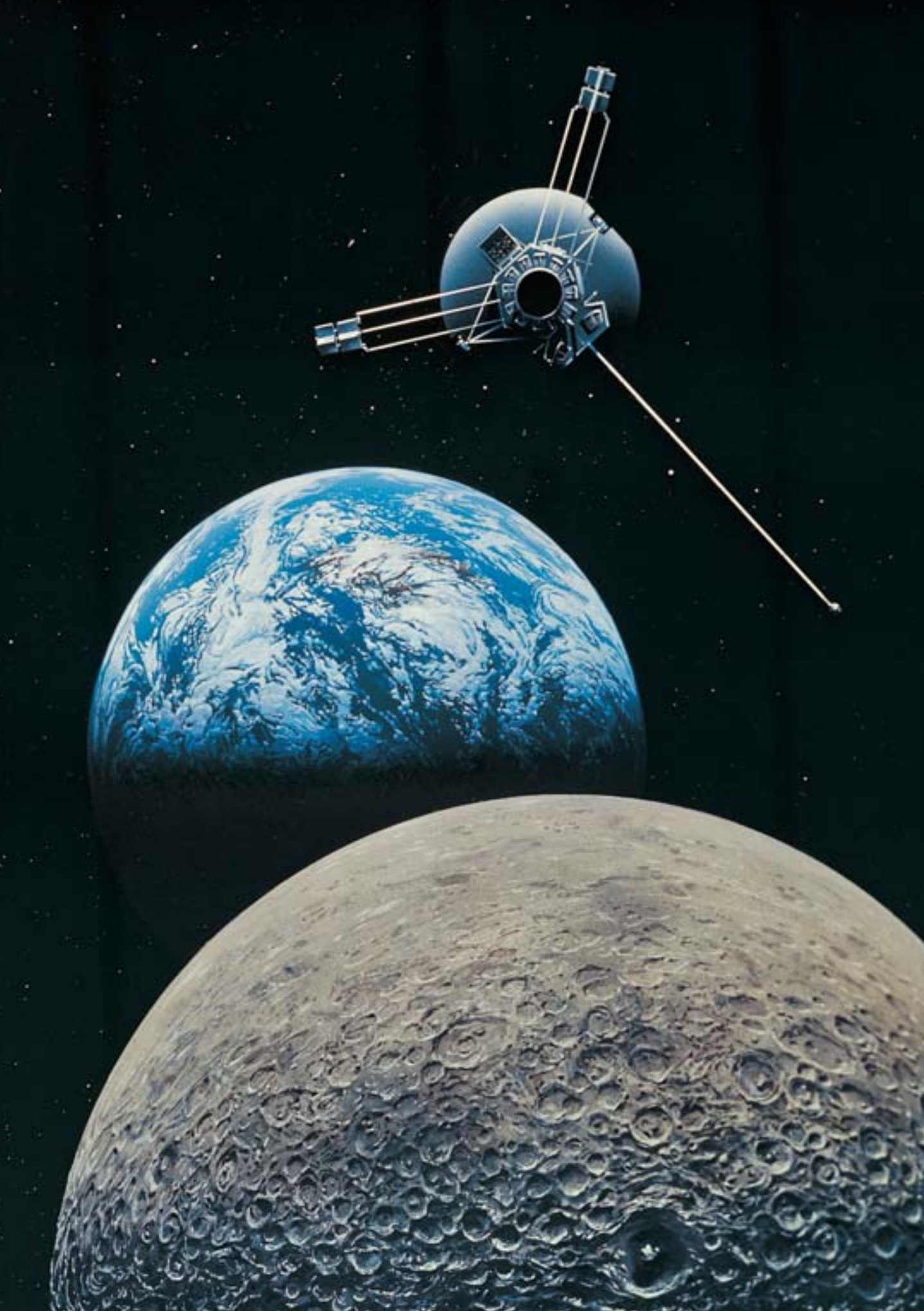
Source: OECD / IFP research (2007).

Table 3.6b. **Selected human spaceflight statistics as of December 2006**

Countries with autonomous capability to launch humans into space	3[1]
Number of launches with humans onboard	+240
Persons who have flown into orbit	451
Persons who have flown over the 100 km altitude threshold (including suborbital flights)	454
Number of nationalities who have flown in space	37
Astronauts who walked on the Moon (1969-1972)	12
Operational and inhabited space stations since the 1960s	9[2]
Professional astronauts currently in orbit (the International Space Station is continuously inhabited since 2003)	3
Number of paying orbital spaceflight participants ("space tourism")	4

1. China, Russia, US.
2. 7 Russian, 1 US, 1 international.

Source: OECD / IFP research, 2007.



List of Acronyms

AIA	Aerospace Industry Association of America
AIAC	Aerospace Industries Association of Canada
AIAD	Associazione delle Industrie per l'Aerospazio i Sistemi e la Difesa (Italian Industry Association for Aerospace Systems and Defence)
AIPAS	Associazione Italiana PMI per l'Aerospazio (the Association of Italian Small and Medium Aerospace Enterprises)
ANBERD	OECD Analytical Business Enterprise Research and Development database
ASAS	Associazione per i Servizi, le Applicazioni e le Tecnologie ICT per lo Spazio (Association for Space-based Applications and Services)
ASD	European AeroSpace and Defence Industries Association
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
BTD	The OECD STAN Bilateral Trade database
BERD	Business Enterprise Research and Development
BNSC	British National Space Centre
CAD	Canadian dollars (currency code)
CAST	China Academy of Space Technology
CNES	Centre National d'Études Spatiales (French Space Agency)
COMTRADE	United Nations' Commodity Trade Statistics Database
CPI	Consumer Price Index
CSA	Canadian Space Agency
CSG	Centre Spatial Guyanais (Space Centre in French Guiana)
DARS	Digital Audio Radio Services
DBS	Direct Broadcast Satellite
DTH	Direct to Home satellite
EO	Earth Observation satellite
EPO	European Patent Office
ESA	European Space Agency
ESA95	European System of Accounts 1995
ESTEC	European Space Research and Technology Centre
ESTP	European Space Technology Platform
EU	European Union
EUR	Euro (currency)
EUROSTAT	Statistical Office of the European Communities
FAA	US Federal Aviation Administration
FAI	Fédération Aéronautique Internationale (International Aeronautic Federation)
FAA/AST	US Federal Aviation Administration's Office of Commercial Space Transportation
FSS	Fixed Satellite Services

G7	Group of 7 leading industrial nations (Canada, France, Germany, Italy, Japan, United Kingdom, United States)
GBAORD	Government Budget Appropriations or Outlays for R&D
GBP	British pounds (currency code)
GDP	Gross Domestic Product
GIFAS	Groupement des Industries Françaises Aéronautiques et Spatiales (French Aerospace Industries Association)
GPS	Global Positioning System
IAF	International Aeronautic Federation
ICT	Information and Communication Technology
IFP	OECD International Futures Programmes
INSEE	Institut National de la Statistique et des Études Économiques (French National Institute for Statistics and Economic Studies)
IPC	International Patent Classification
ISIC	United Nations International Standard Industrial Classification
ISS	International Space Station
ITCS	International Trade in Commodity Statistics Database (UN/OECD)
JAXA	Japan Aerospace Exploration Agency
MSS	Mobile Satellite Services
NACE	Nomenclature d'Activité dans la Communauté Européenne (Economic Classification System in the European Community)
NAF	Nomenclature d'Activités Française (Economic Classification System in France)
NAICS	North American Industry Classification System
NASA	US National Aeronautics and Space Administration
NOAA	US National Oceanic and Atmospheric Administration
NOK	Norwegian krone (currency code)
NSC	Norwegian Space Centre (Norsk Romsenter)
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing Power Parities
R&D	Research and Development
RIMS II	Regional Input-Output Modelling System II
ROI	Return on Investment
SBAC	Society of British Aerospace Companies
SESSI	Service des études et des statistiques industrielles (French Service for Industrial Studies and Statistics)
SIA	US Satellite Industry Association
SNA	UN System of National Accounts
SOHO	Solar and Heliospheric Observatory (ESA and NASA)
SSB	Space Studies Board (US)
STAN	OECD Structural Analysis Statistics database
UK	United Kingdom
UN	United Nations
US	United States
USD	US dollars (currency)
USGS	US Geological Survey
USPTO	United States Patent and Trademark Office
VSAT	Very Small Aperture Terminals

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