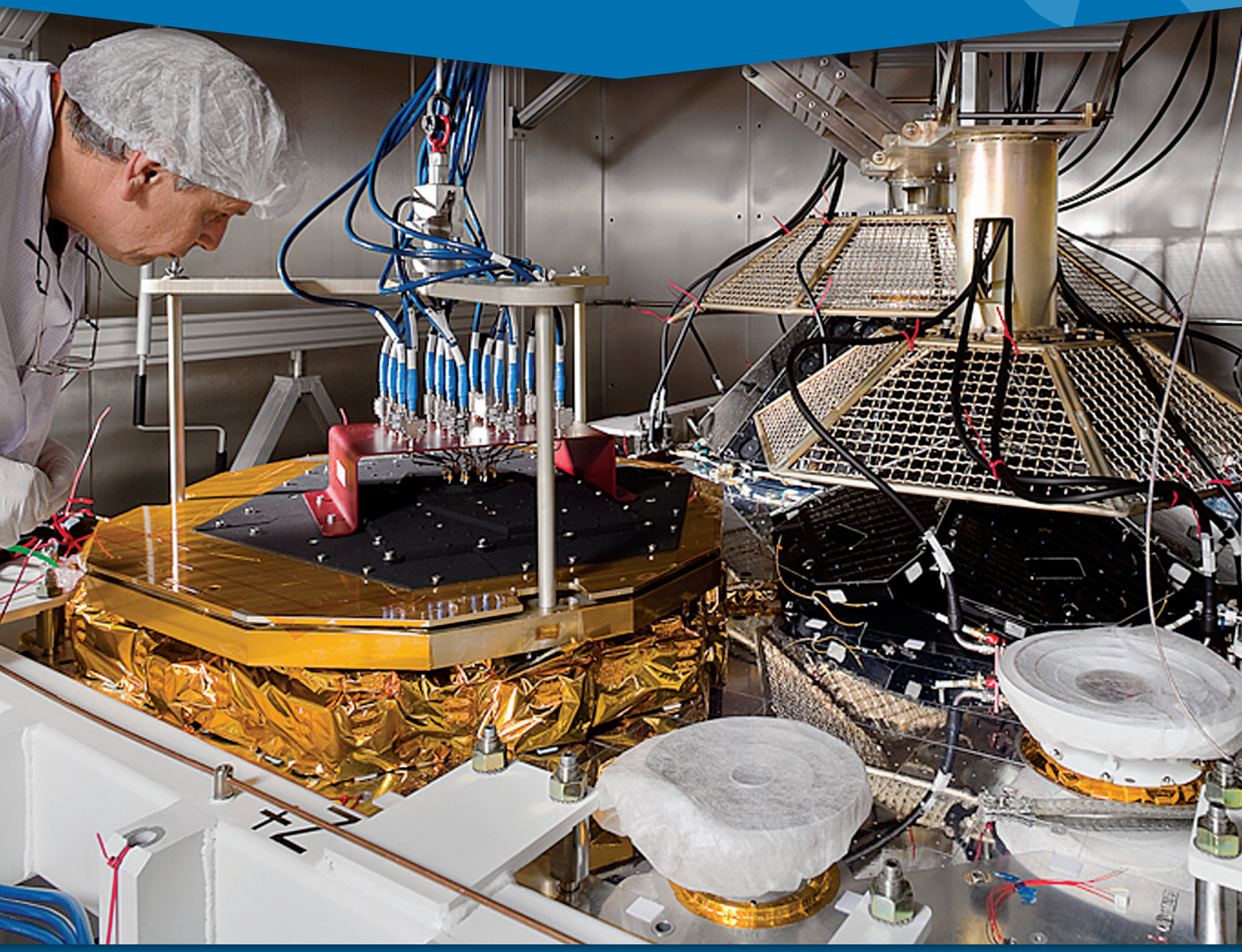
THE SPACE ECONOMY



SPACE FOUNDATION

THE SPACE REPORT

2011

A Thales Alenia Space engineer works on a second-generation Globalstar satellite. Globalstar plans to launch 24 of these satellites, six per launch, for its communications constellation. The advanced constellation, combined with the company's next-generation ground network, will provide Globalstar customers with data speeds of up to 256 kbps, push-to-talk, multimedia messaging, and data devices with GPS integration. *Credit: Boymond/Thales Alenia Space*

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2.0 Introduction

The global space economy continued to demonstrate strong growth in 2010, increasing by 7.7% to reach a record total of $276.52 billion. This figure shows the continuation of a five-year trend of expansion in the space economy, demonstrating growth of 48% from $186.84 billion in 2005. While many other industries declined in recent years due to the recession, growth in the space economy as a whole was at least 5% every year.

Much of the continuing growth in the space economy is driven by commercial space products and services, along with investment in the infrastructure necessary to deliver those services. Commercial space products and services, which include revenue for telecommunications, Earth observation, and positioning services, remain the largest source of revenue in the space economy, growing to $102.00 billion in 2010, a 9% increase from $93.45 billion in 2009. Commercial infrastructure and support industries, which include commercial spacecraft manufacturing, in-space platforms, ground equipment, launch services, independent research and development, and insurance premiums, showed the strongest percentage growth of any space sector in 2010, with revenues totaling $87.39 billion in 2010, a 13% increase from $77.12 billion in 2009. Commercial space transportation services revenues are estimated to total $10 million in 2010, an 88% decrease from $90 million in 2009. This decrease is due primarily to a lack of launch capacity to transport commercial passengers into orbit.

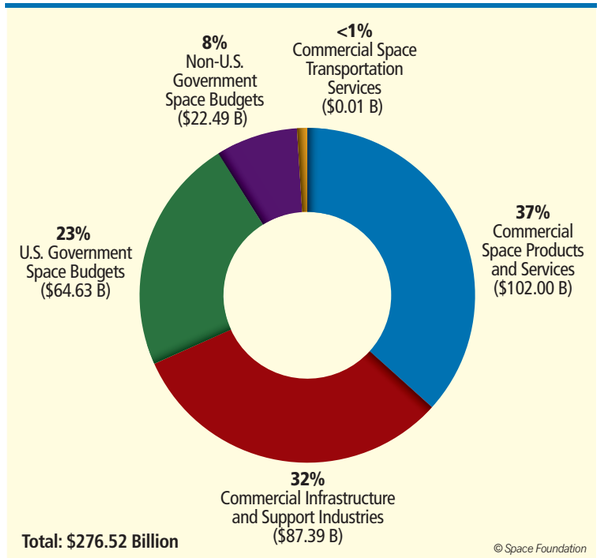
EXHIBIT 2b. The Global Space Economy

Year	Total	Growth
2005	$186.84 B	–
2006	$217.61 B	16.5%
2007	$232.33 B	6.8%
2008	$244.13 B	5.1%
2009*	$256.80 B	5.2%
2010	$276.52 B	7.7%

**The 2009 total was revised from the figure reported previously to incorporate year-end data*

Globally, government spending on space increased slightly from 2009 to 2010. The aggregate growth rate was 1.1%, bringing government spending to $87.12 billion in 2010, accounting for 32% of the global space economy. The U.S. government spent $64.63 billion in 2010, a 0.3% increase from the $64.42 billion spent in 2009. Meanwhile, non-U.S. government space investment reached $22.49 billion in 2010. For non-U.S. countries reviewed in both 2009 and 2010, government space expenditure remained relatively steady, with combined spending increasing by less than 1% from 2009.

EXHIBIT 2c. Global Space Activity, 2010



The strength of the space economy is due in part to the diversity of activities it encompasses, reflected within the space economy sectors shown in Exhibit 2c. In summary, the global space industry as a whole has demonstrated consistent growth over the past five years, suggesting positive prospects for deriving sizeable economic value from space in the future.[1]

EXHIBIT 2d. Revenues for Space Infrastructure, 2010

Commercial Infrastructure and Support Industries	Revenue	Source
Ground Stations and Equipment	$80.47 B	Satellite Industry Association (SIA)/ Futron analysis
Satellite Manufacturing (commercial)	$3.41 B	SIA/Futron analysis
Launch Industry (commercial)	$2.45 B	Federal Aviation Administration (FAA)
Insurance	$0.88 B	XL Insurance
Independent Research and Development	$0.18 B	Futron
Total	**$87.39 B**	

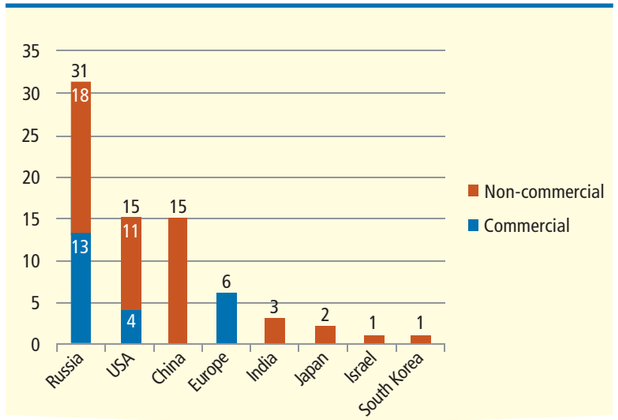
2.1 Commercial Infrastructure and Support Industries

Revenue for commercial space infrastructure, which includes launch services, satellite manufacturing, ground stations, and associated equipment, totaled $87.39 billion in 2010. Information regarding government spending on space infrastructure can be found in Section 2.3, *Government Space Budgets*.

2.1.1 Launch Industry

In 2010, 74 orbital launches occurred carrying 118 payloads into space. These payloads included satellites, other types of robotic spacecraft, and cargo and crew missions to the International Space Station (ISS). Compared to the 78 launches that took place in 2009, the launch rate in 2010 represents a 5% decrease, discontinuing a five-year annual average growth rate of 8% from 2005-2009. At the same time that there was a slight dip in the number of launches, the number of payloads actually increased due to multiple small payloads being deployed by some of the launches. Of the 74 launches in 2010, 23 were conducted by commercial launch providers, while 51 were non-commercial. Futron Corporation, a space industry consulting firm, estimates that the total launch expenditure in 2010, including 12 missions to the ISS, was approximately $7.35 billion. This represents a decrease of 11% from the $8.23 billion total for launches in 2009. Launches to the ISS totaled $1.98 billion in value in 2010. Data from the U.S. Federal Aviation Administration (FAA) indicates that revenue from commercially operated launches grew to $2.45 billion, a 2% increase from $2.41 billion in 2009. China and the multinational Sea Launch and Land Launch did not perform any commercial launches, while providers in the United States, Russia, and Europe increased their market share in 2010.[2]

EXHIBIT 2e. Orbital Launches, 2010



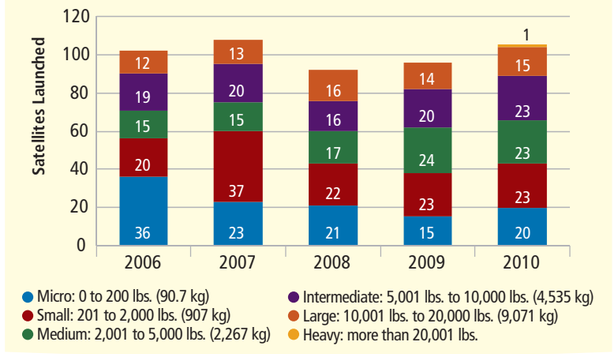
Source: Federal Aviation Administration

As has been the case for the past several years, Russia led the global commercial launch market with 13 commercial launches in 2010, representing 57% of the market. Europe captured 26% of the market, with six Ariane 5 commercial launches in 2010. U.S. vehicles accounted for 17% of the global commercial launch market, with four launches in 2010 generating approximately $307 million in revenue. Launch industry forecasts can be found in Section 3.3.1, *Orbital Launch Vehicles.*

2.1.2 Satellite Manufacturing

In 2010, a total of 105 satellites were launched into space, up by 9% from the 96 satellites launched in 2009. This total includes most spacecraft but excludes missions to the ISS and launch vehicle demonstration missions.

EXHIBIT 2f. Satellite Mass Class, 2006–2010



Source: Futron

The 105 satellites represented approximately $10.55 billion in manufacturing revenue. This figure represents a 25% decline from the 2009 total of $14.04 billion. The lower total is due to the deployment of relatively less expensive satellites in 2010. In particular, 2009 saw the launch of several high value defense-related satellites, which inflated that year's total. During the past five years, the mass of satellites has remained relatively consistent. A comparison of the mass classes of satellites deployed between 2006 and 2010 is shown in Exhibit 2f. Commercial satellite manufacturing revenue decreased from the 2009 total of $4.03 billion to $3.41 billion in 2010, a 15% decline. There were 27 commercially operated satellites launched in 2010, an increase from 26 launched in 2009. Commercial satellites manufactured in the United States totaled 10 in 2010 and were valued at $1.75 billion as compared to 17 satellites valued at $2.75 billion in 2009. The U.S. share of commercial satellite manufacturing revenues in 2010 dropped to 51% of the worldwide total from 68% in 2009.

EXHIBIT 2g. Satellite Manufacturing Revenue Estimates, 2010

Type	Revenue
Government	$7.14 B
Commercial	$3.41 B
Total	**$10.55 B**

2.1.3 Space Stations

The ISS is the only crewed space station in orbit. Due to be completed in 2011, the ISS is also the most active and massive space station ever deployed. NASA, a main contributor, received $2.32 billion for the ISS in fiscal year (FY) 2010 compared to $2.06 billion approved by Congress in FY 2009. This funding does not include flight or ground operations costs of shuttle flights to and from the ISS. Two new modules were added to the ISS during 2010. In February, Space Shuttle *Endeavour* delivered the Tranquility module, which contains life support systems and a unique seven-windowed cupola from which astronauts can conduct robotic operations. In May, Space Shuttle *Atlantis* delivered the Russian-built Mini-Research Module-1 to the station. The 6-meter (twenty-foot) module, also called Rassvet, provides cargo storage and an additional docking port. During 2010, three Space Shuttle missions, five Progress and four Soyuz missions transported cargo and crew to the ISS. After ISS assembly is complete in 2011, the international crew of six astronauts aboard the station will focus more on conducting research and testing technologies. Following Space Shuttle retirement, NASA is planning to meet ISS cargo transportation needs with commercial space vehicles contracted under the Commercial Resupply Services (CRS) program. Other partners will also provide cargo transportation using the European Automated Transfer Vehicle (ATV), the Japanese H-II Transfer Vehicle (HTV), and the Russian Progress vehicle. Crew transportation needs will be met by the Russian Soyuz vehicle until other crew transportation services become available.

Bigelow Aerospace, a commercial company, continued development of its habitation modules in 2010. The company's founder, Robert Bigelow, has spent about $180 million of his own money so far and has stated that he is willing to spend up to $320 million more to develop modules that can be linked together to form space stations or Moon bases.[3] Bigelow has already successfully launched and tested two demonstration modules. The company is currently doubling the size of its Las Vegas, Nevada, facilities as part of the transition from research and development into production. Bigelow Aerospace aims to deploy its first habitable space station in 2014, with a larger station to be deployed in 2016. The two stations could host up to 36 people at a time and would require 15–20 rocket launches each year for supplies and crew transportation.[4]

2.1.4 Ground Equipment

The ground equipment market totaled an estimated $80.47 billion in 2010, a 16% increase above the $69.53 billion total for 2009. Ground equipment includes all the Earth-based infrastructure and technology necessary to communicate with and manage satellites. This includes major network ground control stations, mobile satellite terminals such as very small aperture terminals (VSATs) for private networks, and broadcast video distribution stations. It also encompasses end-user consumer equipment, such as satellite radios, satellite phones, satellite TV receiver dishes, and satellite navigation chipsets, maps, and software. The revenue from these categories is combined into one figure representing the ground equipment market.[5] Ground equipment revenues are driven by its largest component, geolocation and navigation equipment sales, which accounts for 89% of revenue.

2.1.5 Infrastructure Support Industries

The satellite insurance industry saw profits improve in 2010. Aon/ISB, an insurance brokerage, reported that 2010 premiums totaled approximately $885 million and claims amounted to $374 million.[6] XL Insurance, a space industry specialist, estimates that 2010 premiums totaled $880 million, while insurance claims totaled $353 million. These estimates indicate that 2010 was a better year than 2009, when Aon/ISB reported premiums of $800 million and $400 million in claims.

Total independent research and development (IR&D) expenditures in support of space activity were estimated at $181 million for 2010. IR&D is research and development (R&D) initiated and conducted by defense contractors independent of Department of Defense (DoD) control. Space IR&D is estimated by applying the ratio between DoD space R&D and total DoD R&D to the total DoD IR&D estimate from the Defense Contract Audit Agency.

EXHIBIT 2h. Revenues for Commercial Space Products and Services, 2010

Category	Revenue	Source
Direct-to-Home Television	$79.22 B	SIA/Futron analysis
Satellite Communications	$17.92 B	SIA/Futron analysis
Satellite Radio	$2.84 B	SIA/Futron analysis
Earth Observation	$2.01 B	Northern Sky Research
Total	**$102.00 B**	

2.2 Commercial Space Products and Services

The commercial space products and services sector remains the largest component of the space economy. Total revenue for commercial space products and services in 2010 is estimated at $102 billion, 9% more than the 2009 total of $93.45 billion. This estimate includes revenues from satellite broadcasting, satellite communications, and Earth observation products and services. Geolocation and navigation-related revenues are included in the ground equipment sector due to the fact that the majority of revenue is generated by receiver hardware sales. However, the nature of geolocation and navigation products and services is discussed within commercial space products and services. Broadcasting services continue to produce the highest revenues for the commercial satellite services sector due to direct-to-home (DTH) television, which reached $79.22 billion in 2010 sales, a 10% increase from $71.82 billion in 2009. Satellite communications, which include fixed satellite services (FSS) and mobile satellite services (MSS), followed with $17.92 billion in revenues for 2010, a 5% increase from $17.07 billion in 2009. Satellite broadcasting and communications continue to dominate the commercial space products and services, generating 98% of the total revenue.

EXHIBIT 2i. North American Direct-to-Home Television Revenue, 2010

Company	2008	2009	2010*
DIRECTV	$17.45 B	$18.67 B	$20.94 B
DISH Network	$11.62 B	$11.66 B	$12.64 B
Total	**$29.07 B**	**$30.33 B**	**$33.59 B**

**Estimated annual revenue*

2.2.1 Broadcasting

The estimated 2010 revenues for DTH television increased to $79.22 billion in 2010 from $71.82 billion in 2009. DTH comprises 77% of the revenue within the commercial space products and services sector. North American DTH providers DirecTV and DISH Network are the two

largest operators, with combined 2010 revenues estimated at $33.59 billion. As of September 2010, DirecTV and DISH Network had a combined total of 33.2 million subscribers. Other DTH television providers contributed the remaining $45.63 billion in 2010 revenues.

According to market analyst Northern Sky Research (NSR), the number of DTH television subscribers is expected to exceed 217 million by 2019.[7] In North America, high definition channels, digital video recorders, and interactive services are the greatest demand drivers and will likely remain so in future. Despite high hopes for three dimensional (3D) television, usage remains low with DirecTV debuting only three 3D channels in July 2010.[8] Several other operators are also conducting trials of 3D services.[9] While content for 3D television is currently limited, the number of channels is likely to grow over time with initial focus on sports and adventure programming.[10]

On a global scale, the Indian DTH market is one of the markets with the highest subscriber growth. According to market research firm RNCOS, India is expected to surpass North American providers in subscriber base by 2013, with total subscribers reaching 23.5 million as of June 2010.[11] The number of DTH subscribers in India is projected to grow by 48% by 2014.[12] The Indian DTH market is being served by six companies: Dish TV, Tata Sky, Sun Direct, Big TV, Airtel Digital TV, and Videocon D2H.

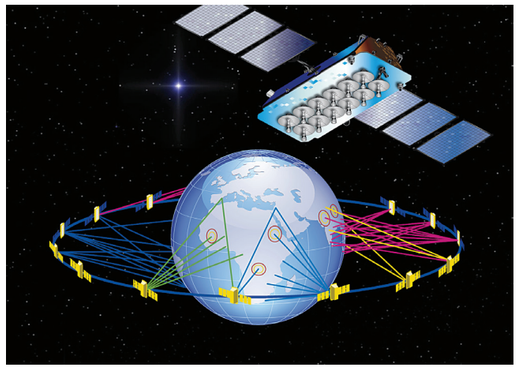
The XM-5 satellite was launched in October 2010 to provide services to Sirius XM satellite radio subscribers, who now number more than 20 million. In addition to radio, the satellite will also help deliver services such as XM NavTraffic, which provides real-time traffic information to vehicles across North America. *Credit: Space Systems/Loral*

Another fast-growing region is Eastern Europe, with subscribers reaching 17.5 million in 2010 compared to 10.7 million in 2008. This increase is fueled by the strong performance of the Polish and Russian markets. Poland's DTH market grew 34.8% from 4.7 million subscribers in 2008 to 6.1 million in 2010. Russia's market more than doubled from two million homes in 2008 to 4.7 million homes in 2010.[13]

Revenue from satellite radio broadcasting in 2010 is estimated to be $2.84 billion, a 12% increase over 2009. Following the bankruptcy and liquidation of WorldSpace, which had provided services globally, satellite radio is available only in North America. U.S.-based Sirius XM announced in November 2010 that it has more than 20 million subscribers despite operating in a difficult financial environment. The company attributes its success to positive consumer opinions of its service and strategic content programming.[14] Industry speculation indicates that, with the added satellite capacity gained by deployment of XM-5 in October 2010, Sirius XM may be positioned to consider bringing service to new markets beyond North America.[15] In the meantime, Spanish company ONDAS Media continues its preparations to begin a satellite radio service in Europe in 2012.

2.2.2 Satellite Communications

The satellite services sector, which includes fixed and mobile satellite services, registered $17.92 billion in 2010 revenue, up from $17.07 billion in 2009. Both types of services communicate information in video, voice, and data formats. Fixed satellite services (FSS) refer to the delivery of satellite communications to stationary ground receivers that can be moved from one location to another but do not work while in transit. Mobile satellite services provide similar capabilities but the communication link ties to mobile receivers, such as satellite telephones or in-flight communications.

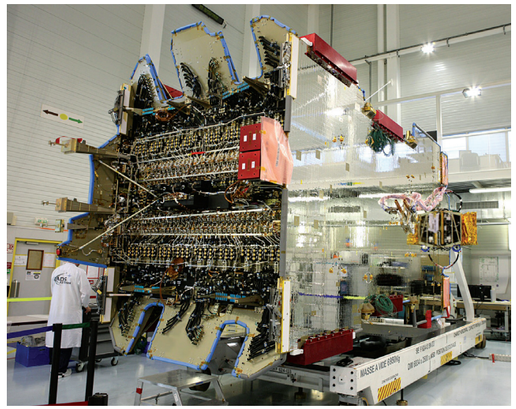


This artist's conception shows the O3b constellation, which will consist of 16 satellites in low Earth orbit. The constellation will offer connectivity to internet service providers in markets in the Middle East, Africa, Asia and the Pacific, and the Americas. *Credit: Briot/Thales Alenia Space*

The FSS market has consolidated around four global providers that represent approximately 60% of the total market: Intelsat, SES, Eutelsat, and Telesat. This market segment has demonstrated continued financial resilience in the face of the recent economic contraction without sacrificing deployment of new offerings and performance improvements. Satellite operators continue to develop new approaches for using satellites to provide communications services. An example is the deployment of new satellites with higher throughput that can enable residential broadband internet services for areas where terrestrial networks are unavailable or insufficient. The FSS operators have also created partnerships across the industry with satellite manufacturers, equipment providers, resellers, and customers, including everything from hosted payloads and hybrid network operations to the repurposing of satellites for new services, markets, and customers.[16]

O3b Networks is a new operator building a medium Earth orbit (MEO) satellite constellation to deliver satellite internet services as well as mobile backhaul services for purposes such as connecting remote cell phone towers to communications networks. The company's stated mission is to connect the "other three billion people" currently without communications services. In November, O3b announced that it had secured $1.2 billion in financial commitments, enough to deploy its satellites, from diverse investment sources that include SES, HSBC, LibertyGlobal, the Development Bank of South Africa, Sofina, Satya Capital, Google, Northbridge Venture Partners, and Allen & Company.[17] O3b intends to begin commercial service during the first half of 2013 following the planned launch of its first eight satellites.

The estimated revenue for consumer satellite broadband internet services in 2010 is $788 million, an 11% increase from 2009. U.S. providers Hughes Network Systems and ViaSat's Wildblue Communications continue to dominate this sector with a 96% share of the market and a combined 925,000 subscribers as of October 2010.[18] Other developments include ViaSat's non-binding agreement with JetBlue to develop a new in-flight broadband internet access system for customers on the JetBlue fleet of more than 160 aircraft. ViaSat will be providing capacity using its WildBlue-1 satellite and the new ViaSat-1 satellite, which will launch in the second half of 2011. In Europe, Avanti Communications' HYLAS-1 satellite was launched in November 2010 and Eutelsat's KA-SAT satellite in December 2010. Both satellites were built to provide broadband internet access in the region. HYLAS-2 is set for a launch in the second quarter of 2012.[19]



The KA-SAT satellite uses an innovative design to deliver Eutelsat's Tooway broadband internet service, available to consumers across Europe and the Mediterranean Basin. With throughput of more than 70 gigabits per second, KA-SAT will be capable of serving more than one million users. *Credit: Dominique Marques/Astrium*

A notable global trend in the broadband internet sector is increasing government support for consumer broadband services. The U.S. government is promoting a National Broadband Plan, to provide more than $7 billion for construction and deployment of broadband networks. The U.S. government awarded $100 million to four satellite broadband providers: $58.7 million to Hughes Network Systems, $19.5 million to Viasat's Wildblue Communications, $14.2 million to EchoStar, and $7.5 million to

Spacenet.[20] There are similar initiatives in countries such Australia, New Zealand, and a number of European countries. One of the most advanced is the Australian government's $38.4 billion National Broadband Network, which will use two satellites to serve approximately 200,000 rural and suburban users throughout the country.[21]

The MSS market continues to experience revenue growth despite strong competition among providers. In 2010, the MSS market saw lower service costs for satellite phones and growth in new maritime and aeronautical services. While revenue growth was modest in 2009 and 2010, major investment in new MSS satellite systems has occurred as the result of positive industry forecasts and the increased use of export credit agency loan guarantees. Most notably, Globalstar and Iridium have received assistance from the French export credit agency Coface for the financing of their second-generation MSS constellations, as discussed in Section 5.1.1, *Alternative Business Models Provide New Opportunities for Growth.* Inmarsat also announced investment of $1.2 billion in a next-generation satellite network that will provide high-speed mobile broadband service targeted for maritime, energy, government, and aeronautical markets.[22]

EXHIBIT 2j. Earth Observation Revenue Estimates

Revenue Source	2009	2010	2019
Data Sales	$0.83 B	$0.89 B	$1.80 B
Value-Added Services	$1.06 B	$1.12 B	$2.00 B
Total	**$1.89 B**	**$2.01 B**	**$3.80 B**

Source: Northern Sky Research

2.2.3 Earth Observation

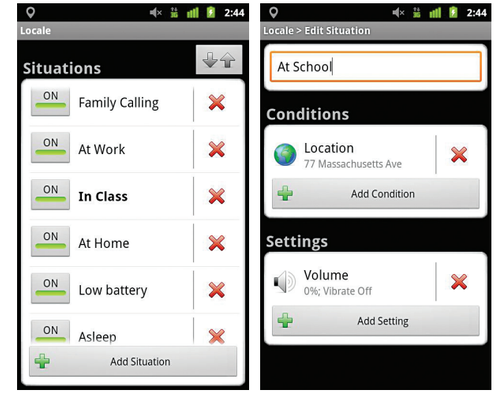
Earth observation revenue in 2010 totaled $2.01 billion, 6% more than the $1.89 billion estimated by market research firm NSR in 2009.[23] Revenues within the Earth observation sector are generated by data sales and value-added services (VAS). Value-added services include new products and services created from existing raw satellite data. According to NSR, the Earth observation market has grown due to demand by civil government and military organizations for applications in the fields of defense, intelligence, surveillance, and security as well as environment and climate change. The commercial and enterprise markets have also increased their adoption of Earth observation data products and services, but at a slower pace. In 2009, NSR estimated that approximately 65% of revenue came from government and military users while 35% came from commercial and enterprise markets. The Earth observation data and VAS markets are expected to grow at an average rate of about 8% per year, reaching $1.8 billion and $2 billion respectively by the end of 2019.[24] This growth will be tied to large contracts from defense and intelligence, food safety and security, and environmental sectors. The commercial and enterprise markets in energy, natural resources, insurance, and online maps will also be key contributors to this growth.

NSR forecasts that the number of operational Earth observation satellites will increase from 180 satellites in 2009 to approximately 240 satellites by 2019. It is expected that 77% of these satellites will be used for civil government or military services, with North America, Europe, and Asia leading the growth.[25] On the satellite manufacturing side, total Earth observation revenue will grow at an average annual rate of 0.8% with average revenues at about $3.5 billion. As of 2010, every dollar spent on satellite systems and ground infrastructure generates roughly three dollars of revenue for value-added services.[26] Global Earth observation market revenues from data sales, services, and satellite manufacturing are expected to reach $7.7 billion per year by the end of 2019.[27]

2.2.4 Geolocation and Navigation

The market for products and services that use satellite geolocation and navigation systems as a significant enabler is one of the largest and fastest-growing in the space industry. Total global market revenue for 2010 is estimated at $71 billion compared to $57 billion in 2008. This estimate is derived from the Global Navigation Satellite System (GNSS) Market Report released by the European GNSS Agency (GSA) in October 2010.

The GSA report divides the global market into four segments: personal navigation devices and in-vehicle systems, location-based services, agriculture, and aviation. Location-based services includes satellite navigation-enabled mobile phones and services. However, only the parts of the mobile phone's retail price that are attributable to geolocation and navigation such as chipset, maps, and navigation software are included. The largest volume of users are found in the automotive sector, followed by the mobile phone sector, with 56.4% and 42.8% market share respectively. The GSA expects that the worldwide market will increase at an average annual rate of 11% between 2008 and 2020, with revenue reaching $203 billion per year by 2020.



The Locale App for the Android mobile operating system gathers data from GPS, Wi-Fi, and cellular transmissions to determine the device's location, which can then trigger actions based on user-defined settings. For example, an "At School" setting could set the device to silent mode and turn off Wi-Fi to save battery life. *Credit: two forty four a.m.*

Global shipments of personal navigation devices and in-vehicle systems, such as those manufactured by Garmin and TomTom, are estimated at 115 million units for 2010. North America leads with 43 million units, followed by the European Union and the rest of the world with 36 million each. By 2018, it is expected that North American and EU markets will begin to saturate and the fastest growth will be observed elsewhere, with global annual sales of 347 million units.

The GNSS-enabled mobile phones and services sector is forecast to expand rapidly. Global shipments of GNSS-enabled mobile phones reached 352 million units in 2010 and are expected to reach 1 billion in 2020. This is driven by increasing attractiveness and affordability of devices offering location-based services. Besides navigation, new applications such as mobile commerce and location-based games are becoming prevalent.

For the aviation sector, GNSS-based navigation systems complement radio navigation systems near airports. In addition to GNSS integration into new aircraft avionics systems, older aircraft can be easily outfitted with standalone GNSS units that do not require a complete avionics overhaul. Shipments of GNSS devices worldwide for the aviation market reached 94,000 units in 2010, up 3% from 91,000 units in 2009. Annual shipments are predicted to increase to 147,000 units by 2020.

Preloaded with airport charts, topographical data, and road maps, Garmin's Aera series of portable GPS devices gives pilots a single navigation solution for both aviation and driving. *Credit: Garmin*

GNSS equipment in the agriculture sector is being used in increasingly sophisticated applications. Traditionally, GNSS devices have been used for low-accuracy fertilization, cultivation, and logistics applications such as land parcel identification and measurement. Newer and more sophisticated solutions use GNSS to manage crops that require high-accuracy cultivation. This specialized agricultural equipment is capable of precise transplantation of plants and mechanical removal of weeds. Annual shipments of GNSS devices in the agriculture sector are expected to grow in all regions from 118,000 units in 2010 to 537,000 units by 2020. This increase is mainly driven by growth in the number of tractors and higher penetration of GNSS in new tractors.[28]

2.2.5 Commercial Space Transportation Services

Development continued in 2010 on new commercially operated transportation services that can carry cargo, passengers, and possibly professional astronauts into space. SpaceX and Orbital Sciences made significant

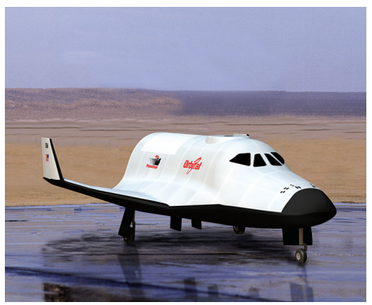
progress in development of cargo transportation systems that will be used to resupply the ISS. NASA provided funding to advance development of commercial crew transportation concepts. Although no commercial human spaceflight occurred in 2010, companies developing vehicles to carry people into space attracted investment while testing vehicles and passing milestones in infrastructure development.

Following retirement of the Space Shuttle in 2011, NASA is planning to resupply the ISS through a mix of foreign and domestic cargo and crew space transportation services. The Commercial Orbital Transportation Services (COTS) program is providing funding to support development of U.S. commercial cargo transportation capabilities. Two launch vehicles and associated spacecraft have received funding under the COTS program: Orbital Sciences' Taurus II rocket and Cygnus spacecraft and SpaceX's Falcon 9 rocket and Dragon spacecraft. Both SpaceX and Orbital have won contracts under NASA's Commercial Resupply Services (CRS) program, a follow-on to the COTS program, to provide cargo supply services to the ISS. Under these contracts, SpaceX and Orbital are required to launch a minimum of 20 tons of cargo each to the ISS through 2016.

Employees of Paragon Space Development Corporation successfully test the Commercial Crew Transport Air Revitalization System, supported by funding from NASA's CCDev 1 program. The partnership concluded in December 2010 within budget and on schedule, meeting all technical requirements. *Credit: Paragon Space Development Corporation*

SpaceX was selected to execute 12 missions under the program for $1.6 billion, with an option for additional missions that may bring the cumulative total to $3.1 billion. In June 2010, SpaceX successfully completed the first launch of the Falcon 9 launch vehicle. Development and testing of the Dragon spacecraft continued, leading to the first successful launch, in-space maneuvering, re-entry, and recovery of the Dragon capsule in December 2010.

Orbital Sciences has been contracted for eight flights to the ISS for $1.9 billion. In 2010, the Taurus II launch vehicle made significant progress towards a first launch planned for late 2011. Orbital Sciences also made major advancements in its construction of the Taurus II launch pad at NASA's Wallops Flight Facility in Virginia. In July, it was announced that a new $312 million demonstration flight prior to Orbital's first CRS mission will be funded by NASA.[29]



The spacecraft proposed by Orbital Sciences for NASA's CCDev 2 program would seat four astronauts and launch atop an expendable launch vehicle, such as the Atlas V rocket. The vehicle would return to Earth with a conventional runway landing. *Credit: Orbital Sciences*

No commercial spaceflight customers flew during 2010. This compares with two passenger flights in 2009. Both customers in 2009 flew on the Soyuz spacecraft and stayed for more than a week aboard the ISS. Retirement of the Space Shuttle will mean increased demand for crew transport services to the ISS via Soyuz. However, in January 2011, Space Adventures announced that three seats on Soyuz spacecraft bound for the ISS will begin to be available in 2013. To accomplish this, Space Adventures will need to raise enough funding for Russia to increase production of the Soyuz from four to five spacecraft per year.[30]

In February 2010, NASA announced the award of Commercial Crew Development 1 (CCDev 1) Space Act Agreements to Blue Origin, Boeing, Paragon Space Development, Sierra Nevada Corporation, and United Launch Alliance. CCDev 1 awards totaled $50 million in funding by NASA to advance development of commercial crew transportation concepts. Funding is divided amongst awardees as depicted in Exhibit 2k. A second round of awards, dubbed CCDev 2, was expected to be announced in March 2011. NASA has plans to fund full-scale development of multiple commercial human spaceflight systems capable of carrying astronauts to the ISS by 2012. NASA's Kennedy Space Center in Florida will lead development of the full-scale crew capability with help from Johnson Space Center and other NASA centers. NASA originally requested $500 million for commercial crew capability development in FY 2011 but the NASA Authorization Act signed by the U.S. President in October 2010 only authorizes $312 million in 2011 and $1.3 billion total from 2011 to 2013.[31] According to NASA, the majority of funding in 2011 will be dedicated to CCDev 2 awards.

Suborbital spacecraft development continued in 2010 with a variety of business deals and hardware tests. Vertical takeoff, vertical landing vehicle developer Armadillo Aerospace signed an agreement in April with Space Adventures to offer competitively priced seats on suborbital vehicles that Armadillo is developing.[32] XCOR Aerospace and Virgin Galactic/Scaled Composites continued development of winged suborbital spacecraft capable of carrying passengers into space.

The first Lynx vehicles will be operated by XCOR from the Mojave Spaceport and Civilian Aerospace Test Center. XCOR is also working with Space Experience Curaçao (SXC) and the Republic of Korea to supply leased Lynx spacecraft, representing a backlog of vehicle orders approaching $50 million.[33] Under the agreement with SXC, announced in October, XCOR will maintain and operate the Lynx vehicle while SXC will market the venture and operate Space Port Curaçao, beginning in January 2014.[34] In November 2010, KLM Royal Dutch Airlines announced a new relationship with SXC to promote Lynx flights through purchases, inclusion in its frequent flyer program, the development of KLM vacation packages, and other support.[35] XCOR is also working with the Yecheon Astro Space Center in the Republic of Korea to supply leased Lynx Mark II suborbital spacecraft. In addition to the leasing agreements, XCOR has booked approximately 100 reservations on the Lynx Mark I for space tourism and scientific research missions.[36]

EXHIBIT 2k. Commercial Crew Development Round 1 Awards

Company	Award
Boeing	**$18 million** to begin development of the CST-100 spacecraft
Blue Origin	**$3.7 million** for development of the composite crew module and escape system for the New Shepard spacecraft
Paragon Space Development	**$1.4 million** to advance an engineering model for an air revitalization system to be used in new spacecraft
Sierra Nevada	**$20 million** to support development of a hybrid rocket engine and structure for its Dream Chaser spaceplane
United Launch Alliance	**$6.7 million** for an emergency detection system required to human-rate the Atlas or Delta rocket families

Source: Space News

Virgin Galactic continued development of its commercial human spaceflight vehicle capable of carrying six passengers into space on a suborbital trajectory. Passenger flights will begin once the flight testing program is successfully completed. Virgin Galactic has not yet released its final testing schedule. To date, Virgin estimates it has invested $200 million, and an additional $280 million investment was made by Aabar Investments in 2009. Virgin Galactic believes it has generated enough investment to support completion of spacecraft development and to begin initial commercial operations.[37] The company reports signing up 400 potential passengers with deposits totaling more than $54 million.[38] In its first year, Virgin Galactic hopes to fly 500 passengers.[39]

2.2.6 In-Space Activities

In-space activities include research and development services, manufacturing, satellite refueling, and orbital debris clean-up. NASA's Commercial Reusable Suborbital Research Program (CRuSR) is helping fund development of vehicles capable of carrying payloads on brief trips into space. The CRuSR program will spend up to $15 million annually through 2013 to fly research payloads on commercial suborbital vehicles. The funding is intended to spur development of new technology, improve microgravity research, and support the fledgling suborbital launch industry. In August 2010, NASA awarded CRuSR contacts of $475,000 to Armadillo Aerospace and Masten Space Systems to help fund test flights.[40] Masten signed an agreement in May 2010 with XCOR Aerospace to develop robotic landers for use in missions to the Moon, Mars, and asteroids.[41]

The Google Lunar X PRIZE is a $30 million international competition among privately funded teams to send robots to explore the lunar surface and transmit high resolution video and imagery back to the Earth. Competition participants must seek out sources of funding to support their projects. A major funding source became available in August 2010, when NASA announced a $30 million program to purchase data from X PRIZE participants through 2012, called the Innovative Lunar Demonstrations Data (ILDD) program. The data will be used to assist development of future NASA human and robotic lander vehicles and exploration systems. In October, NASA selected six teams to participate in the program, including Astrobotic, Next Giant Leap, FREDNET, Omega Envoy, the Rocket City Space Pioneers, and Moon Express. In December, NASA awarded $500,000 to three ILDD organizations to address the top technical risks associated with a low-cost lunar surface mission. Each team is required to improve a challenging technical component of its mission to a level of readiness necessary to actually conduct the spaceflight.[42]

EXHIBIT 2l. Government Space Budgets, 2010

Country/Agency	Budget (U.S. Dollars)	Source	Description
United States	$64.63 B	See Exhibit 2n	Fiscal Year 2010 Request/Authorization
European Space Agency	$4.60 B	European Space Agency	Calendar Year 2010 Appropriation
European Union	$1.63 B	European Commission	Calendar Year 2010 Appropriation
Brazil	$0.18 B	Government of Brazil	Calendar Year 2011 Authorization
Canada*	$0.29 B	Government of Canada	Fiscal Year 2010/2011 Appropriation
China	$2.24 B	Futron estimate	Calendar Year 2010 Estimated Spending
France*	$0.92 B	*Space News*	Calendar Year 2010 Appropriation
Germany*	$0.64 B	Government of Germany	Calendar Year 2010 Appropriation
India	$1.25 B	Government of India	Fiscal Year 2010/2011 Allocation
Israel	$0.01 B	Futron	Calendar Year 2010 Estimated Spending
Italy*	$0.44 B	Government of Italy	Calendar Year 2010 Planned Spending
Japan	$3.83 B	Society of Japanese Aerospace Companies	Fiscal Year 2010/2011 Appropriation
Russia	$3.04 B	GlobalSecurity.org estimate	Calendar Year 2010 Planned Spending
South Korea	$0.21 B	Government of South Korea	Calendar Year 2010 Planned Spending
Spain*	$0.05 B	Government of Spain	Calendar Year 2010 Appropriation
United Kingdom*	$0.10 B	United Kingdom Space Agency	Fiscal Year 2009/2010 Appropriation
Emerging Countries	$0.74 B	See Exhibit 2z	
Non-U.S. Military Space	$2.30 B	Futron	Futron estimate
Total	**$87.12 B**		

**Excludes ESA spending*

2.3 Government Space Budgets

Government spending on space remains strong even in the midst of tight budgets, with continuing financial commitments to space exploration, national security programs, and scientific research. Investment has also continued in societal-benefit programs covering disaster planning and management, rural communications, and initiatives to stimulate broadband connectivity. While the United States accounts for 74% of global government space spending, on par with recent years, a large and growing number of countries appropriate sizeable sums for various space programs. Government space programs accounted for approximately $87.12 billion in spending during 2010, which represents about a third of the total global space economy.

This year's report includes space spending data from a variety of new sources, including the Indonesian, Malaysian, Taiwanese, Thai, and Turkish governments. Excluding these new additions, government investment in space worldwide increased by approximately 0.3% since 2009. The top line figures, however, do not fully depict how some countries significantly increased space spending while others made cuts, as can be seen in Exhibit 2m. Since not all governments operate under the same fiscal year cycle, international space spending numbers were derived from the most recent budgetary information available for each country. The figures reported in the following country profiles are presented first in the local currency, and then in U.S. dollars as of June 30, 2010. Changes in exchange rates from year to year mean that budget growth from 2009 to 2010 in the local currency may appear as a decline when viewed in U.S. dollars, and vice versa.

EXHIBIT 2m. International Space Budget Growth, 2010

Country/Agency	Currency	2008 Funding	2009 Funding	2010 Funding	2009–2010 Change
European Space Agency*	Euro	€3.03 B	€3.59 B	€3.74 B	4.3%
Brazil*	BRL (Reais)	BRL0.294 B	BRL0.298 B	BRL0.330 B	10.8%
Canada*†	CAD	C$0.317 B	C$0.315 B	C$0.303 B	-3.8%
France†	Euro	€0.691 B	€0.738 B	€0.749 B	1.5%
Germany*†	Euro	€0.426 B	€0.537 B	€0.521 B	-3.1%
India*	Rupee	Rs40.7 B	Rs49.6 B	Rs57.9 B	16.78%
Italy*†	Euro	€0.31 B	€0.33 B	€0.36 B	9.7%
Japan	Yen	¥314.0 B	¥344.8 B	¥339.0 B	-1.7%
Russia*	Ruble	R45.02 B	R87.9 B	R94.9 B	8.0%
South Korea*	KRW (Won)	KRW287 B	KRW267.9 B	KRW262 B	-2.2%
United Kingdom*†	Pound	£0.06 B	£0.06 B	£0.07 B	9.7%

**Civil space budget only*
†National budget only (Excluding ESA contributions)

2.3.1 United States

U.S. government agency space budgets in 2010 totaled $64.63 billion, a 0.3% increase from 2009. The combined U.S. defense-related space activities, including the U.S. Department of Defense (DoD), the National Reconnaissance Office, and the National Geospatial-Intelligence Agency, totaled $43.66 billion, or 68% of U.S. government spending. This figure, when combined with NASA's budget, accounts for 97% of all U.S. government agency space budgets. The remaining 3% is comprised of space-related spending within a set of other U.S. government agencies such as the Department of Agriculture (USDA), the Department of Energy, the FAA, the Federal Communications Commission (FCC), the Department of the Interior (DOI), the National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation, which collectively budgeted $2.25 billion on space.

EXHIBIT 2n. U.S. Government Agency Space Budgets, 2010

Agency	Budget	Source
Department of Defense (DoD)	$26.66 B	Futron estimate
National Reconnaissance Office (NRO)	$15.00 B	GlobalSecurity.org estimate
National Geospatial-Intelligence Agency (NGA)	$2.00 B	GlobalSecurity.org estimate
National Aeronautics and Space Administration (NASA)	$18.72 B	NASA
National Oceanic and Atmospheric Administration (NOAA)	$1.40 B	NOAA
Department of Energy (DOE)	$0.04 B	DOE
Federal Aviation Administration (FAA)	$0.02 B	FAA
National Science Foundation (NSF)	$0.64 B	NSF
Federal Communications Commission (FCC)	$0.01 B	Futron estimate
United States Geological Survey (USGS)	$0.15 B	DOI
Total	**$64.63 B**	

In certain agencies, such as the USDA, space spending is distributed in small amounts across the agency for activities such as the purchase of remote sensing data, and therefore space budgets are not systematically tracked. In other agencies, such as the Department of Interior, space spending is concentrated in a single organizational or functional line item. Within the DOI, the U.S. Geological Survey (USGS) operates the Landsat Earth observation satellite program and associated mapping and data products. In 2010, USGS spent approximately $145.6 million dollars on Geographic Research, Investigations, and Remote Sensing, which included the Landsat program and a geospatial data program.[43] The NOAA and FAA budgets increased by the largest percentage in 2010, while the other U.S. government agency space budgets either grew or remained constant from 2009 to 2010, with the exception of the National Science Foundation. The majority of the civil space spending in the United States is on NASA, with funding of $18.72 billion in 2010. In FY 2010, civil space spending in the United States represented approximately 0.5% of the $3.59 trillion U.S. national budget.[44]

NASA's funding decreased by 0.3% in 2010 as compared to 2009. NASA's FY 2010 enacted budget totaled $18.72 billion.[45] The agency also received approximately $522.4 million in American Recovery and Reinvestment Act economic stimulus funds in 2010.[46] These funds are not included in FY 2010 NASA budget totals. As of the end of 2010, the FY 2011 presidential budget request for NASA had not been reflected in an appropriation passed by

Congress, and as a result NASA has not been funded at levels described in the budget request. In the absence of a NASA appropriation for FY 2011, the NASA Authorization Act of 2010, passed by Congress and signed into law by the President in October 2010, provides the best indication of planned NASA funding levels in future years.

EXHIBIT 2o. NASA Fiscal Year 2012 Budget Request

Budget Authority, $ in million	Actual FY 2010	CR FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014
Science	4,497.6	4,469.0	5,005.6	5,016.8	5,016.8	5,016.8
Earth Science	1,439.3	–	1,801.8	1,797.4	1,821.7	1,818.5
Planetary Science	1,364.4	–	1,485.7	1,540.7	1,429.3	1,394.7
Astrophysics	647.3	–	1,076.3	682.7	758.1	775.5
James Webb Space Telescope	438.7	–	–	373.7	375.0	375.0
Heliophysics	608.0	–	641.9	622.3	632.7	653.0
Aeronautics	497.0	501.0	579.6	569.4	569.4	569.4
Space Technology	275.2	327.2	512.0	1,024.2	1,024.2	1,024.2
Exploration	3,625.8	3,594.3	3,706.0	3,948.7	3,948.7	3,948.7
Human Exploration Capabilities	3,287.5	–	2,751.0	2,810.2	2,810.2	2,810.2
Commercial Spaceflight	39.1	–	612.0	850.0	850.0	850.0
Exploration Research and Development	299.2	–	343.0	288.5	288.5	288.5
Space Operations	6,141.8	6,146.8	5,508.5	4,346.9	4,346.9	4,346.9
Space Shuttle	3,101.4	–	1,609.7	664.9	79.7	0.8
International Space Station	2,312.7	–	2,779.8	2,841.5	2,960.4	3,005.4
Space and Flight Support (SFS)	727.7	–	1,119.0	840.6	1,306.8	1,340.7
Education	180.1	182.5	145.8	138.4	138.4	138.4
Cross-Agency Support	3,017.6	3,018.8	3,111.4	3,192.0	3,192.0	3,192.0
Center Management and Operations	2,161.2	–	–	2,402.9	2,402.9	2,402.9
Agency Management and Operations	766.2	–	–	789.1	789.1	789.1
Institutional Investments	27.2	–	–	–	–	–
Congressionally Directed Items	63.0	–	–	–	–	–
Construction and Environmental Compliance and Restoration	452.8	448.3	394.3	450.4	450.4	450.4
Construction of Facilities	389.4	–	–	397.9	384.0	359.5
Environmental Compliance and Restoration	63.4	–	–	52.5	66.4	90.9
Inspector General	36.4	36.4	37.0	37.5	37.5	37.5
NASA FY 2011	18,724.3	18,724.3	19,000.0	18,724.3	18,724.3	18,724.3

Source: NASA

Both the FY 2011 President's Budget Request and the NASA Authorization Act of 2010 provide planned total funding levels of $19.0 billion for NASA in 2011. This is $275.7 million more than the NASA budget enacted in FY 2010, an increase of 1.47%. The NASA Authorization Act includes funding in FY 2011 and future years to extend operations aboard the ISS to at least 2020 in order to expand research, Earth science, and technology development capabilities. These capabilities are expected to enable research to support future human exploration beyond low Earth orbit. The NASA Authorization Act also provides additional funding for climate research and observations.

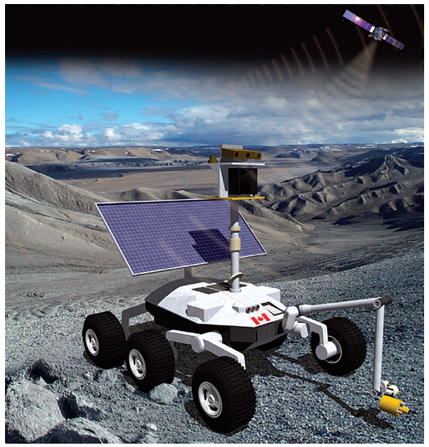
Both the budget request and the Authorization Act anticipated the retirement of the Space Shuttle in 2011, and neither budget document provided for the continuation of the Constellation Program. Instead, the NASA Authorization Act of 2010 proposes FY 2011 funding of $612 million for the development of commercial crew and cargo systems, $1.1 billion for the development of a multipurpose crew vehicle, and $1.6 billion for the development of a new space launch system.

2.3.2 Brazil

The National Congress of Brazil's 2011 Federal Budget authorizes 333.0 million reais (US$180.0 million) for activities associated with the National Program of Space Activities (PNAE), a decrease of 5.3% from the authorization for the previous year.[47] This authorization includes 274.7 million reais (US$152.9 million) for the Brazilian space agency, Agência Espacial Brasileira (AEB), and 50.0 million reais (US$27.8 million) in capital investment associated with the Alcântara Space Centre.[48] As in previous years, the most significant expenditures in Brazil's planned 2011 civil space spending are directed toward the development of future Earth observation satellites.[49] The 2011 PNAE Budget authorizes 40.0 million reais (US$22.3 million) for the development of Amazonia-1, an Earth observation satellite due to launch in 2013; 60.0 million reais (US$33.4 million) for the development of China-Brazil Earth Resources Satellite 3 (CBERS-3), due for launch in 2011; and 15.7 million reais (US$8.7 million) for the development of CBERS-4, due for launch in 2014. The majority of the decrease in authorized AEB funding between the 2010 and 2011 budgets can be attributed to a decrease of 27.6 million reais (US$15.4 million) in authorized funding levels for general technology and engineering development activities.[50]

The budget also includes authorization for spending 16.2 million reais (US$9.0 million) on the continued development of the Cyclone-4 launch vehicle.[51] This vehicle is to be manufactured in Ukraine and launched from Brazil.[52] In September 2010, the Alcântara Cyclone Space Binational Company, a joint Brazil-Ukraine company responsible for the commercialization and operation of Cyclone-4 launch services, laid the cornerstone of the vehicle's planned launch pad at Alcântara. The first flight of the Cyclone-4 from Brazil is anticipated in early 2012.[53]

The joint programs with China and Ukraine are illustrative of the AEB's policy of pursuing cooperative programs of technological development with more advanced space programs. In addition to the CBERS and Cyclone programs, the AEB has active cooperation agreements with Argentina, Chile, Colombia, the European Space Agency, France, Germany, India, and Russia.[54]



Macdonald, Dettwiler and Associates (MDA) received contracts from the Canadian Space Agency in 2010 to build prototypes for a lunar rover and a Mars Exploration and Science Rover. This artist's conception of the Mars rover shows it undergoing tests in terrain similar to that of Mars. *Credit: MDA*

2.3.3 Canada

The Canadian Space Agency (CSA) managed an FY 2010 budget of C$340.0 million (US$320.0 million), including a planned contribution of C$37.2 million (US$35.5 million) to the European Space Agency. The CSA-only budget of C$302.8 million (US$285.5 million) represents a 3.9% decrease from the previous year's CSA-only budget of C$315.0 million (US$300.4 million).[55] The CSA focused its funding in three main activity areas: Earth observation; space science and exploration, which includes robotic and human spaceflight; and satellite communication and navigation systems.[56]

EXHIBIT 2p. Canadian Space Agency Planned FY 2010 Spending by Program Activity

Program Activity	Funding* (U.S. Dollars)
Space-Based Earth Observation (EO)	$83.62 M
Space Science and Exploration (SE)	$174.79 M
Satellite Communications (SC)	$18.57 M
Generic Technological Activities in support of EO, SE, and SC	$43.56 M
Space Awareness and Learning	$7.64 M
Internal Services	$40.35 M
Total	**$368.53 M**

**Planned spending, not reflecting 2010 final Canadian Budget. Planned spending is greater than budget appropriation by C$10 M.*
Source: Government of Canada, Ministry of Industry, Canadian Space Agency, The Canadian Space Agency 2009-2010 Estimates. Report on Plans and Priorities.

The most notable increase in FY 2010 was in the area of space science and exploration, where planned spending increased by C$39.7 million (US$37.4 million) over the previous year. This increase was likely tied to activity associated with Canadian government economic stimulus funds given to the CSA in 2009. During FY 2010, which ran from April 1, 2010 to March 31, 2011, Canada's space spending constituted approximately 0.13% of Canada's C$280.5 billion (US$260.4 billion)

projected national expenditure budget.[57] Despite a budget increase in FY 2010, the CSA's planned spending for the next two fiscal years is less than its current spending. However, the figures for FY 2011 and FY 2012 reflect CSA planning only, not Canadian budgetary policy. As Canadian government budgets are developed for those years these figures may change. Current CSA planned expenditure for FY 2011 and FY 2012 is C$378.4 million (US$356.7 million) and C$312.7 million (US$294.8 million) respectively.[58]

In 2010 the Canadian Space Agency prepared a new 10-year Long Term Space Plan (LTSP). This plan, which as of year-end 2010 had not been made public, is under review by the Canadian government. According to the CSA, a major purpose of the LTSP is to improve coordination of space activities within the set of government organizations that hold responsibility for the use of space assets in Canada. The LTSP aims to provide a space policy vision and direction that addresses the use of space services to support Canadian public policy interests, advances the sustainability and capacity of Canadian space industry, and strengthens the CSA's international partnerships. The LTSP also places an emphasis on enhancing Canada's expertise in space robotics.[59]

Canada has begun development of its next generation of radar-based Earth imaging satellites, the three-satellite RADARSAT Constellation Mission (RCM).[60] In August 2010, the Canadian government approved C$397.0 million (US$374.2 million), in addition to the C$100.0 million (US$94.3million) already budgeted by the CSA, over a five-year period for the development of the RCM.[61] The agency also plans to build upon its existing expertise in space robotics. In November 2010, the CSA awarded two Canadian companies, MacDonald, Dettwiler and Associates (MDA) and Neptec, contracts valued at C$11.5 million (US$10.8 million) each to build prototype lunar exploration rovers. These contracts were awarded using funds from the C$110.0 million (US$103.7 million) stimulus funding the CSA had been given in 2009 to spend over a three-year period. The rover prototypes, which are to be completed by the end of 2012, are intended to position Canada for future international lunar exploration missions that require rover technology.[62]

2.3.4 China

Responsibility for Chinese space activities is shared by several agencies including the China National Space Administration (CNSA) and the People's Liberation Army (PLA), which operates the country's human spaceflight program and its launch centers. Data on the Chinese national space budget is difficult to obtain and estimates vary widely. During an April 2006 speech in Washington, DC, CNSA Vice Administrator Luo Ge stated that the CNSA budget was approximately US$500 million per year. While this figure is credible for the CNSA as an agency by itself, it is likely too low to represent the full extent of space spending in China. A 2010 report by European firm Euroconsult estimated China's space spending in 2009, including both civil and military activities, to be greater than US$2 billion.[63] One way to estimate Chinese space spending is by comparing China to its peers. On average, the major spacefaring countries—excluding the United States, where spending is significantly higher than in other countries—devote approximately 0.045% of their current-price gross domestic product (GDP) to civil space activities, as depicted in Exhibit 2q. Using China's 2009 current-price GDP of 34.05 trillion yuan, the country's 2010 space spending can be estimated at 15.2 billion yuan (US$2.24 billion).[64] This estimate falls within the range of Chinese space spending estimates published by other analysts.

EXHIBIT 2q. Space Spending as a Percentage of Gross Domestic Product (GDP), Selected Countries

Country	2009 GDP (constant prices)	2010 Space Spending	% GDP Spent on Space
Brazil	BRL3.143 T	BRL0.33 B	0.011%
Canada*	C$1.527 T	C$0.34 B	0.022%
France*	€1.907 T	€1.43 B	0.075%
Germany*	€2.397 T	€1.20 B	0.050%
India	Rs59.520 T	Rs57.91 B	0.097%
Italy*	€1.521 T	€0.73 B	0.048%
Japan	¥474.297 T	¥339.00 B	0.071%
South Korea	KRW1,063 T	KRW262.0 B	0.025%
Spain*	€1.054 T	€0.26 B	0.025%
United Kingdom*	£1.393 T	£0.31 B	0.022%
		Average % GDP Spent on Civil Space	**0.045%**

** Includes ESA Contribution*
Source: International Monetary Fund, World Economic Outlook Database, October 2010. Accessed December 7, 2010. Space spending sources as cited in the main text.

A mock payload segment for the new Vega launch vehicle is hoisted into position at Europe's spaceport in French Guiana. A full-scale mock-up was assembled in February 2011 as part of testing procedures prior to the maiden launch planned for later in the year. *Credit: ESA*

Although China does not publicly reveal much detail on its space programs, a number of major space projects were underway in the country during 2010. The country continues to deploy its Beidou satellite-based navigation system, a counterpart to the U.S. GPS, launching five Beidou satellites in 2010.[65] The first phase of the Beidou program, which will provide a regional navigation system in the Asia-Pacific region, is expected to be operational by the end of 2012, with a total estimated cost of US$1.46 billion.[66]

China's space program also marked notable developments in its exploration and human spaceflight activities. In March, plans for a Chinese space station were announced. The first module of this station is expected to launch at the end of 2011. Additional modules will be launched in 2012, as will crewed missions.[67] In October 2010, China launched its second lunar exploration spacecraft, Chang'e-2. The Chang'e-2 spacecraft will create a detailed map of the lunar surface, which China intends to use for planning a robotic lunar landing in 2013. The operational phases of Chang'e-2's mapping mission are expected to cost an estimated US$134 million.[68] China is also building a new space launch facility in the city of Wenchang located in the Hainan province. The facility will include a science theme park for the general public. The theme park project, to be finished in 2013, is expected to cost 3.0 billion Yuan (US$442.0 million).[69]

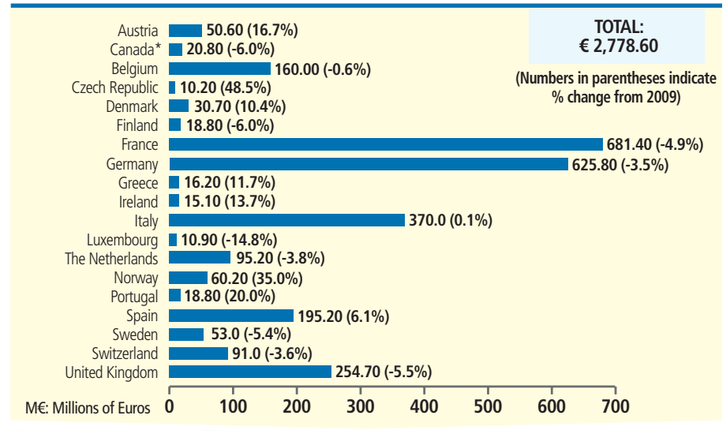
2.3.5 Europe

Government spending on space programs and activities in Europe comes from three distinct sources: activities directed by the EU and executed by the European Commission (EC); activities by ESA; and activities carried out by European countries independent of both the EU and ESA.

2.3.5.1 European Commission

The 2010 budget of the EC includes €1.33 billion (US$1.63 billion) in funding for space-related programs.[70] This represents approximately 0.9% of the EU's €141.5 billion (US$173.9 billion) budget for 2010.[71] The EC space-related budget focuses on three primary areas: space research, security research, and European satellite navigation programs.

EXHIBIT 2r. Member States' Contributions to the European Space Agency, 2010



**Canada is an associate member of ESA and contributes on an optional basis.*
Note: Total does not equal total ESA Budget due to contributions received from other sources (e.g. the European Union)
Source: European Space Agency. ESA Budget for 2010.

EU spending in the space research area, with a 2010 appropriation of €212.85 million (US$261.63 million), is intended to support the development of European space applications, including the Global Monitoring for Environment and Security (GMES) program.[72] GMES is a joint initiative of the EU and ESA which aims to develop and support a sustained European capacity for Earth observation. The security research area, with a 2010

EXHIBIT 2s. European Space Agency Budget by Program, 2010

Program	2010 Funding	Percent Change from 2009
Navigation	€714.0 M	84.4%
Earth Observation	€708.4 M	20.9%
Launchers	€566.6 M	-14.0%
Science	€409.5 M	-5.7%
Human Spaceflight	€330.4 M	-14.6%
Telecommunications	€325.4 M	1.9%
General Budget	€211.4 M	-11.8%
Associated to General Budget	€196.7 M	0.0%
Exploration	€102.0 M	-11.7%
Technology*	€84.8 M	-24.9%
Microgravity	€79.9 M	-14.7%
Space Situational Awareness	€9.9 M	10.0%
European Cooperating States Agreement	€5.2 M	62.2%

*Financed by third parties
Note: Changes in ESA accounting for third party financing may limit utilty of year-over-year comparisons
Source: European Space Agency. ESA Budget for 2010.

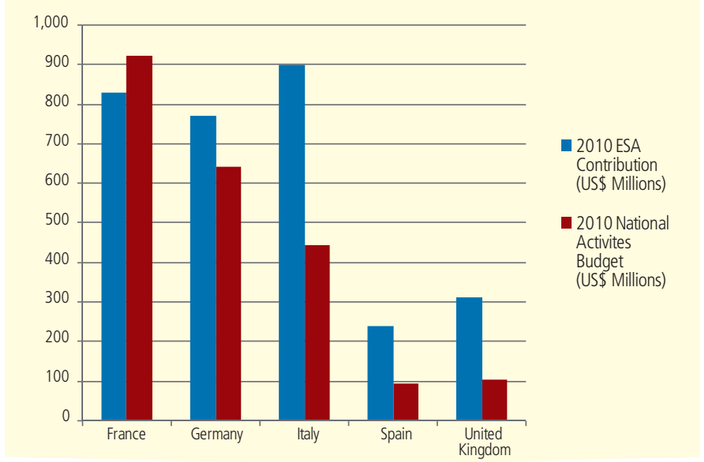
appropriation of €215.05 million (US$264.33 million), supports the development of space-related technology and knowledge to enable applications for civil safety and security, including natural disaster management, anti-terrorism and anti-crime activities, and human rights monitoring.[73] The 2010 combined appropriation of space and security research increased by approximately 70% from the 2009 total.[74]

In the area of satellite navigation, the EC's 2010 budget commits €896.04 million (US$1.1billion) toward the deployment of the Galileo system, the European counterpart to the U.S. GPS. It also includes the associated European Geostationary Navigation Overlay Service (EGNOS), which improves the accuracy of satellite navigation systems.[75] In November 2010, EU policymakers reaffirmed their intent to secure long-term funding for both EGNOS and Galileo in the post-2013 time frame. However, short-term funding scenarios for the program remain uncertain as European policymakers attempt to address the balance of funding that should be provided to the program between ESA and the EC.[76]

2.3.5.2 European Space Agency

ESA, representing 18 member states, had a 2010 budget of €3.74 billion (US$4.60 billion), 10.1% more than the 2009 budget of €3.59 billion (US$5.16 billion).[77] The largest three ESA funding line items are navigation activities at 19.1% of the budget, Earth observation activities at 16.32% of the budget, and launcher activity—related to the Ariane and Vega launch vehicles—with 15.1% of the budget.[78] Despite the approved budget of €3.74 billion, ESA expected to limit its 2010 spending to €3.35 billion (US$4.12 billion), as the result of a spending freeze agreed upon in January 2010.[79] Savings were to be achieved from internal cost reductions and stretching out contract payments over multiple years.

EXHIBIT 2t. Comparison of ESA Contributions vs. National-only Expenditures



Despite the ongoing economic downturn in 2010, ESA expects its 2011 budget to be roughly the same as 2010 and does not anticipate any reductions in contributions from its member states.[80] The 2010 combined space spending of the five largest ESA contributors, including both national space programs and ESA contributions, amounted to about €3.84 billion (US$4.72 billion). This represented approximately 0.15% of the combined national budgets of France, Germany, Italy, Spain, and the United Kingdom.

2.3.5.3 France

France's space agency, the Centre National d'Études Spatiales (CNES), operated on a government budget of approximately €749.0 million (US$920.6 million) in 2010, excluding contributions made to ESA.[81] This represented a 1.5% increase from the 2009 budget of €738.0 million. In 2010, France contributed €681.4 million (US$837.6 million) to ESA programs.[82] Combined, the CNES budget and the French contribution to ESA total €1.43 billion (US$1.76 billion), representing approximately 0.26% of France's €547.0 billion (US$672.4 billion) national budget in 2010.[83] France plans to increase its ESA contribution by roughly 10.0% in 2011 to €755.0 million (US$928.0 million), while CNES-only spending is expected to increase by 1.5%.[84] CNES expects its ESA contribution to continue to increase each year, reaching €849.0 million (US$1.04 billion) by 2015. The spending increase is intended to allow France to pay off approximately €500.0 million (US$614.6 million) in debt it owes ESA stemming from a 2002 Ariane 5 launch failure.[85]

In 2010, CNES was given management of an additional €500.0 million (US$614.6 million) in French government stimulus funds. The funding is to be administered by the agency over a five-year period as a public bond issue intended to stimulate research. CNES expects to spend half of the funds to support early development work on a new launch vehicle to replace the Ariane 5. The new vehicle is expected to enter service in the mid-2020s. The remaining half of the funding is to be devoted to satellites focusing on environmental and climate science.[86]

EXHIBIT 2u. German Planned Contributions to ESA, by Program Area

Budget Information by Application	2010 (planned spending by calendar year)	2011	2012	2013
Obligatory Programs				
Science program	€93.8 M	€96.3 M	€99.7 M	€103.2 M
Ordinary Budget	€43.0 M	€43.8 M	€44.9 M	€46.0 M
Operating the Kourou Launch Site	€16.2 M	€16.5 M	€17.0 M	€17.6 M
Optional Programs				
Infrastructure for Manned Spaceflight	€125.4 M	€129.3 M	€124.6 M	€85.0 M
Space Transportation Systems	€108.0 M	€124.3 M	€95.9 M	€87.2 M
Earth Observation	€87.4 M	€84.1 M	€108.7 M	€54.3 M
Satellite Communications	€57.3 M	€52.1 M	€56.4 M	€54.4 M
Microgravity	€37.5 M	€42.5 M	€41.0 M	€18.5 M
Aurora/ExoMars/CSTS	€19.0 M	€16.6 M	€5.8 M	€6.7 M
General Support Technology Programme (GSTP)	€10.9 M	€11.5 M	€8.4 M	€9.3 M
Space Situational Awareness (SSA)	€2.5 M	€2.3 M	€1.4 M	–
Esrange Special Project	€2.3 M	€2.3 M	€2.4 M	€2.5 M

Source: German Federal Ministry of Finance

2.3.5.4 Germany

The Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany's national space agency, oversaw an authorized budget of €521.0 million (US$640.3 million) in 2010, excluding contributions made to ESA. In addition to the DLR-only spending, Germany made €625.8 million (US$769.2 million) in ESA contributions in 2010.[87] Combined, the DLR authorization and ESA contribution total €1.2 billion (US$1.5 billion), representing approximately 0.37% of Germany's 2010 budget of €325.4 billion ($400.0 billion).[88] The total German space budget remained constant from 2009.

In November 2010, the German government announced the approval of a new German Space Strategy. The policy document is intended to provide strategic direction for the development of the German space sector during the coming years. The strategy supports expansion of areas of national space expertise, such as space-borne radar sensing technology and space-related robotics, in order to maintain the competitiveness of German space companies in the international marketplace.[89] Under this strategy, Germany plans to expand its spending on space activities to approximately €1.4 billion (US$1.72 billion) by 2014.[90] The majority of the planned increase will come through increased contributions to ESA's programs, rather than through the national programs within DLR.[91]

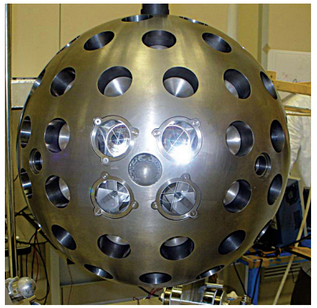
EXHIBIT 2v. Italian, ASI-only Planned Space Spending, by Program Area

Budget Information by Topical Area	2010 (planned spending by calendar year)	2011
Earth Observation	€81.68 M	€100.48 M
Observation of the Universe	€73.94 M	€61.87 M
Medicine and Biotechnology	€13.54 M	€13.77 M
Space Transportation	€12.86 M	€13.39 M
Telecommunications	€7.80 M	€52.96 M
Human Habitability in Space	€6.34 M	€6.00 M
New Technologies and Technology Transfer	€5.91 M	€19.12 M

Source: Agenzia Spaziale Italiana (ASI), Piano Triennale Delle Attivita 2009-2011.

2.3.5.5 Italy

The Agenzia Spaziale Italiana (ASI), Italy's space agency, managed a budget of €362.0 million (US$445.0 million) in 2010, excluding contributions made to ESA.[92] This represents a 9.7% increase from ASI-only spending totaling €330.0 million in 2009. Italy's contribution to ESA totaled €370.0 million (US$737.5 million) in 2010, an increase of 0.1% from 2009.[93] Combined, the ASI budget



Einstein's theory of general relativity will be tested by a new satellite planned for launch in 2011 by the Italian Space Agency. The LARES (LAser RElativity Satellite) is a passive satellite equipped with retroreflectors that allow the satellite's motion to be measured using a ground-based laser. *Credit: ASI*

and Italy's ESA contribution total €732.0 million (US$899.8 million), representing approximately 0.16% of Italy's planned 2010 budget of €458.0 billion (US$563.0 billion).[94] The total Italian space budget increased by 4.46% compared to the amount in the previous year. Space spending has been spared from Italian government-wide budget cuts in 2010, and future budgets are also expected to remain unaffected.[95] A 2010–2020 Strategic Vision Plan developed by the Italian government for ASI in 2010 plans €7.0 billion (US$8.6 billion) of Italian space-related spending over that time period. Approximately 37% of these funds are to be devoted to science activities, 33% to Earth observation, and the remainder is to be split equally between launch vehicle development and Italy's contribution to the ISS.[96]

In November 2010, the fourth and final satellite in the COSMO-SkyMed constellation of radar Earth observation satellites was launched. Funded by both ASI and the Italian Ministry of Defence, the total cost of the COSMO-SkyMed development program is estimated at €1.13 billion (US$1.39 billion). ASI plans to issue a €600.0 million (US$737.5 million) contract in 2011 to procure two new satellites to replace the first two COSMO-SkyMed spacecraft. The new satellites are expected to launch in 2014 or 2015.[97] Within ESA, Italy continues to lead the Vega small launch vehicle development program. The first Vega launch is scheduled for mid-2011 and will carry the Laser Relativity Satellite, developed by ASI. The satellite will study objectives related to Earth sciences and fundamental physics.[98]

2.3.5.6 Spain

The Instituto Nacional de Técnica Aeroespacial (INTA), the primary organization responsible for space activities in Spain, oversaw a budget of €76.7 million (US$94.3 million) in 2010. This budget included €39.1 million (US$48.1 million) in appropriations from Spain's national budget and €36.8 million (US$45.2 million) in expected revenue from other sources, including INTA's own commercial operations.[99] The 2010 INTA appropriation in the Spanish national budget decreased by 2.1% from 2009. Spain's contribution to ESA is not funded through INTA, but through the Center for the Development of Industrial Technology (CDTI). In 2010, Spain's ESA contribution was €195.3 million (US$240.0 million), an increase of 6.1% from Spain's 2009 ESA contribution of €184.0 million (US$226.2 million).[100] Combined, Spain's ESA contribution and government funding for INTA represented €260.7 million (US$320.4 million), or 0.06% of Spain's 2009 national budget of €386.4 billion (US$475.0 billion).[101]

Major Spanish space projects underway in 2010 and 2011 include the Ingenio and Paz system and the PROBA-3 satellites. The Ingenio and Paz system will be a two-satellite Earth observation constellation planned for launch in 2012. Designed for dual civil and military use, this system will feature one radar imaging satellite and one optical imaging satellite. PROBA-3 is a mission consisting of two low-cost microsatellites, planned to launch together in late 2011 or early 2012. The mission objective is to demonstrate formation flying technologies in space.[102]

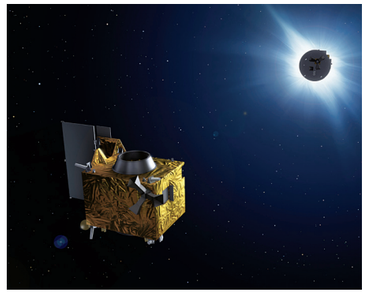
EXHIBIT 2w. United Kingdom Space Spending, by Program Area

Budget Information by Topical Area	FY 09/10
Science/Exploration	£111.70 M
Earth Observation	£89.46 M
Telecomms and Navigation	£73.60 M
Transportation	£36.66 M
ESA General Budget	£29.66 M
Other	£0.80 M
Technology	£0.30 M

Note: Includes ESA Spending. Fiscal Year 2009/2010.
Source: United Kingdom Space Agency. UK in Space 2010.

2.3.5.7 The United Kingdom

The British government established the United Kingdom Space Agency (UKSA) in 2010. However, the organization was not fully operational during 2010 and responsibility and funding for space activities remained distributed through several agencies. In FY 09/10, which ran from April 2009 through March 2010, estimated space spending in the UK totaled £69.69 million (US$104.2 million), excluding the country's ESA contribution.[103] This was an increase of 9.7% from 2009.[104] The UK contribution to ESA totaled



The two PROBA-3 spacecraft will test algorithms, sensors, propulsion systems, and other technologies needed for groups of small satellites flying in formation. One of the spacecraft will fly in such a way that it eclipses the Sun, allowing the second spacecraft to observe the solar corona. *Credit: ESA/S. Corvaja*

€254.7 million (US$313.2 million) in calendar year 2010, a decrease of 5.5% from the 2009 ESA contribution of €269.4 million (US$331.1 million).[105] The total FY09/10 space spending in the UK, including both ESA and national programs, of £312.5 million (US$467.4 million) represented 0.5% of the £671.0 billion (US$1.0 trillion) planned national budget.[106]

The UKSA was established in March 2010 and is expected to become a fully operational agency in April 2011. Its purpose is to serve as a consolidated, centralized agency for the development and execution of UK space activities, including interactions with academia, industry, and international partners.[107] The UK plans to continue investing in its existing competencies in space science and climate change observation. Major funding commitments planned for future years include: a £10.0 million (US$15.0 million) contribution to the data analysis and processing capability for ESA's Gaia astrometry mission, which is due to launch in 2012; £5.2 million (US$7.8 million) to develop an instrument for ESA's 2013 BepiColombo Mercury mission; £19.3 million (US$28.9 million) as contribution toward an instrument for the James Webb Space Telescope, which is under construction by NASA; and £10.5 million (US$15.7 million) in funding for ESA's 2018 ExoMars rover.[108]

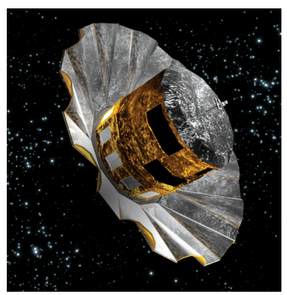
2.3.6 India

For FY 2010, the combined budgets of India's Department of Space (DOS)—which includes funding for the Indian Space Research Organisation (ISRO)—and the Ministry of Earth Sciences' Satellite Services program was 57.9 billion rupees ($1.25 billion), an increase of 16.8% from the reported figure in the previous fiscal year.[109] The civil space share of India's 11 trillion rupee ($238.9 billion) overall government budget was approximately 0.5% in FY 2010, a percentage that has remained relatively steady during the previous decade.[110] Indian space budgets are expected to continue to grow at double-digit percentage rates in the near future.[111] In FY 2010, slightly more than 60% of the DOS budget was devoted to spending on space technology development. This included funding for launch vehicle and space propulsion development, human spaceflight activities, and contributions to the manufacture and operation of various communications and remote sensing satellites. The remainder of the budget was split among space applications, operational satellite communications, space sciences, and administration.[112]

EXHIBIT 2x. Indian Space Budgets

Budget Information by Application	FY 2009/2010 (U.S. Dollars)	FY 2010/2011 (U.S. Dollars)
Department of Space		
Space Technology	$722.27 M	$ 774.13 M
Space Applications	$116.57 M	$ 160.98 M
Space Sciences	$60.50 M	$ 77.84 M
INSAT (Operational)	$95.15 M	$ 152.32 M
Direction and Administration	$61.31 M	$ 77.98 M
Total	**$1,055.79 M**	**$1,243.27 M**

Source: Government of India, Department of Space Budget 2010-2011.



The mission of the Gaia spacecraft is to create the largest, most precise map of the galaxy, monitoring a billion stars over a five-year period. The spacecraft will be equipped with a deployable Sun-shield covering an area of one hundred square meters (1,000 square feet), to minimize the temperature fluctuations in the highly sensitive optics. A second key component is a new micro-propulsion system to smoothly maneuver the spacecraft without disturbing the optics. *Credit: ESA/C.Carreau*

During 2010, ISRO maintained its traditional focus on the application of space activities for societal benefit through funding for tele-education, telemedicine, and remote sensing applications. The agency also continued to diversify its activities in exploration and space science.[113] The DOS budget for FY 2010 included funding to complete the development and launch preparations for the Resourcesat-2 and RiSat-1 Earth observation satellites, both due to launch during 2011. The FY 2010 budget included 1.25 billion rupees (US$26.9 million) in funding for the development of the next generation of communications satellite capabilities. In space sciences, the budget included 1 billion rupees ($US21.5 million) in FY 2010 for the development of the robotic Chandrayaan-2 lunar mission, scheduled for launch in 2013.[114]

In early 2010, India announced details on future plans for incremental development of a human spaceflight capability. The first phase of the project, which is funded at 124 billion rupees (US$2.6 billion) over a four-year period beginning in FY 2010, consists of a series of unmanned flights to test the development of spacecraft capable of carrying people.[115] Flights of this spacecraft would use India's Geosynchronous Satellite Launch Vehicle Mark II (GSLV Mk. II). However, this vehicle relies on engine technology that is new to the Indian space program, and the first flight of the GSLV Mk. II suffered a launch failure in April 2010.[116] While continued development of the GSLV Mk. II and a follow-on Mk. III version is funded in the FY 2010 budget, the schedule for the human spaceflight development program remains uncertain.

2.3.7 Israel

Civil space expenditures in Israel are small, estimated at 38.7 million New Israeli Shekels (US$10 million) in 2010.[117] The majority of Israel's space spending is for military purposes, amounting to 310 million New Israeli Shekels (US$80 million) annually.[118] This accounts for roughly 0.1% of the country's 2010 national budget of 325.3 billion New Israeli Shekels (US$83.9 billion).[119] The Israeli government expects to dramatically increase space spending in its FY 2011–2012 budget. Over a five-year period beginning in that fiscal year, Israel plans to invest US$77.5 million in the civilian space program. Officials hope these funds will stimulate the development of the country's space companies, leading to a civilian space industry with anticipated yearly revenue of as much as US$10 billion.[120]

JAXA hopes to simplify and standardize the launch process, resulting in lowered costs and more frequent missions with the new Epsilon Launch Vehicle it is developing. In its standard configuration, Epsilon will lift 1,200 kilograms (2,650 pounds) into low Earth orbit. *Credit: JAXA*

2.3.8 Japan

In FY 2010, Japan's national budget allocated ¥339.0 billion (US$3.83 billion) for space programs across the government, a decrease of 1.7% from the previous year's total of ¥345 billion.[121] This represents approximately 0.37% of the country's ¥92.3 trillion (US$1.04 trillion) national budget.[122] Japanese space spending is allocated among several government ministries, coordinated through the Strategic Headquarters for Space Policy. In FY 2010 the Japan Aerospace Exploration Agency (JAXA), funded through the Ministry of Education, Culture, Sports, Science and Technology, was operated with a budget of ¥180 billion (US$2.03 billion), representing approximately 53% of Japan's space spending.[123] In 2010, the largest programs executed by JAXA were activities related to the development of the H-II Transfer Vehicle for delivering cargo to the ISS and activities related to research and operations aboard Japan's Kibo ISS module. Other programs include the operations of the first satellite in the Quasi-Zenith Satellite System (QZSS) navigation program, funding for the development of Advanced Land Observation Satellite-2 (ALOS-2), and funding for the development of a new small satellite launch vehicle, known as Epsilon.[124]

EXHIBIT 2y. Japanese Space Spending by Agency, 2010

Budget Information by Agency	FY 2010/2011 (Yen)	(U.S. Dollars)	Percent of Total
Ministry of Education, Culture, Sports, Science and Technology	¥185.373 B	$2,094.31 M	54.69%
Japan Aerospace Exploration Agency	¥180.000 B	$2,033.61 M	53.10%
Cabinet Secretariat	¥63.638 B	$718.97 M	18.77%
Ministry of Defense	¥60.933 B	$688.41 M	17.98%
Ministry of Land, Infrastructure, Transport, and Tourism	¥10.954 B	$123.76 M	3.23%
Ministry of Economy, Trade, and Industry	¥9.130 B	$103.15 M	2.69%
Ministry of Internal Affairs and Communication	¥4.372 B	$49.39 M	1.29%
Ministry of the Environment	¥1.682 B	$19.00 M	0.50%
Ministry of Agriculture, Forestry, and Fisheries	¥1.110 B	$12.54 M	0.33%
Cabinet Office	¥0.801 B	$9.05 M	0.24%
National Police Agency	¥0.782 B	$8.83 M	0.23%
Ministry of Foreign Affairs	¥0.190 B	$2.15 M	0.06%
Total	**¥338.965 B**	**$ 3,829.56 M**	**100.00%**

Source: Society of Japanese Aerospace Companies

Looking to 2011 and beyond, the Japanese government has, as a part of its ongoing restructuring of civil space activity, announced plans to reorient space spending away from government research and development programs and toward more commercially oriented activities. Initial policy actions toward achieving this goal have focused on launch services and include extending the operations window for Japan's H-IIA launch vehicle to allow year-round operations, committing to the development of the Epsilon small satellite launch vehicle, and beginning the process of crafting new regulatory regimes to enable more commercial space launches.[125] The government is also reviewing the costs of existing programs, notably the QZSS navigation system. The first of three satellites in this GPS-like system, intended to provide regional precision navigation and time services in Japan, was launched in September 2010. The initial satellite cost an estimated US$700 million. Japanese policymakers are reviewing whether to proceed with the additional two satellites required to make the system operational.[126] Also under evaluation for inclusion in future Japanese budgets is a follow-on mission to the Hayabusa asteroid sample return mission.[127]

2.3.9 Russia

In calendar year 2010, the estimated planned budget for Roscosmos, the Russian Federal Space Agency, was more than 94.9 billion rubles (US$3.04 billion).[128] This amount constitutes an increase of 8% from the previous year's budget of 87.9 billion rubles and represents approximately 0.9% of Russia's 9.93 trillion ruble (US$318.3 billion) planned 2010 federal expenditure.[129] Russian space-related spending in 2010 continued a program of infrastructure investments begun under the large funding increase received during 2009. Areas of priority include the new Angara family of rockets, reaching full operational status of the Global Navigation Satellite System (GLONASS), constructing a new space launch center in the Russian Far East, and continuing to support the ISS. Russia has announced plans to spend 115 billion rubles (US$3.7 billion) in 2011 on national space activities.[130]

In December 2010, the launch failure of a Russian Proton-M rocket carrying three new GLONASS satellites resulted in the loss of the satellites. As a result, Russia has activated two spare GLONASS satellites already in orbit. Prior to the December 2010 launch failure, Russia had planned to spend 1.7 billion rubles (US$54.5 million) on GLONASS in 2011. Two billion rubles (US$64.1 million) were spent on the system in 2010.[131] Russia plans to spend a total of 24.5 billion rubles (US$785.0 million) on the development of the Vostochny launch center from 2011 to 2013. All preliminary design work is expected to be complete by the end of 2011, with construction commencing after that. The first launch from the facility is anticipated in 2015 or 2016. Human spaceflight launches from the facility may begin as soon as 2018.[132] In addition to these investments in space launch infrastructure and satellite navigation services, Russia plans to launch two space science missions in 2011, the astrophysical observatory Spektr-R and the Phobos-Grunt spacecraft to Mars' moon Phobos.[133]

The Communication, Ocean and Meteorological Satellite (COMS) collects meteorological and oceanographic data around the Korean peninsula in addition to providing experimental Ka-band broadband and multimedia communications services. *Credit: EADS Astrium*

2.3.10 South Korea

In calendar year 2010, South Korea spent an estimated 262.0 billion won (US$214.4 million) on civil space, a 2.2% decrease from the 2009 budget of 268.0 billion won ($228.0 million).[134] South Korea's 2010 planned civil space spending constitutes approximately 0.08% of the country's 309.1 trillion won (US$253 billion) national budget.[135] Civil space activities in South Korea are carried out by the Korea Aerospace Research Institute (KARI) and the Korea Advanced Institute of Science and Technology (KAIST). During 2010, South Korean space activities included the launch of the Communication, Ocean and Meteorological Satellite (COMS-1) and a second attempted flight of the Korea Space Launch Vehicle-1 (KSLV-1), South Korea's space launch vehicle. This flight, in June 2010, was unsuccessful.[136]

In 2011 and 2012, KARI plans continued investment in Earth observation technology and launch vehicle development. Kompsat-5, planned to launch in 2011, will feature a synthetic aperture radar (SAR) payload with 1-meter (3-foot) resolution. This will be South Korea's first SAR satellite. Kompsat-3, planned for launch in late 2011 or early 2012, will carry an electro-optical camera with a resolution of approximately 0.7 meters (2 feet). Kompsat-3 will launch as a secondary payload aboard a Japanese H-IIA launch vehicle. Kompsat-3A, planned for launch in 2012, will carry an imaging sensor which will operate in the infrared range. In the area of launch activities, South Korea plans a third launch attempt for the KSLV-1 launch vehicle. This launch would occur in late 2011 or early 2012.[137] As of June 2010, South Korea had spent an estimated $418 million on the KSLV-1 program, excluding costs associated with developing associated launch facilities at the Naro Space Center.[138]

2.3.11 Emerging Spacefaring Countries

Nascent and emerging spacefaring countries are becoming more active, committing resources to developing space products, services, and infrastructure. Exhibit 2z reveals the most current available budgets of selected emerging countries that have established or at least identified an organization that acts as a national space agency. Space agency budgets are often allocated from a country's Ministry of Science & Technology. Most of the agency expenditures are devoted to technology research and development. Some agencies have satellite manufacturing capabilities and many operate their own satellites.

EXHIBIT 2z. Space Budgets of Selected Emerging Countries

Country	Agency Name	2010 Budget Figure (U.S. Dollars)	Description	Source
Argentina	Comisión Nacional de Actividades Espaciales (CONAE)	$0.0724 B	Calendar Year 2010 Planned Spending	Government of Argentina
Australia	Space Policy Unit	$0.0273 B	Fiscal Year 2010/2011 Appropriation	Government of Australia
Chile	Agencia Chilena del Espacio (ACE)	$0.0004 B	Calendar Year 2010 Appropriation	Government of Chile
Indonesia	Lembaga Penerbangan Dan Antariksa Nasional (LAPAN)	$0.0002 B	Calendar Year 2010 Estimated Spending	Futron
Malaysia	Agensi Angkasa Negara (ANGKASA)	$0.2795 B	Calendar Year 2010 Estimated Spending	Futron
Mexico	Agencia Espacial Mexicana (AEM)	$0.0008 B	Calendar Year 2010 Planned Spending	Government of Mexico
Nigeria	National Space Research and Development Agency (NASRDA)	$0.0213 B	Calendar Year 2010 Planned Spending	Government of Nigeria
Pakistan	Pakistan Space and Upper Atmosphere Research Commission (SUPARCO)	$0.0271 B	Fiscal Year 2010/2011 Appropriation	Aman News
South Africa	South African National Space Agency (SANSA)	$0.0802 B	Calendar Year 2010 Planned Spending	Government of South Africa
Taiwan	National Space Organization (NSPO)	$0.1918 B	Calendar Year 2010 Estimated Spending	Futron
Thailand	Geo-Informatics and Space Technology Development Agency (GISTDA)	$0.0295 B	Calendar Year 2010 Estimated Spending	Futron
Turkey	Türkiye Bilimsel ve Teknolojik Ara tırma Kurumu (TÜBİTAK)	$0.0071 B	Calendar Year 2010 Estimated Spending	Futron
Total		**$0.7376 B**		

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2.3.12 Military Space Budgets

Most nations do not make details about their budgets, programs, and missions related to national security and intelligence activities publicly available. In addition, as some programs have civilian and military applications, isolating the military portion of dual-use programs is not always possible. As a case in point, the European Defence Agency continues to consolidate its relationship with ESA through coordinating definitions, research, technology, and feasibility studies, with particular focus on the development of a three-satellite Multinational Space-based Imaging System (MUSIS) program. The impetus behind this pan-European coordination is to reduce costs by pooling resources. However, this type of multinational collaboration requires very detailed tracking of budget line items, assuming the data is available, to prevent double-counting between national civil space spending, military space spending, and multinational initiatives overseen by ESA.

While the issues of data availability, transparency, and dual-use remain, it is possible to combine available data and publicly cited sources to estimate that global military space spending reached $46 billion in 2010, a 0.55% increase compared to $45.7 billion spent in 2009. The United States accounts for approximately 95% of this spending, or $43.7 billion. European industry figures estimated the annual value of military programs at around €1.0 billion ($1.6 billion) in 2008, compared to €0.8 billion ($1.2 billion) in 2004. These figures highlight that European military space budgets have increased over the past several years, although spending declined slightly in 2009.[139] These figures do not include dual-use programs.

Technicians lift the STPSat-2 satellite to place it in the payload area of a Minotaur IV launch vehicle at Kodiak Launch Complex. The satellite was one of seven launched as part of the Space Test Program-S26 mission. The U.S. Department of Defense uses the Space Test Program to test experimental technologies that will enhance military operational capability. *Credit: Jose (Lou) Hernandez*

2.4 Summary of Data

Space industry revenue and government budgets associated with global space activity based on collected data and estimates are shown in Exhibit 2aa. Due to rounding, some percentages may not add up to 100%. *The Space Report 2011* separates industry revenue and government budgets to eliminate double-counting whenever sufficiently detailed source data is available. All figures included were selected to provide the most complete and consistent figures possible. However, in a continual effort to improve the fidelity of estimates and consistency of year-to-year collection, some methodological changes have been made in the organization and collection of certain elements. First, revenues for the Commercial Infrastructure sector and the Infrastructure Support Industries sector have been combined to form a single Commercial Infrastructure and Support Industries category. Second, the number of emerging space nations for which budget data has been collected is expanded in 2010. Third, a new methodology is used to calculate changes in U.S. DoD space spending. Previous editions of *The Space Report* have relied on DoD space budget projection included in NASA's *Aeronautics and Space Report of the President*. This report is not available for 2010, therefore trends in unclassified DoD space spending are identified based on publicly available DoD budgets, while classified spending remains fixed.

EXHIBIT 2aa. Global Space Activity Revenues and Budgets, 2010

Type	2007 ($B)	2008 ($B)	2009 ($B)	2010 ($B)	Growth*	2010 Source	Description
Commercial Infrastructure and Support Industries	**$92.92**	**$85.54**	**$77.12**	**$87.39**	**13%**		
Launch Industry (commercial)	$1.55	$2.00	$2.41	$2.45	2%	Federal Aviation Administration	2010 estimated value of commercial launches
Satellite Manufacturing (commercial)	$3.80	$5.20	$4.03	$3.41	-15%	SIA/Futron analysis	2010 revenue from production of commercial satellites
Ground Stations and Equipment	$86.87	$77.23	$69.53	$80.47	16%	SIA/Futron analysis	2010 revenue from production of telecommunications and PNT ground equipment
Independent Research and Development (IR&D)	$0.17	$0.16	$0.18	$0.18	0%	Futron	2010 estimate of space industry IR&D
Insurance	$0.53	$0.95	$0.96	$0.88	-9%	XL Insurance	2010 satellite insurance premiums
Commercial Space Products and Services	**$72.60**	**$84.10**	**$93.45**	**$102.00**	**9%**		
Direct-to-Home Television (DTH)	$55.40	$64.90	$71.82	$79.22	10%	SIA/Futron analysis	2010 direct-to-home television revenue
Satellite Radio	$2.10	$2.50	$2.54	$2.84	12%	SIA/Futron analysis	2010 revenue from Sirius XM
Satellite Services (FSS & MSS)	$15.10	$16.70	$17.07	$17.92	5%	SIA/Futron analysis	2010 revenue from FSS and MSS satellite communications
Earth Observation	–	–	$2.01	$2.01	0%	Northern Sky Research	2010 Earth observation data sales and value-added services
Commercial Space Transportation Services	**$0.04**	**$0.04**	**$0.09**	**$0.01**	**-88%**		
Orbital	$0.03	$0.03	$0.08	$0.00	-100%		2010 revenue from commercial orbital flights
Suborbital (deposits)	$0.01	$0.01	$0.01	$0.01	0%	Virgin Galactic, XCOR	2010 deposits for suborbital flights
U.S. Government Space Budgets	**$52.84**	**$57.98**	**$64.42**	**$64.63**	**0%**		
Department of Defense (DoD) Space	$22.42	$25.95	$26.53	$26.66	0%	Futron Estimate	FY 2010
National Reconnaissance Office (NRO)	$10.00	$10.00	$15.00	$15.00	0%	GlobalSecurity.org	FY 2010 intelligence budget estimate
National Geospatial-Intelligence Agency (NGA)	$3.00	$3.00	$2.00	$2.00	0%	GlobalSecurity.org	FY 2010 intelligence budget estimate
National Aeronautics and Space Administration (NASA)	$16.25	$17.40	$18.78	$18.72	0%	NASA	FY 2010 enacted
National Oceanic and Atmospheric Administration (NOAA)	$0.80	$0.96	$1.25	$1.40	12%	NOAA	FY 2010 enacted budget
Department of Energy (DOE)	$0.03	$0.03	$0.04	$0.04	5%	DOE	FY 2010 actual
Federal Aviation Administration (FAA)	$0.01	$0.01	$0.01	$0.02	50%	FAA	FY 2010 actual
National Science Foundation (NSF)	$0.33	$0.63	$0.80	$0.64	-20%	NSF	FY 2010 budget
Federal Communications Commission (FCC)	–	–	–	$0.01	–	Futron	FY 2010 estimated spending
United States Geological Survey (USGS)	–	–	–	$0.15	–	USGS	FY 2010 enacted
Non-U.S. Government Space Budgets**	**$13.96**	**$16.47**	**$21.73**	**$22.49**	**3%**		
European Space Agency (ESA)	$4.02	$4.27	$5.16	$4.60	-11%	ESA	2010 appropriation
European Union	–	–	$1.56	$1.63	5%	European Union	2010 appropriation
Brazil	–	$0.13	$0.19	$0.18	-3%	Government of Brazil	2011 authorization
Canada	$0.34	$0.27	$0.30	$0.29	-5%	CSA	FY 2010 appropriation, excluding planned ESA contributions
China	$1.50	$1.70	$1.79	$2.24	25%	Futron Estimate	2010 estimated budget
France	$0.95	$0.97	$1.06	$0.92	-13%	CNES	2010 appropriation, excluding ESA
Germany	$0.39	$0.60	$0.77	$0.64	-17%	Government of Germany	2010 appropriation, excluding ESA
India	$0.66	$0.82	$1.06	$1.25	18%	Government of India	2010-11 budget allocation
Israel	–	$0.01	$0.01	$0.01	0%	Futron	2010 estimated budget
Italy	$0.65	$0.44	$0.47	$0.44	-5%	ASI	2010 planned spending, excluding ESA
Japan	$2.21	$3.50	$3.72	$3.83	3%	Society of Japanese Aerospace Companies	FY 2010 appropriation
Russia	–	$1.50	$2.90	$3.04	5%	GlobalSecurity.org	2010 planned spending
South Korea	$1.32	$0.23	$0.23	$0.21	-6%	KARI	2010 appropriation
Spain	–	–	$0.06	$0.05	-17%	Government of Spain	2010 appropriation, excluding ESA
United Kingdom	$0.12	$0.09	$0.10	$0.10	4%	UKSA	FY 2010 appropriation, excluding ESA
Non-U.S. Military Space	$1.77	$1.95	$2.18	$2.30	10%	Futron Estimate	2008 Euroconsult ratio
Selected Emerging Countries	–	–	$0.17	$0.74	–	Various	See Exhibit 2z
TOTAL	**$232.33**	**$244.13**	**$256.80**	**$276.52**	**7.7%**		

*Growth estimates include new data sources available in 2010 but not available in 2009.
**Non-U.S. budget growth rates may vary from text due to currency exchange

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2.5 Space Investment Outlook

Throughout 2010, companies in the space industry made strategic use of abundant capital and opportunities for transactions. To a larger degree than in 2009, in terms of aggregate deal value, mergers and acquisitions (M&A) provided a ready tool for the space industry to reshape itself. M&A involves the buying, selling, or combining of different companies and can be an effective corporate strategy for achieving rapid growth. M&A activity in 2010 was similar to that of the preceding decade, large in volume but small in individual transaction size, with a median space-related deal size of about $50 million. Capital flow into the space industry increased substantially over 2009. Nearly all acquisitions featured strategic buyers who used existing cash reserves and other assets to fund transactions. The space industry's use of capital is likely to increase again in 2011, given the industry's strong balance sheets along with capacity to benefit from more favorable financial markets. With government policy decisions taking shape, the space industry has entered an important period of transition that will afford the private sector ample opportunities for growth.

2.5.1 Mergers and Acquisitions

Companies of all shapes and sizes have used M&A to accelerate their growth and execute their business strategies. What was notable about 2010 and recent years was the volume and relative valuation sustained by a wide array of buyers pursuing targets in high demand. Transactions in 2010 included Lockheed Martin's sale of Enterprise Integration Group, an adviser to government agencies on military platforms. This divestment was due to increased scrutiny of potential organizational conflicts of interest that arise when contractors advise the government on systems for which they end up competing. In other notable deals, EADS' Astrium unit announced three acquisitions—Aviospace, ND SatCom, and Jena-Optronik—that were in large part intended to enhance the growth potential of its service business. Orbital Sciences acquired General Dynamics' spacecraft development and manufacturing business to enhance Orbital's position in the growing market for national security space systems.

Several transactions involved companies that serve civil government and military markets. Such diversified companies typically produce consistent, predictable cash flow. High government spending and commercial success have allowed them to build strong balance sheets and deploy this cash flow into investments with the profits and returns their investors have come to expect. With overall defense budgets facing downward pressure over the next several years due to competing spending priorities and escalating federal budget deficits, M&A can help offset declining growth rates in risky business areas and programs by affording the opportunity to rapidly rebalance product and service offerings to emphasize strategic priorities.

The majority of transactions suggest the buyers are using M&A as a rapid way to fill gaps, strengthen offerings, and incorporate differentiated technical or market niche capabilities. The median size of space-related deals was more than $50 million in 2010, a significant decline from the 2009 median of approximately $115 million. This figure is also lower than the $90 million median for an acquisition in the aerospace, defense, and government industries in 2010, which declined from a median of $150 million in 2009, indicating a broad trend toward smaller transactions.

The number of M&A transactions closely matched that of 2009, but the total value of space-related M&A transactions more than doubled due to a few exceptionally large transactions, involving SkyTerra Communications, Intergraph, and Lockheed Martin Enterprise Integration Group. With improved availability of debt financing and built-up equity capital, investors showed greater interest in undertaking large deals in 2010, albeit with a higher degree of caution in terms of how much debt is incurred. In the most notable space-related private equity investment of 2010 in terms of target size, Harbinger Capital Partners purchased SkyTerra Communications, a leading North American developer and supplier of mobile satellite communications services, for $1.5 billion. As in 2009, more private equity sellers participated than buyers in the industry. Private equity-backed space-related assets sold during the year included Intergraph, CapRock Communications, and Wavestream. In each case, private equity sellers decided to exit their investment in order to optimize financial returns.

EXHIBIT 2bb. **Space-Related Transactions in 2010**

Acquirer	Primary Business	Target	Primary Business	Deal Value
TeleCommunication Systems, Inc. (TCS)	Wireless messaging and location technology	Trident Space & Defense, LLC	Space, military, and industrial products and services	NA
Thales	Information systems for defense and security, aerospace, and transportation	Société Européenne de Systèmes Optiques	High-precision optical components and systems	NA
GeoEye, Inc.	Geospatial intelligence system products and services	SPADAC, Inc.	Geointelligence and predictive analysis solutions	$46.0 M
EADS N.V. [Astrium]	Civil and defense space systems and services	ND SatCom GmbH	Satellite network solutions and ground stations	NA
CACI International Inc.	IT and communications solutions	TechniGraphics, Inc.	Imagery and geospatial services	NA
Gilat Satellite Networks Ltd	High power solid state amplifiers	Wavestream Corp.	Products and services for satellite-based communications networks	$130.0 M
Veritas Capital	Private equity firm	Lockheed Martin Enterprise Integration Group	Systems engineering and integration services	$815.0 M
EADS N.V. [Astrium]	Civil and defense space systems and services	Jena-Optronik GmbH	Space sensors and optical systems	NA
L-3 Communications Holdings, Inc.	C3ISR systems, aircraft and government services	3Di Technologies, LLC	Secure satellite communications	NA
Indra Sistemas, S.A.	IT and defense systems	Indra Espacio S.A. [Thales Alenia Space 49% stake]	Ground segment systems for space applications	$102.0 M
Amari Metals, B.V.	International multi-metal distributor	Service Centres Aero	Aluminum products for aeronautics and space	NA
Hexagon AB	Measurement and positioning systems	Intergraph Corp.	Engineering, geospatial, and security software	$2,125.0 M
Aeroflex, Inc.	Microelectronic and test solutions to the broadband communications, aerospace, and defense markets	Radiation Assured Devices, Inc. (RAD)	Radiation engineering and qualification services and products for commercial and military spaceborne electronics	$14.0 M
Teledyne Technologies, Inc.	Electronic components and subsystems, instrumentation, and communications products	Intelek plc	Electronic systems for satellite and microwave communication	$51.9 M
Ensign-Bickford Aerospace & Defense Company	Reliable energetic solutions	NEA Electronics, Inc.	Space and defense electronic products	NA
Harris Corp.	Communications and electronics products and services	CapRock Communications, Inc.	Managed satellite communications solutions	$525.0 M
Kontron America, Inc.	Embedded computer technology	AP Labs, Inc.	Rugged systems packaging and enclosures	$42.0 M
Energia Overseas Limited	Space hardware	Sea Launch Company, LLC	Heavy commercial satellite launch operations	NA
Integral Systems, Inc.	Satellite ground systems and other communications equipment	Sophia Wireless, Inc.	Satellite communications, broadcast, and radar components	$2.5 M
Harbinger Capital Partners LLC	Private equity firm	SkyTerra Communications, Inc.	Mobile satellite communications services	$1,495.6 M
Gilat Satellite Networks Ltd	Products and services for satellite-based communications	RaySat Antenna Systems (RAS), LLC	Satellite antenna systems	$30.7 M
Integral Systems, Inc.	Satellite ground systems and other communications equipment	CVG, Inc. and its subsidiary, Avtec Systems, Inc.	Satellite-based government and commercial communication solutions	$34.7 M
Orbital Sciences Corp.	Small- and medium-class rockets and space systems	Spacecraft development and manufacturing business of General Dynamics Corp.	Medium-class satellite manufacturing, integration and testing	$55.0 M
The Government of South Africa	State agency	SunSpace and Information Systems Pty Ltd.	Small- and medium-sized satellites and related systems	NA
Elbit Systems Ltd.	Defense electronic and electro-optic systems	Azimuth Technologies Ltd.	Satellite navigation systems (GPS), electro-optics, and data communications	$46.5 M
OM Group, Inc.	Metal-based specialty chemicals	EaglePicher Technologies, LLC	Batteries, battery management systems, and energetic devices	$171.9 M
Broadcast Facilities Inc. (nka: Encompass Digital Media Inc.)	Digital media service provider with broadcast facilities	Crawford Communications' satellite services division	Television network origination, teleport, satellite uplink trucks, Internet, production, and government services	NA
EADS N.V. [Astrium]	Civil and defense space systems and services	Aviospace S.R.L.	Aerospace research services	NA
LSE Space Engineering & Operations AG	International space systems consultancy and support services	Aurora Technology B.V.	Astronomical instruments and ground segment control systems	NA

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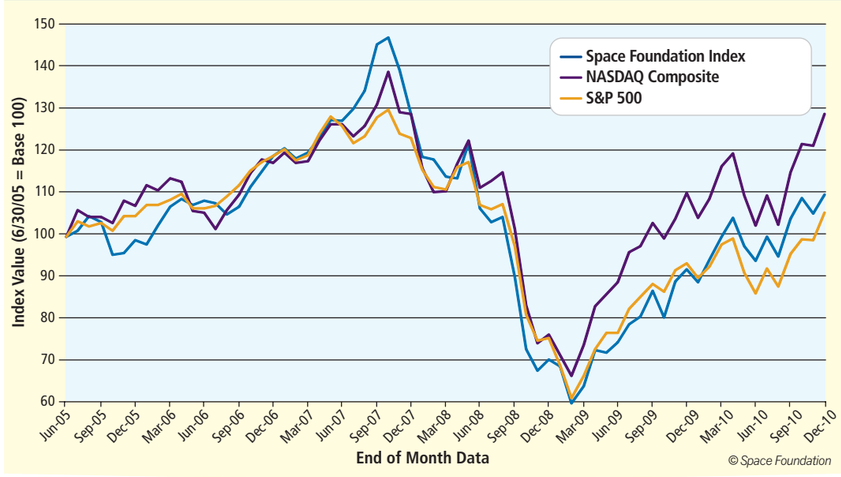
2.5.2 Near-Term Investment Outlook

Many funding questions remain that will continue to affect the industry's financial support and activity. Due to a lack of resolution of the FY 2011 budget, 2010 ended with NASA funding in limbo. The longer budget delays persist, the more difficult it will be to achieve any new objectives on time. Consequently, industry participants will likely diversify their customer base to include international growth opportunities. Military space programs that have suffered a decade of cost overruns, development delays and unnecessarily invasive oversight are transitioning to fixed-price contracts designed to promote competition. Despite near-term budget uncertainties, investment in space programs is a long-range wealth creator that may be less at risk of funding cuts than other discretionary programs.

Many factors suggest M&A activity will continue unabated, including the financial strength of the space industry and opportunities for further consolidation of a strong, but fragmented, second tier of the industry. After more than a decade of rising defense budgets, a flurry of consolidation is expected in anticipation of slowing future defense spending and the outcome of budget cuts to individual programs. M&A activity, especially by large prime contractors, will be sustained by the strategic imperative for defense-oriented companies to widen their capabilities and reach in the face of budget pressures in their traditional markets. Other companies or assets will be sold by investors who see that as the best option for realizing financial returns on their investment.

Stock market valuations will reflect the ability of industry participants to communicate to customers and investors the potential for productivity and profit to be realized from space. Solid program execution is imperative to maintain funding for program activities and realize sufficient profitability on behalf of investors. Downward pressure on government spending threatens space companies' growth and profitability. However, some companies are set to benefit as certain programs are scaled back or cut entirely while others flourish due to shifting spending priorities. At a time when resources are tightening, the commercial sector's ability to demonstrate cost savings to the government will be key to increased outsourcing opportunities.

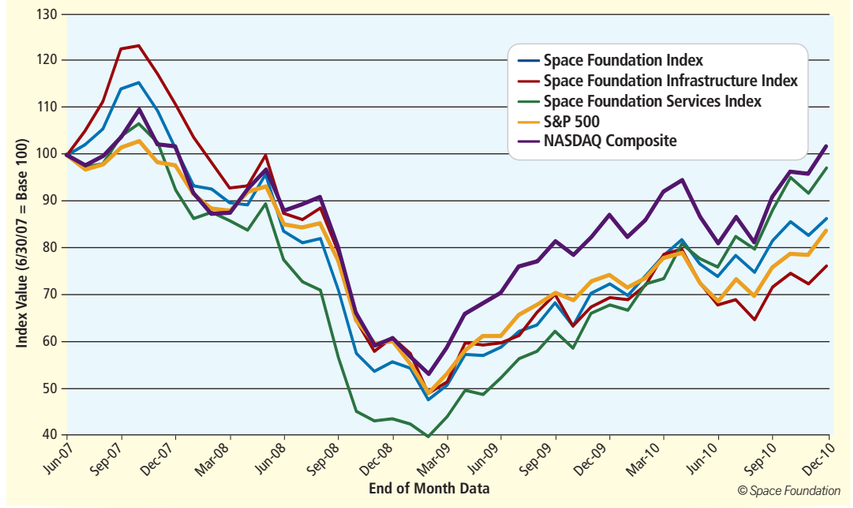
EXHIBIT 2cc. **Space Foundation Index vs. Other Market Indexes**



2.6 Space Foundation Indexes Overview

The *Space Foundation Indexes* consist of three weighted indexes that track the performance of the overall space industry as well as the space infrastructure and services segments in the U.S. public markets. The *Space Foundation Indexes* continued to recover from the recent economic downturn with gains of 10–43% in 2010.

EXHIBIT 2dd. Space Foundation Indexes vs. Other Market Indexes



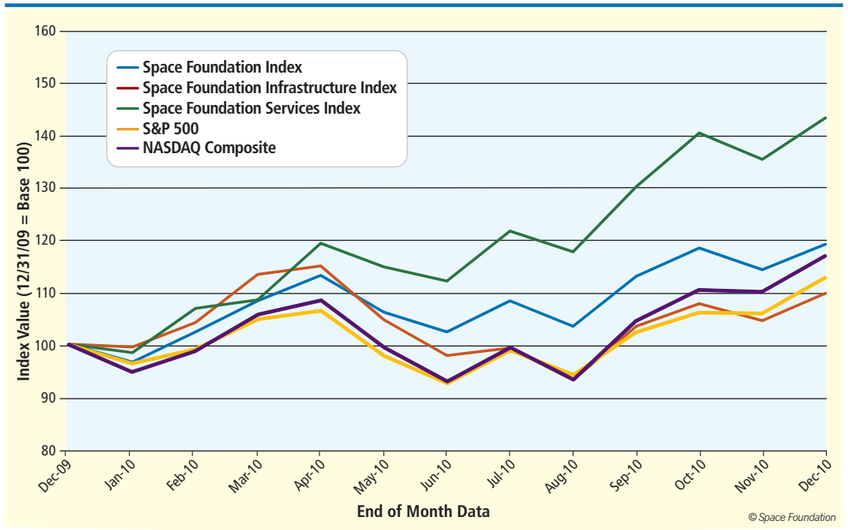
▶ The Space Foundation Index (SFI), now in its sixth year, tracks the market performance of 31 publicly held companies that derive a significant portion of their revenue from a broad range of space-related assets and activities. The SFI was initiated on June 30, 2005 at a level of 100, enabling quick determination of the percentage change in value since inception.

▶ The Space Foundation Infrastructure Index (SFII) tracks companies in the U.S. public markets that derive significant revenues from the sale of space-related infrastructure, including hardware, software, and integration services for space-related applications such as the manufacturing of satellites and launch vehicles, or ground-based items such as terminals and chipsets. It was initiated with a level of 100 as of June 30, 2007.

▶ The Space Foundation Services Index (SFSI) tracks companies in the U.S. public markets that derive significant revenues from space services and depend heavily on space assets for collection, transmission, or provisioning, including satellite broadcast, communications, and remote sensing. It was initiated with a level of 100 as of June 30, 2007.

All three of the *Space Foundation Indexes* are available and updated daily on the Space Foundation's web site, www.SpaceFoundation.org/spaceindex. The online information shows the performance of each index compared to the NASDAQ and S&P 500 since the inception of each index as well as in daily, weekly, monthly, quarterly, and yearly intervals. The indexes are updated each business day shortly after U.S. markets close.

EXHIBIT 2ee. Space Foundation Indexes vs. Other Market Indexes, 2010



2.6.1 Index Performance

The *Space Foundation Index* continued its 2009 recovery with gains in 2010, finishing the year with a 19.28% increase in value. The index performed well in each quarter, except the second quarter when it shared in a brief market downturn. However, the *Space Foundation Index* outperformed both the S&P 500 and NASDAQ Composite indexes during that period by a factor of two. For the year, the index outperformed the S&P 500 by 6.5 percentage points and the NASDAQ by 2.37 percentage points, as can be seen in Exhibit 2ff.

EXHIBIT 2ff. Space Foundation Index Returns vs. Benchmarks

Returns Period	SFI	S&P 500	Difference in Returns	NASDAQ Composite	Difference in Returns
Since SFI Inception	9.90%	5.57%	**4.34%**	28.97%	**-19.07%**
CY 2006	20.08%	13.62%	**6.46%**	9.52%	**10.56%**
CY 2007	8.43%	3.53%	**4.90%**	9.81%	**-1.38%**
CY 2008	-45.02%	-38.49%	**-6.54%**	-40.54%	**-4.48%**
CY 2009	29.94%	23.45%	**6.49%**	43.89%	**-13.94%**
CY 2010	19.28%	12.78%	**6.50%**	16.91%	**2.37%**
1Q 2010	8.37%	4.87%	**3.49%**	5.68%	**2.69%**
2Q 2010	-5.54%	-11.86%	**6.32%**	-12.04%	**6.50%**
3Q 2010	10.39%	10.72%	**-0.33%**	12.30%	**-1.91%**
4Q 2010	5.56%	10.20%	**-4.64%**	12.00%	**-6.44%**

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The *Space Foundation Index* is expanding to include Globalstar in 2011. Globalstar reached a major milestone in 2010 with the successful launch of the first six satellites of its second-generation constellation. The company is expected to launch six more satellites in 2011, allaying concerns over a decline in service from its first-generation satellite constellation. Renewed investor confidence in 2010 led to the company almost doubling its market capitalization.

Another change in index composition is that L-3 Communications will replace SAIC in both the *Space Foundation Infrastructure Index* and the main *Space Foundation Index* due to significant shifts in space-related revenues at each company. Also of note, a former index component, ITT, has announced that it intends to split into three separate publicly listed companies in 2011 to unlock the value of each business line. One of these new companies will include the bulk of ITT's space-related revenues and will have a substantially higher proportion of space revenues to its overall revenues than the current conglomerate. That shift would immediately qualify the new entity for inclusion in both the *Space Foundation Infrastructure Index* and the *Space Foundation Index*.

The *Space Foundation Services Index* substantially outperformed the *Space Foundation Infrastructure Index* for the second year in a row, with respective growth rates of 43.43% and 9.83% for the year, as can be seen in Exhibits 2gg and 2hh. As in 2009, improvement in the consumer and enterprise markets that drive services revenues was a key factor contributing to this growth. While many space infrastructure companies experienced growth in 2010, ongoing uncertainty in government defense and civil space programs, along with corresponding spending cuts, had a negative impact on several index components. In particular, NASA programs for human spaceflight, NOAA and Air Force programs to replace the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program, and ongoing delays in finalizing the FY 2011 budget have had an impact on the infrastructure index.

EXHIBIT 2gg. Space Foundation Services Index Returns vs. Benchmarks

Returns Period	SFSI	S&P 500	Difference in Returns	NASDAQ Composite	Difference in Returns
Since SFSI Inception	-2.90%	-16.34%	**13.45%**	1.91%	**-4.80%**
CY 2008	-53.07%	-38.49%	**-14.59%**	-40.54%	**-12.53%**
CY 2009	56.13%	23.45%	**32.68%**	43.89%	**12.25%**
CY 2010	43.43%	12.78%	**30.65%**	16.91%	**26.52%**
1Q 2010	8.51%	4.87%	**3.64%**	5.68%	**2.83%**
2Q 2010	3.30%	-11.86%	**15.16%**	-12.04%	**15.34%**
3Q 2010	16.11%	10.72%	**5.39%**	12.30%	**3.81%**
4Q 2010	10.21%	10.20%	**0.00%**	12.00%	**-1.80%**

Key components of the *Space Foundation Services Index* led the way with remarkable growth in their market capitalization for 2010:

- For the second year in a row, Sirius XM had the highest growth rate, experiencing a 176% increase in market capitalization over the year as it achieved growth milestones and alleviated concerns about its ability to service its debt. Sirius XM reported its first-ever quarterly profit in 4Q2009, has shown a profit for four quarters in a row, and reached a total of 20 million subscribers in late 2010.
- BSkyB experienced a 28.5% growth in market capitalization from a combination of strong performance and an announcement that News Corp. was going to attempt to acquire the balance of the company that it does not already own.
- The satellite imaging sector performed well in 2010. Both GeoEye and DigitalGlobe experienced significant growth, 80% and 34% respectively. The companies were buoyed by awards of 10-year EnhancedView commercial imagery contracts with the National Geospatial-Intelligence Agency. The contracts were valued at $3.8 billion for GeoEye and $3.55 billion for DigitalGlobe.
- Loral, Viasat, Hughes, and ICO Global all demonstrated more than 50% growth in 2010.
- DirecTV's modest 4% gain and Dish Network's 6% decline in market capitalization are indicative of increasing competition for video services from cable, telecom, and internet providers. In 2010, DirecTV initiated a $3.5 billion stock buyback program that helped drive its stock price up 20% overall as it repurchased approximately 13% of its outstanding shares.

EXHIBIT 2hh. Space Foundation Infrastructure Index Returns vs. Benchmarks

Returns Period	SFII	S&P 500	Difference in Returns	NASDAQ Composite	Difference in Returns
Since SFII Inception	-23.89%	-16.34%	**-7.55%**	1.91%	**-25.80%**
CY 2008	-45.23%	-38.49%	**-6.74%**	-40.54%	**-4.69%**
CY 2009	14.15%	23.45%	**-9.31%**	43.89%	**-29.74%**
CY 2010	9.83%	12.78%	**-2.95%**	16.91%	**-7.08%**
1Q 2010	13.48%	4.87%	**8.60%**	5.68%	**7.80%**
2Q 2010	-13.82%	-11.86%	**-1.96%**	-12.04%	**-1.78%**
3Q 2010	5.73%	10.72%	**-4.99%**	12.30%	**-6.56%**
4Q 2010	6.22%	10.20%	**-3.98%**	12.00%	**-5.78%**

The *Space Foundation Infrastructure Index* experienced 9.8% growth during 2010 despite lingering concerns over government space markets:

- Loral Space & Communications had the highest growth rate of any space infrastructure company for the second year in a row, with a 145% increase in market capitalization. The company was the second best performing stock in the indexes as it benefited from another robust year with several major spacecraft manufacturing orders.
- In the GPS sector, Trimble benefited from solid profits and a strong cash flow, posting a 58% gain for the year, while Garmin's performance remained flat as its core personal navigation device market reached saturation points in developed markets.
- In the very small aperture terminal (VSAT) markets, both Viasat and Hughes Communications performed extremely well, with 80% and 57% gains respectively.
- Several core space industry contractors were down in 2010 as various NASA, NOAA, and Air Force space programs experienced delays, budget cuts, and restructuring. ATK, Harris, Gencorp, Lockheed Martin, Raytheon, and SAIC all experienced 7–25% declines in value in 2010.
- A year after the ground infrastructure segment of the space industry experienced across-the-board declines, EMS Technologies recovered 37% and Integral Systems 16%. However, Comtech continued to slide, with a 23% decline for the year.

2.6.2 Index Composition

The *Space Foundation Indexes* are modified market capitalization-weighted indexes of representative space companies listed on U.S. market exchanges. Component companies are selected based upon an evaluation of several criteria, including proportion of revenues attributable to space-related products and services, market capitalization, and trading volume.

Consideration is also given to providing diverse representation across various space-related markets. Space revenues include the manufacture of launch vehicle, satellite, and ground segment systems and components; satellite communication services and capacity leasing; space-related positioning and remote sensing data and services and related equipment (including GPS chipsets); and space-related software, operations, and support services. Space revenue estimates were based upon a review of multiple sources, including Space News' Top 50 lists, company web sites, SEC filings, as well as internal experience.

The *Space Foundation Indexes* were prepared by ISDR Consulting, LLC on behalf of the Space Foundation. Changes in the index values are driven by changes in the market capitalization of the component companies (price multiplied by number of shares outstanding of each company). The contributions of certain component companies' market capitalization to a given index have been discounted to adjust for lower percentage of revenues attributable to the space-related products and services that are the focus of a given index. Certain component

companies' market capitalization contributions to a given index have also been adjusted to discount for size. The levels of the indexes are not directly altered by stock splits, stock dividends, or trading halts, nor are they affected by new listings, additional issuances, delistings, or suspensions.

EXHIBIT 2ii. Composition of the Space Foundation Indexes for 2011

Infrastructure Companies—Space Foundation Infrastructure Index			
Space Segment Manufacturers and System Integrators		Ground Segment Manufacturers	
Ticker	Company	Ticker	Company
ATK	Alliant Techsystems Inc.	CMTL	Comtech Telecommunications Corp.
BA	The Boeing Co.	SATS*	EchoStar Corp.
CSC	Computer Sciences Corp.	ELMG	EMS Technologies, Inc.
GY	GenCorp Inc.	GRMN	Garmin Ltd.
HRS	Harris Corp.	GILT*	Gilat Satellite Networks Ltd.
LLL*	L-3 Communications Holdings, Inc.	GCOM*	Globecomm Systems Inc.
LMT	Lockheed Martin Corp.	HUGH*	Hughes Communications, Inc.
LORL*	Loral Space & Communications Inc.	ISYS	Integral Systems, Inc.
NOC	Northrop Grumman Corp.	LLL*	L-3 Communications Holdings, Inc.
ORB	Orbital Sciences Corp.	TRMB	Trimble Navigation Ltd.
RTN	Raytheon Co.	VSAT*	Viasat, Inc.

Satellite Services Companies—Space Foundation Services Index			
Consumer/Retail Services		Enterprise/Government Services	
Ticker	Company	Ticker	Company
BSY	British Sky Broadcasting Group plc	DGI	DigitalGlobe, Inc.
DTV	The DirecTV Group, Inc.	SATS*	EchoStar Corp.
DISH	DISH Network Corp.	GEOY	GeoEye, Inc.
SIRI	Sirius XM Radio Inc.	GILT*	Gilat Satellite Networks Ltd.
		GSAT	Globalstar, Inc.
		GCOM*	Globecomm Systems Inc.
		HUGH*	Hughes Communications, Inc.
		ICOG	ICO Global Communications Ltd.
		IRDM	Iridium Communications Inc.
		LORL*	Loral Space & Communications Inc.
		ORBC	Orbcomm Inc.
		VSAT*	Viasat, Inc.

*Company has major operations in more than one industry segment

Index Composition: The *Space Foundation Index* is composed of all the companies represented in the *Space Foundation Infrastructure Index* and the *Space Foundation Services Index.*

The Space Economy | 2.0

2.7 Metrics

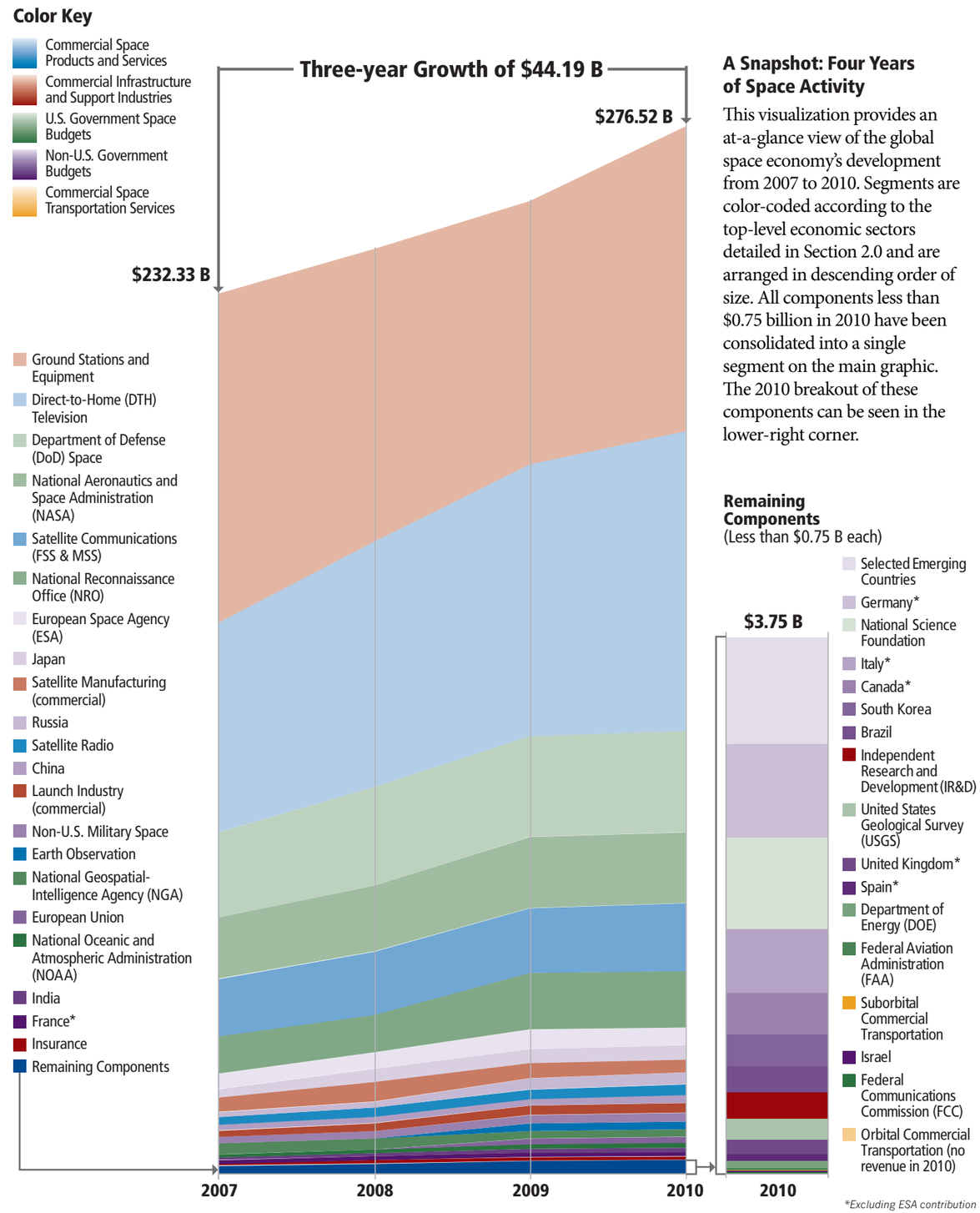
The growing scale and broader scope of the space economy highlights its integration into most facets of government, business, and daily life. Despite its large and growing monetary value, metrics to track the space industry are not standardized or consistently available, with significant gaps in how governments and industry collect, analyze, and benchmark the space economy.

While a few governments provide figures for overall space spending, many nations do not publish detailed space budgets that provide integrated figures across all space-related projects in the multiple agencies that may be involved. Military space programs are often classified so the associated budget data remains unpublished. Space-related activities at the local level, conducted by states, provinces, and city governments, are often not available or tracked.

Collecting consistent information on government space budgets is further complicated by budgeting processes. In the United States, as of the end of 2010, there was uncertainty regarding funding levels for federal agencies in FY 2011. In February 2010, the president had released the FY 2011 federal budget proposal. For NASA, the proposed budget would have provided a 1.46% overall increase from 2010 actual spending, while discontinuing the Constellation program and restructuring human exploration activities. U.S. budgetary process requires that Congress pass a yearly appropriations bill to provide funding. Congress may also issue authorization bills, which provide policy guidance and suggested funding levels but do not appropriate actual funds. The House of Representatives and the Senate passed a NASA Authorization Bill in October 2010 that suggested the same top-level spending as the Budget Request, although it altered funding levels for specific programs within the agency's portfolio.[140] As of the end of 2010, Congress had not passed an appropriations bill providing funding for NASA for FY 2011. NASA, and the majority of the rest of the U.S. federal government, is operating through at least early March 2011 under a measure known as continuing resolution (CR), through which agencies are funded at the level of the previous year's appropriation. The CR provides only a top-level agency budget and does not specify funding levels for programs or projects within NASA. The lack of a 2011 appropriations bill combined with the lack of programmatic specificity in the CR means that there is a great deal of uncertainty in the structure and amounts of NASA's 2011 funding.[141]

Satellite dishes near Cheyenne, Wyoming, transmit data for Echostar Satellite Services at one of the company's uplink centers.
Credit: Echostar

Different definitions, classifications, accounting systems, and budgetary cycles further complicate the important task of identifying and globally assessing the value of space investments. Neither are there sufficient mechanisms to track how average companies or individuals use and benefit from space. As a result, any estimation of the market size and its impact is likely to be missing critical components such as standardized methodologies to differentiate between space industry segments and space-enabled industry segments, as in the case of GPS equipment and the associated location-based services. This limits the potential for quantifying and assessing the true size of the space industry. As the value of space continues to increase, there is a growing need for better quantitative information. A few initiatives are underway to improve this issue, such as the Organisation for Economic Co-operation and Development (OECD) initiative on space economics, which hosts semi-annual exchanges on national practices and lessons learned concerning the space sector's economic data.[142] However, there is significant opportunity for improvement and a need for leadership to achieve a better understanding of the space economy.



A Snapshot: Four Years of Space Activity

This visualization provides an at-a-glance view of the global space economy's development from 2007 to 2010. Segments are color-coded according to the top-level economic sectors detailed in Section 2.0 and are arranged in descending order of size. All components less than $0.75 billion in 2010 have been consolidated into a single segment on the main graphic. The 2010 breakout of these components can be seen in the lower-right corner.

Remaining Components
(Less than $0.75 B each)

*Excluding ESA contribution

Endnotes

Section 2.0: The Space Economy

1 Data and analysis into the space economy offer insight by providing revenue and budget figures as well as the growth drivers and underlying trends for space infrastructure, space products and services, and government space budgets. Data is derived from publicly available commercial revenue reports and government budget sources. Where possible, multiple sources of data are reported and documented. Forecasts and projections from industry research firms and other open sources are included in order to provide a forward-looking view of the global space industry. The methodology to measure the space economy uses several valuation techniques that combine data collection, estimates, internal analysis, and external citations. The sources include public information as well as analysis by a number of third parties such as the media, market analysts, and researchers. The sources are cited throughout the document to ensure consistency, transparency, and traceability. Data is reported in then-year dollars, and international space agency budgets are reported in their respective domestic currencies. Unless otherwise stated, all currency conversions into U.S. dollars use exchange rates as of June 30, 2010.

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