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# Space Policies, Issues and Trends in 2010/2011

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Spyros Pagkratis

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http://www.espi.or.at
Tel. +43 1 7181118-0; Fax -99



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# 1. Global Political and Economic Trends

The following section attempts a brief description of recent developments in seven key thematic areas: economy, security, environment, energy, resources, knowledge and mobility. These fields enclose all human activities that directly influence or are influenced by space activities, determining their perception from society and their impact upon it. The way in which activities in these areas involve the use of space assets also makes the case in favour of the further development and use of space technologies, services and products.

## 1.1 Global Economic Outlook

In 2010 and 2011 the symptoms of the 2008 financial crisis were still broadly felt worldwide. Although global financial expansion has resumed already in 2009, its pace remains slow and uncertain. The key element of that recovery has been its uneven pace between developed and emerging countries, with the second achieving a much faster and bullish return to growth, as it was already predicted in the "Space Policies Issues and Trends in 2009/2010" report. Although global economic activity is expected to rise by roughly 5% in 2010 and 4.2% in 2011, advanced economies are projected to expand by only 2.2 to 2.7%, whereas emerging countries' development is expected to be up to three times higher[1].

Furthermore, while emerging economies seem to have overcome the worst of the crisis with the help of suitable fiscal policies, advanced economies are still under considerable fiscal stress, especially in Europe. This increasing difference between emerging and developed economies has increased the systemic danger of a new crisis by exacerbating global financial imbalances and encouraging excessive capital volatility and especially flows from advanced to emerging economies. This unstable situation is mostly fuelled by the different approaches chosen by developed and emerging economies in order to counter the crisis' consequences. The former, on the one hand, have been observing a policy of fiscal consolidation and monetary contraction in order to hedge the risks from the 2008 bailouts, which resulted in raising unemployment, crippling domestic demand and increasing exports. The latter, on the other hand, are continuing to provide fiscal stimuli and to follow monetary expansion policies that favour domestic consumption, which is expected to rise by 8% in 2010[2].

The main reason behind the different approaches adopted was the poor sovereign and banking fiscal condition of developed economies, compared to the emerging ones. Another reason has been the limited margin for further consumption growth in developed economies: starting from much higher consumption rates, they would not have been able to profit from any further expansion as much as emerging economies, even with the adequate fiscal measures. In the years immediately preceding the crisis, emerging and developed economies have been following completely different paths to economic development. The former manifested a fiscally solid, industrial output and export oriented posture, while the latter a fiscally more precarious, financial services' and domestic consumption oriented approach. In the time of global economic expansion, the two different approaches were able to cooperate and complement each other in a mutually beneficial way. It is clear however that in the aftermath of the crisis and the recovery efforts that followed they are set upon two very different and rapidly diverting paths of economic development.

Advanced economies still have a number of challenges lying ahead, with the most important being to carefully balance the necessary sovereign and banking fiscal stabilisation measures with the need to restrain unemployment and improve household finances and consumption demand. First of all, financial sector policies and practices need to be improved, addressing the financial and banking imbalances that caused the recent crisis. This applies particularly to the banking sector (especially in Europe), where bank consolidation is still in process, as well as to mitigating the effects of the sovereign debt crisis that followed the financial melt down. On the

[1] International Monetary Fund. World Economic Outlook: recovery, Risk and Rebalancing. Washington DC: IMF, Oct. 2010.

[2] Ibid.

other hand however, in the presence of very low interest rates and tax policies that progressively favour production rather than consumption, such measures also increase the risk of deflation, if domestic private demand is further reduced. On the short term, such measures have already begun to create unemployment, complicating the effort to restore consumption levels. On the medium term, they could pose a threat to medium and small enterprises that rely mostly on domestic demand rather than exports. On the longer term, they could lead to further stagnation and deflation as exports to emerging economies will drop as a result of their rapidly improving position vis-à-vis the advanced economies.

Emerging economies on the other hand have a completely different set of challenges to meet. So far, most such countries have opted to boost their domestic consumption in order to remedy the drop in international consumer demand due to the crisis. This trend would have to be accelerated if they were to restore output levels to their pre-crisis standards. This is especially true for countries that relied heavily on demand from advanced economies to boost their growth. On the other hand, carefully balanced monetary tightening and exchange rate flexibility measures would have to be put in place in order to avert inflationary risks and maintain credit growth at reasonable levels.

Finally, a key plank during the past twelve months has been the increased capital volatility and flow from advanced to emerging markets. At this point in time, this phenomenon threatens to destabilise the global financial system and compromise its recovery. These capital flows are the result of the combination of low market confidence, credit availability and interest rates in advanced economies, with the higher growth rate, expansionary fiscal policies and higher interest rates in emerging ones. Consequently, this increased volatility and speculation in capital markets is slowing recovery in the advanced economies and increasing inflationary risks in the emerging ones. In short, it increases the pro-cyclical movement of the global economy, significantly complicating the recovery effort worldwide[3].

In the face of these challenges, space economy and especially the commercial space services sector can play a pivotal role in boosting global economic growth without further fuelling the aforementioned imbalances. In being inherently global by its very nature, it has the potential to repatriate capital flows to advanced economies, while at the same time distributing financially beneficial services to emerging countries. In fact, space services can instigate growth in both cases, without creating the negative effects from capital flows mentioned above. Space infrastructure creates jobs both in advanced and emerging economies; it encourages global synergies and enhances international cooperation; and its operating costs are evenly distributed among its users, who can nevertheless reap the full advantages of its use. As space infrastructure is not based in any territory, it does not have any of the disadvantages related to more traditional international investments or services' exports, especially for the importing countries. Furthermore, it allows space services' providers to enjoy operational and financial flexibility that as we have seen consist a decisive advantage in view of the crisis' consequences for global economic integration. At the same time, it can benefit both from the fiscal consolidation measures witnessed in high income economies (that encourage outsourcing services to the private sector), and from the booming growth in emerging countries.

## 1.2 Political Developments

### 1.2.1 Security

From a security perspective, 2010 and 2011 were marked the geopolitical events that took place in the Middle East. Earlier protests that took place in Egypt and Tunisia were followed on 16 February 2011 by civil protests against the Libyan leader Moammar Gadhafi and his government, with the ultimate goal to replace him and form a new government. Moammar Gadhafi has been in charge since a coup d'état in September 1969 and confronted with the civil protests, declared his intention not to leave the country[4]. Amid violence repression of the protesters and government attacks against civilians, the death toll begun to rise.

Continued violence forced the U.N. Security Council to intervene[5]. It approved a no-fly zone resolution for Libya and gave permission to the use of any means in order to protect

[3] The World Bank. Global Economic Prospects: Navigating Strong Currents. Washington DC: World Bank, Jan. 2011.

[4] "The Libya War of 2011." STRATFOR Global Intelligence, 21 March 2011 <http://www.stratfor.com/analysis/20110319-libyan-war-2011?utm_source=SpecialReport&utm_medium=email&utm_campaign=110319a&utm_content=readmore&elq=3c7acd0ccb4540ad8f71e78079162462>.

[5] „U.N. Security Council approves no-fly zone in Libya." CNN, 18 March 2011 <http://edition.cnn.com/2011/WORLD/africa/03/17/libya.civil.war/index.html>.

civilians. There were no opposing votes at the 15-member council, but China, Russia, Germany, India and Brazil abstained. The ongoing civil unrest and armed conflict that followed had repercussions in many fields. Since the beginning of the conflict the stock market and the oil market has suffered huge falls and the prices increased around 2%. The OPEC was considering measures to stabilize the petroleum prices in the market around the world, as Libya's petroleum production fell to less than 400.000 barrels per day, around ¼ of the production before the crisis and the risk of a complete stop was imminent, according to the CEO of Libya National Oil.

The population began to move in order to escape the conflict zone. However the numbers of displaced persons presented by the media were not confirmed by the analysis based on satellite images and maps. During the crisis, it was deemed urgent to identify the geographic flows of the displaced in order to determine the aid in need. In order to do this, the U.N. Institute for Training and Research (UNITAR) utilised the UN Operational Satellite Applications Programme (UNOSAT)[6] which was providing information since mid-February. On 22 March international military operations started in western Libya against Gadhafi's regime among protests from Russia, China and the Arab League countries that originally supported the operation.

### 1.2.2 Environment

On March 11, 2011 a tsunami spawned by the fifth-largest quake ever recorded, slammed Japan's eastern coast. The magnitude 8.9 offshore quake unleashed a seven-meter tsunami was followed by more than 50 aftershocks for hours. This Earthquake has caused major damage in broad areas in northern Japan[7]. The death toll is around 22.000, at this moment[8].

One day after the earthquake the Fukushima I nuclear power station started registering explosions. A state of emergency has been declared at a nuclear plant. The earthquake consequence on the nuclear power station and his liberation of radioactive energy has been considered the worst nuclear accident since Chernobyl[9]. The US Nuclear Regulatory Commission affirmed, recently, that the situation at Japan's troubled nuclear complex seems to be stabilizing and Japan's Nuclear and Industrial Safety Agency (NISA) said, on March 12, that the explosion at the Fukushima Daiichi No. 1 nuclear plant could only have been caused by a meltdown of the reactor core. The seawater contamination level near the Fukushima facility has being monitored. The level of iodine is 27.1 times higher than normal level and the level of caesium – which can affect fish and selfish is 2.5 times higher than normal level[10]. He full environmental policy impact of this nuclear catastrophe is yet to be unveiled.

### 1.2.3 Energy

Volatility in the energy sector prices continued in 2010. In spite of the fact that consumption levels have yet to reach pre-crisis levels, investing in oil and other fossil energy resources has been a constant trend in the past two years, in view of the general market instability. This new perception of oil as a secure asset class in the midst of financial turmoil has led to considerable fluctuations at the oil market, which cannot be justified by the present demand and supply conditions. Unforeseen geopolitical events in the Middle East during the end of 2010 and the beginning of 2011 have further exacerbated the situation. Despite the progress made in alternative power sources, fossil fuel is expected to remain dominant in the energy mix, mainly due to rising demand in the transportation sector, particularly in emerging Asian markets that are responsible for 75% of the projected consumption growth in the next twenty years. On the other hand, the rising potential of gas utilisation might reverse this trend in the medium term[11].

Although oil demand has risen in 2010 compared to the previous year, it has yet to reach pre-crisis levels. Furthermore, oil exploitation costs have continued to rise in 2010, requiring considerable upstream investments to increase production, especially within the OPEC countries. In the absence of

[6] Godoy, Julio. "Satellite Technology to Help the Displaced.", Terraviva, 15 March 2011, <http://www.ipsterraviva.net/UN/news.asp?idnews=54851>. And <http://allafrica.com/stories/201103151462.html>.
[7] "Japan Hit By Tsunami after Massive Earthquake." 11 March 2011, <http://www.bbc.co.uk/news/world-asia-pacific-12709850>.
[8] "Japão confirma 22 mil mortos e desaparecidos." Publico, 22 March 2011, <http://www.publico.pt/Mundo/japao-confirma-22-mil-mortos-e-desaparecidos_1486147>.
[9] Concentracões elevadas de iodo radioactivo detectadas no pacífico." Publico, 21 March 2011, <http://www.publico.pt/Mundo/concentracoes-elevadas-de-iodo-radioactivo-detectadas-no-pacifico_1485890>.
[10] "Japanese Government Confirms Meltdown." STRATFOR Global Intelligence, 12 March 2011, <http://www.stratfor.com/analysis/20110312-japanese-government-confirms-meltdown?utm_source=redalert&utm_medium=email&utm_campaign=110312%286%29&utm_content=readmore&elq=96da7bd6198c44f9a29a05659469a594>.
[11] Organisation of the Petroleum Exporting Countries. World Oil Outlook. Vienna: OPEC, Sept. 2010.

such investments, crude oil production would remain at roughly the present levels in the medium term, something which may not be sufficient if global economic activity returns to pre-crisis levels, while at the same time it could instigate further price speculation should additional geopolitical disturbances occur. On the other hand, if recovery proves to be slower than anticipated, demand could remain flat in the medium term, depriving fossil fuel exploitation companies of the resources necessary to invest in modernising production[12].

Low demand has particularly hit the refining industry in advanced economies, which has demonstrated an increasing surplus in capacity. This trend is expected to continue as refining capacity in emerging countries (especially Asia) will increase, severely limiting their medium-term profitability. In general, demand in advanced economies is considered to have reached its peak, a fact that combined with the refining surplus and increasing demand in Asia is expected to force the bulk of the oil downstream sector to migrate from the Atlantic to the Pacific region[13]. This trend could be accelerated in the medium term, if economic recovery remains sluggish in advanced economies and new climate change and energy policies are implemented, especially in the U.S. Particularly carbon related legislation, which is still in a formative stage, could potentially further reduce demand growth and increase competition for product markets.

### 1.2.4 Resources

In spite of the fragile economic recovery witnessed on average worldwide, world trade and commodity prices have shown considerable increase in 2010. This development was principally driven by emerging-market economies that reached their previous pre-crisis peak of April 2008. Almost all of emerging economies outside the European region returned to their pre-crisis growth levels in 2010. While developing economies let the global recovery, the situation in developed countries started resembling more and more to the pre-crisis patterns, sparking fears of a double-tip recession, especially in Europe. Only countries with a strong reliance on exports such as Japan or Germany were able to make some progress[14].

The rise in primary commodity prices that had started in 2009 continued in 2010 as well, particularly in metals, minerals and energy products. However, one should note that the same commodities were the ones that had experienced the steepest fall during the crisis. Agricultural commodities' price rise was particularly felt, raising by almost 50% in 2009 from its lowest in 2008 and continuing upwards in 2010. Strong demand from emerging countries and financial investor behaviour were the main reasons for this trend, especially since the food shortages that ensued following poor crops in 2008 worldwide. In spite of the improvement in 2010, food security remains a pressing issue for the developing world[15].

### 1.2.5 Knowledge

The economic philosophy of the European Union is particularly influenced by the neo-liberal theory of free market and the importance of innovation. Little by little the EU has realized the crucial importance to foster innovation beyond the strict paradigm of free liberalism not even and especially not respected by the U.S. The EU places innovation at the core of its economic policy, as the main factor of European companies' competitiveness and so key element to assure the economic growth allowing independence and well-being for the European citizen. We can notice this will by various initiatives such as the European Research Area or the knowledge triangle. This philosophy is besides particularly shared by the ESA and EU. In this context, part of space activities has been becoming more and more crucial and it is not astonishing. Indeed, this domain has the particularity to be connected to a lot of different field such as agriculture, environment, energy and so on. It can have a direct effect by enhancing their efficiency like earth observation for agriculture or indirectly by its technology.

Space has also the speciality to necessitate cut edging technology to move about in a particularly hostile environment. Those kinds of developments need heavy investment with a high rate risk what also explains the prominence so far of states in this area. However interest of the private sector for space is due to take growing importance. The space market itself is rather tiny and fortunately those technologies are not exclusively destined to the space sector and can find an interesting application on earth as well. This is particularly true in certain domain such as energy, industry, medicine etc...or even in extreme

[12] Ibid.
[13] Organisation of the Petroleum Exporting Countries. World Oil Outlook…
[14] United Nations Conference on Trade and Development. Trade and Development Report, 2010. Geneva: UNCTD 2010.
[15] Ibid.

environment like sea bed or irradiated grounds.

We are going to see concrete relations between space and innovation as a motor of economic development for the whole society and not only dedicated to an obscure governmental project.

Energy is a crucial topic for the future developments of our societies, a lot of space challenges can alleviate or settle the difficulties encountered in this domain which is a major preoccupation especially within the EU. Space Nuclear Power Systems are internationally recognized to be compulsory for solar system exploration[16], at least for deep space missions or planet surface exploration which make solar energy not reliable enough to supply a spacecraft engaged in a long term mission exploration too far from the Sun. Nuclear energy is still an utterly contested source of energy especially in civil use on earth. The researches carried out to develop more reliable and efficient reactor with for instance less radioactive waste would be a crucial advanced for the whole human-being. In the same way, solar energy is often presented as a possible alternative to nuclear one without being really able to compete with it. The environment of space activities including its proximity with the Sun without atmosphere allows crucial technological developments which can be reused on earth to improve the existing systems[17] throughout the knowledge accumulated in Space experience, to develop new solar sail for instance[18]. Energy is an important part of the smooth running of a modern economy and therefore an essential element of high energy consuming innovation industry. In addition to energy savings and cost cuts for many companies, these new techniques may generate a new market with a significant turnover, create new jobs and ideas for services

Industry can benefit from space technology as well. Actually, with some adjustments it can often constitute a tremendous opportunity for industrials eager to develop innovative solutions. We call this transfer "spin-off"[19]. Different kinds of industries are concerned such as nanotechnologies[20]. These ones are due to play a crucial role in future industrial developments and it is a necessity to find a concrete use for these ones in order to facilitate funding of future scientific programmes concerning this topic, for instance the ceramic diskless turbines[21] recently invented from nanotechnologies which could find many applications on earth. This is also particularly true with sensor and navigation which are as essential as in space activities as in earth. However, we can note that space challenges boost earth technological expectations and allow us not to content with sufficient solutions but rather more going always farther. Improving sensor includes for instance a lot of different engineering areas (micro-electronic, robotic, optical Microsystems or the recent system of mini-multispectral camera[22] (MMC)) and exponential effects which put into perspective the previous investment. Other examples can be taken such as Shape Memory Alloy[23] will have an important impact in the development of space mechanism in Europe since it will allow the replacement of the current technologies used as triggering mechanisms. The impact of the development of this technology is not limited to space. The development of the proposed technology for space will directly open the door to transfer these technologies to other areas such as medicine (artificial muscles and valves), automotive (replacing several electrical motorised actuators and valves) and Aeronautics (replacement of electrical motors and generation of smart structures). Space also encourages innovation in deserted sector by Europe such as robotic[24] whereas it has a high economic potential just like subsea robotics crucial for future exploitation of marine resources (oil/gas, minerals etc.). We can also add the invention of the optical frequency comb[25] and more generally laser technology which was initially mainly developed for space activities and now regularly used and earth. Even pro-

[16] FP8 hearing on Space Research, Jean-Pierre Roux, AREVA, 8 Dec. 2010, Brussels, Belgium

[17] FP8 hearing on Space Research, Pekka Janhunen, Bernd Biering, Daniele Romagnoli, Peter Spietz, Finnish Meteorological Institute, DLR, 8 Dec. 2010, Brussels, Belgium.

[18] FP8 hearing on Space Research, Bernd Biering, Daniele Romagnoli, Peter Spietz, DLR, 8 Dec. 2010, Brussels, Belgium.

[19] "NASA Technologie SpinOff 2010.", NASA, 2010, < http://www.sti.nasa.gov/tto/Spinoff2010/pdf/Spinoff2010.pdf>.

[20] FP8 hearing on Space Research, Jeroen Rotteveel, Chris Verhoeven., Mark Bentum, ISIS – Innovative Solutions In space; Delft University of Technology; University of Twente, 8 Dec. 2010, Brussels.

[21] FP8 hearing on Space Research, Edwin Gevorkyan and Valery Manchesko, CermetULtd, University of Twente, 8 Dec. 2010, Brussels.

[22] FP8 hearing on Space Research, Dirk van Toledo, Progress Control, 8 Dec. 2010, Brussels.

[23] FP8 hearing on Space Research, Francisco Gutiérrez, ARQUIMEA Ingeniería S.L., 8 Dec. 2010, Brussels, Belgium

[24] FP8 hearing on Space Research, Dr. Thomas Vögele, German Research Centre for Artificial Intelligence, (DFKI) GmbH- Robotics Innovation Centre Bremen, 8 Dec. 2010, Brussels.

[25] FP8 hearing on Space Research, Steve Lecomte, Centre Suisse d'Electronique et de Microtechnique SA, Switzerland, 8 Dec. 2010, Brussels.

ject apparently far from "daily industrial" preoccupations could be crucial for innovation in the nearest future, this is for example the case of the Melissa project[26] which includes micro-algae production, waste recycling, water recycling, microbial and chemical detection and removal, modelling. Have major interest in terrestrial industry (e.g. pharmacy, chemical industry, oil). Moreover the environment, ecology, toxicology, is totally in line with the interest of European citizen. Innovation in space and industry are therefore closely related and it is often a matter of independence to sustain program to assure growth and employment into a worldwide market more and more competing. That takes shape several sides throughout the innovative scheme. After funding a space related program, it is necessary to find it when it is profitable and possible a practical application and protection by patent. It is also important to keep an efficient industrial basis made up of experienced engineers and news generation of scientific graduated which constitute the core of a space and more generally innovative industry. This is the condition not to be dependent on foreign supplies regulation such as ITAR and to have a dynamic and innovative market.

Science itself can take advantage of space environment. Astrobiology[27] research on the ISS is considered as a stepping stone and allows advanced provides a unique platform to perform studies in physical and life sciences. Understanding processes in fluid behaviour, material and plasma physics, human physiology and plant and cell biology are important for basics knowledge but also for application in society. Medicine is often concerned as the space environment provokes special effects on human body. This is therefore the ideal place to elaborate treatments or study phenomena related to bones or muscles which become critical in our older population. Even in Social Sciences[28] like Psycho-sociology space stimulates innovation. Space exploration brings about a lot of questions about human organizations isolated and living in small places for a long time. An experience such as Mars500 undertaken in Moscow can easily be source of reflection in similar conditions experienced in submarines or off-shore stations for instance. Related to social and engineering sciences recent researches have been also put forward innovations related to virtual reality to improve space activities. This innovative movement is going from the both side, technologies from earth enhance space technology and vice versa in a fruitful relation.

Another domain particularly concerned by space innovations is constituted by environment. A lot of technologies of this topic are strongly dependant on space assets whereas this question becomes more and more pressing. By assessing more precisely, through observations and climate model studies, the trends in the climate, European decision makers will have a solid tool to minimize the changing climate impacts[29]. It is also an excellent tool to organize the socio-economic organization in order to better coordinate the innovations with our environment. Various consequences of space technologies can be found in this field, illustrated for instance by the importance that can represent studies of climate from space to enhance the communication differently affected by the perturbations depending on the band used. A better understanding of the greenhouse effect is the key to develop innovative and efficient technologies which could become an ecological so as profit-making asset. Communication has been become a vital need of our information society and space has played a great role in its development and will continue in the future with the technological challenges of long distances communication.

Spaces activities constitute also an ideal platform for cooperation between European and different countries like Russia[30] with which we already share number of common projects due to foster innovation. A set of common experience and trust which will be useful in other innovative domains.

We can note that innovation and space activities are therefore closely linked in a fertile relation, while we develop systems allowing us to survive and use outer space, those technologies find concrete applications in our daily life on earth. To conclude, space activities have the advantage to stimulate the traditional roots of innovation in human-being. The necessity to adapt oneself to another and often hostile environment, and the perpetual aspiration for humanity to explore and push back always farther its limits and boundaries.

[26] FP8 hearing on Space Research, Max Mergeay, MELiSSA: Closed Loop Life support System, 8 Dec. 2010, Brussels.
[27] FP8 hearing on Space Research, Prof. Charles Cockell, Open university, 8 Dec. 2010, Brussels.
[28] FP8 hearing on Space Research, Richard Aked, Space Applications Services NV, 8 Dec. 2010, Brussels.
[29] FP8 hearing on Space Research, Per Høeg, Technical University of Denmark, DTU Space, 8 Dec. 2010, Brussels.
[30] FP8 hearing on Space Research, Dr. Yuriy Sheynin and Dr. Tatiana Solokhina, Saint-Petersburg State University of Aerospace Instrumentation (SUAI), Ekvess RnD Centre, 8 Dec. 2010, Brussels.

### 1.2.6 Mobility

Despite renewed demand in emerging economies and especially in the pacific region, maritime transport remained stagnant in 2010, continuing the downward trend of 2009. The considerable increase in size of the world merchant fleet, a direct result of a record new deliveries figure in 2009, resulted in declining productivity for shipping companies. The excessive tonnage supply and lower tonnage carrying capacity trends are expected to continue well into 2011. The only notable exception to the overall picture has been China, which pursued its spiralling growth both in supply and demand in shipping services. Chinese companies are the fastest growing worldwide and the country is home to the most important container and crane manufacturers. As Chinese containerised exports represent 25% of the global total, this trend is expected to continue. In 2009 alone, China overtook Germany as the third largest shipping country, Japan as the second ship-building country and India as busiest ship-recycling country[31].

[31] United Nations Conference on Trade and Development. Review of Maritime Transport 2010. Geneva: UNCTD 2010.

# 2. Global Space Sector Size and Developments

In the following chapter, there will be a brief discussion of space related public budgets and commercial revenues. This should allow for a quantitative assessment of the overall market value and financial performance of space activities in the last 12 months. However, providing an accurate estimate of global space activities' financial and market figures is a complicated task. In the absence of internationally uniform standards, most countries and space research institutions have adopted slightly different ways of categorising and distributing funding for space activities. The relative lack of transparency in certain government space programmes, such as military space projects, further complicates calculations. Commercial companies on the other hand publish their financial figures regularly, but not in a uniform and synchronised way that would allow direct horizontal industry comparisons.

## 2.1 Global Space Budgets and Revenues

The 2010 year constitutes the result of a steady growth of worldwide national budgets. The world government expenditure totalizes $71,5 billion[32]. However the rate of increase (Compound Annual Growth Rate (CAGR)) has considerably slowed down to 2% between 2009 and 2010 whereas it amount to 9% during the period 2004-2009. A more detailed view on institutional budgets can be found in the following paragraph 2.2.

In terms of commercial revenues of space activities, the Space Report 2011 indicates the total revenue of commercial satellite services to have been about $102 billion comprising telecommunications, Earth observation and positioning services (what represents an increase of 9% from 2009). The revenue of space-related commercial infrastructure including manufacturing of spacecrafts and in-space platforms, launch services as well as ground equipment is estimated to have reached around $87,39 billion (a decrease of 8% compared to 2009 due to a lack of launch capacity). In conclusion, the commercial space revenues of 2010 can be sum up to $189.39 billion[33].

## 2.2 Overview of Institutional Space Budgets

The total institutional spending on space in 2010 can be estimated to be approximately $71.5 billion, a figure which shows a nominal increase of 9% compared to 2009[34]. This space spending is comprised of $37 billion in civil expenditures (or 52% of the total) and $34 billion in defence expenditures (or 48%). Consequently, the share remained virtually the same compared to last year's figures. The overall budget levels could have even decreased for the first time in 15 years if they had not been supported by exceptional growth in SatCom expenditures (+49%, $2.8 billion) driven by the US DoD.

Out of the estimated $34 billion of defence related space expenditures worldwide, between $28 billion were spent by the United States, representing a share of 82% and indicating a minor percentage decrease compared to the year before. These funds came from the Department of Defence (DoD), the National Reconnaissance Office (NRO), the National Geospatial-Intelligence Agency (NGA) and other government entities. It should be borne in mind that not all relevant funding is made public, resulting in a degree of uncertainty regarding the exact figures of expenditures on defence space activities. The U.S.'s activity is therefore a major support to the worldwide activity and particularly in the defence area.

The state hierarchy is quite similar to 2009. Without being particularly surprising, the U.S. has the biggest budget including civil ($20.3 billion) and defence ($20.3 billion) expenditures (Figure 2.1). The assessment of Russian's budget must be put into perspective. This is a low estimation which would be certainly higher considering its intensive military activity entailing regular classified launches or scientific programmes. However, we can

[32] Figures in this section are based on Euroconsult data.

[33] The Space Foundation. The Space Report 2010. The Space Foundation: Colorado Springs, 2010: 30.

[34] Figures in this section are based on Euroconsult data.

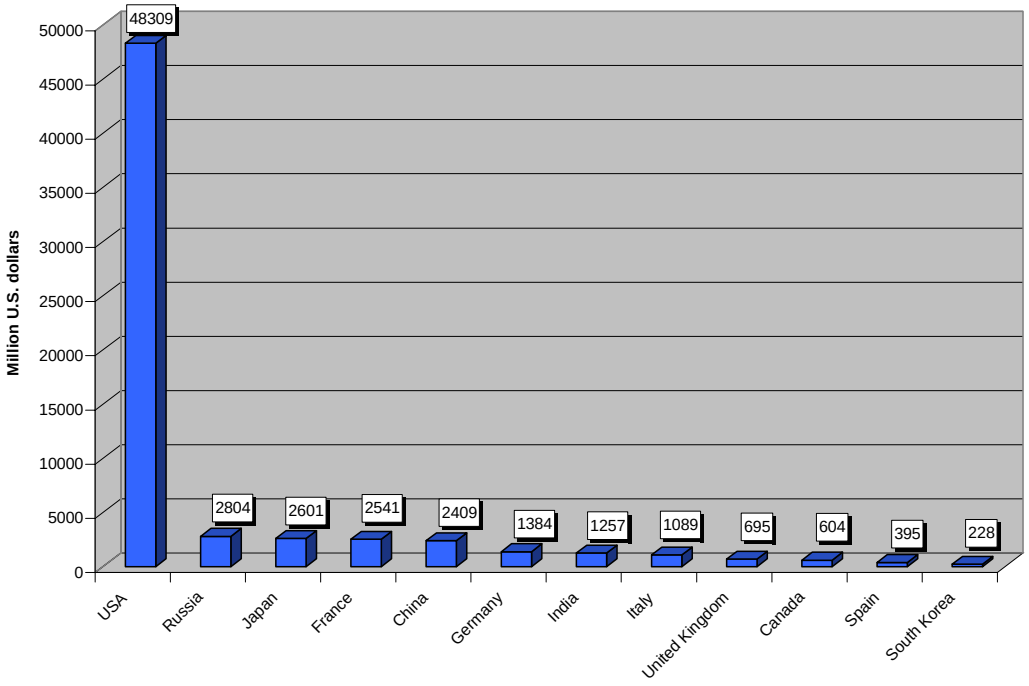


Figure 2.1: Public space budgets of major space powers in 2010 (Based on Euroconsult data).

notice the rise of China ($2.4 billion) closer than 2009 to France ($2.5 billion) and India which overtakes Italy becoming the 7th biggest budget. It is worth noticing that the second protagonist is not a state but an international organization namely the European Space Agency with a budget of ($5.32 billion[35]) managing the joint investment of 18 Member States), the five most important contributor being France 18.2%, Germany 16.7; Italy 9.9; UK 6.8; Spain 5.2. The Japan budget has sharply decreased compared to 2009. It is therefore noticeable that the U.S., European countries, ESA and Russia concentrate most of the world budget allocated to space activities comparable to 2009 with 82%.

In order to measure the concrete effort provided by a country in space sector it is necessary to put into perspective these figures in regards with GDP[36] (Figure 2.2)

Indeed, consulting the absolute numbers alone only tells one side of the story, as comparisons between countries with different economic conditions like prices or wages levels can be misleading. The U.S.'s figures of space budget confirm their strong engagement in the space effort but we notice a stabilisation or even a slight decrease. The information concerning Russia as previously explained must be taken with reserve, they show a short fall which is due to be counterbalanced by recent statement and engagement from the Russian government to increase the Russian's activity in this field[37]. Follow then France that stays stable (0.1%) and India which significantly rises its effort (0.09%). Most of the space leading countries in Europe spend approximately between 0.05 and 0.03 of their GDP into space activities.

Another perspective is furnished by with the space budget per capita (Figure 2.3) which is still largely dominated by the U.S. ($155.7), then by France 40.4. The budget per capita of Luxembourg $39.8 and Belgium $21.4 are mainly due to their strong participation in ESA (Belgium 4.3% and Luxembourg 0.3 relatively to their modest economic importance). Finally Norway and Japan have a budget per capita of 20.4. These figures are symptomatic of the milestone that could represent 2010, as an apogee for space budget. The space budget per capita of France, Japan, Belgium and most of the countries which follow show a slight decrease compared to 2009. Growing space actors such as India or China are of course in such chart underrepresented due to their socio-economic characteristics which include a large population.

[35] Source ESA figures, exchange rate 1 EUR = 1,42158 USD

[36] The data used is the nominal GDP converted to current U.S. dollars using the official exchange rates as indicated by the International Monetary Fund.

[37] Gleb, Bryanski." Russia targets bigger role for space program." Reuters 8 April. 2011 <http://www.reuters.com/article/2011/04/08/us-russia-space-putin-idUSTRE7366RB20110408>

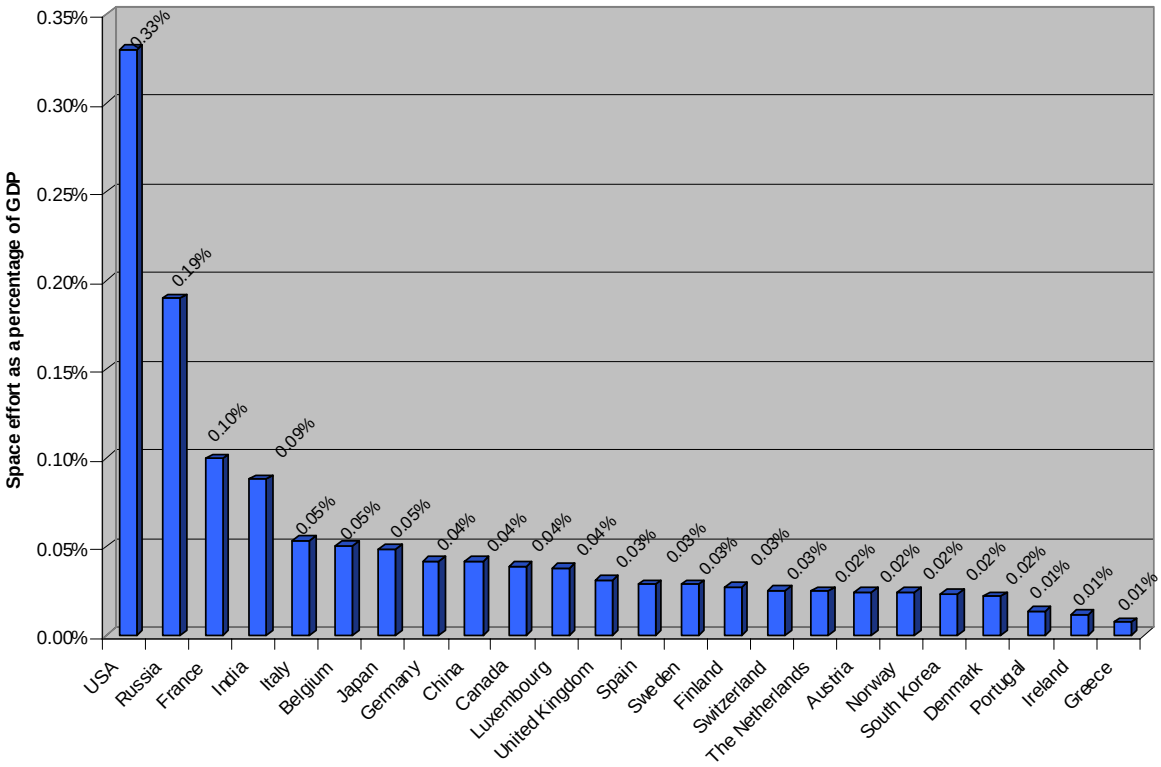


Figure 2.2: Public space budgets (selection) as a share of nom. GDP in 2010 (source: Euroconsult/IMF)

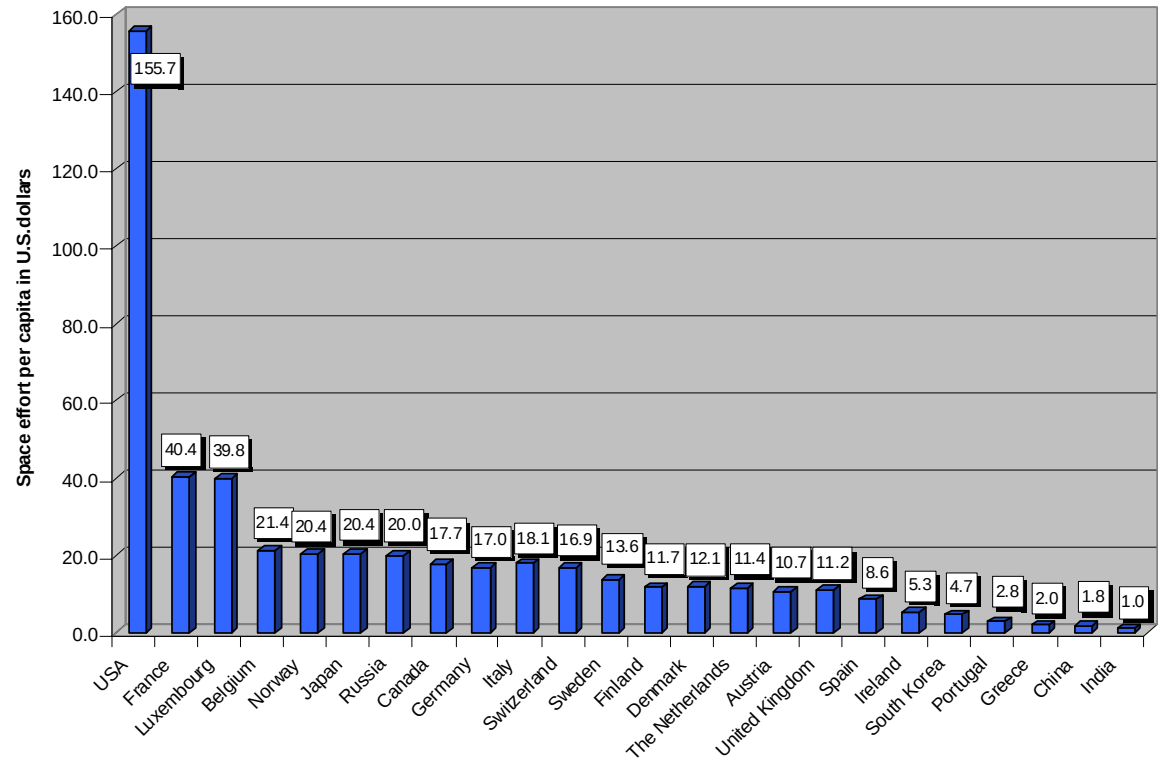


Figure 2.3: Public space budgets per capita (selection) in 2010 (source: Euroconsult/UN World Population Prospects)

It is also possible to rate the GDP share of public space funds against the public space funds per capita. This is done in figures 2.4 and 2.5, with the latter excluding the United States and Russia to display the other countries more clearly. The U.S. dominates of course in both dimensions the debates. France arrives in second position in a more balanced way than Russia whose we must consider the position cautiously considering the foggy data concerning it. This one has however a noteworthy proportional discrepancy between per capita spending and GDP share. Japan follows leading a group which composed the majority of second class space powers namely Germany, Canada, Italy, UK, Spain South Korea which display comparable value in the both dimension. China and India have a rather singular position with a large part of their GDP spent into space and a budget per capita behind the other nations. This situation being mainly the consequence as explained previously of their huge population compared to the other nations which made up this figures.

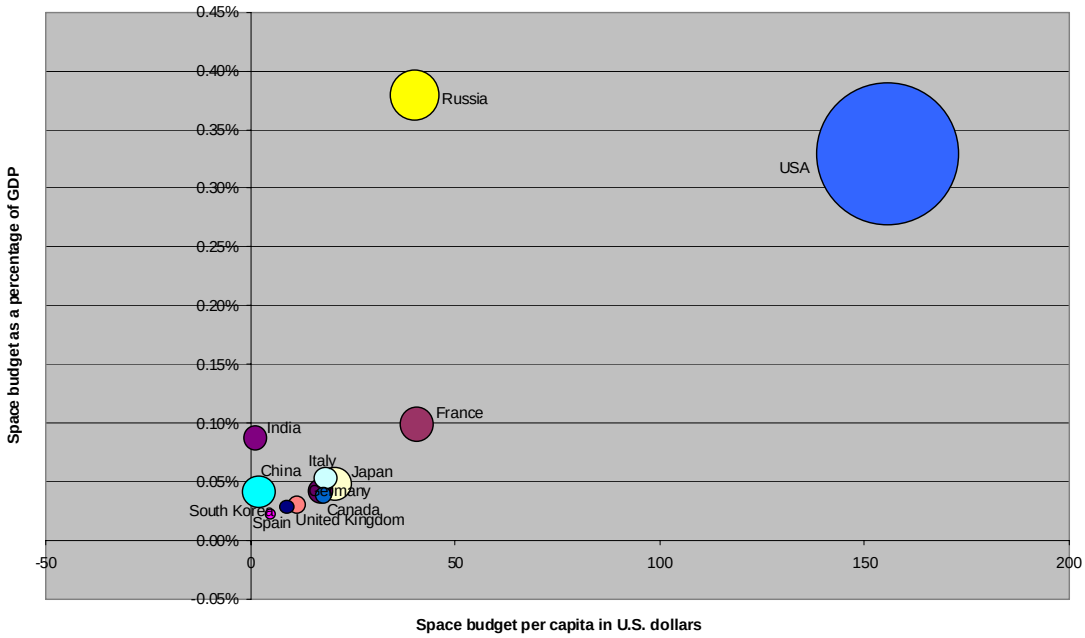


Figure 2.4: Public space budgets as share of GDP mapped against space budgets per capita in 2010. The bubble size indicates the absolute space budget (Based on Euroconsult data)

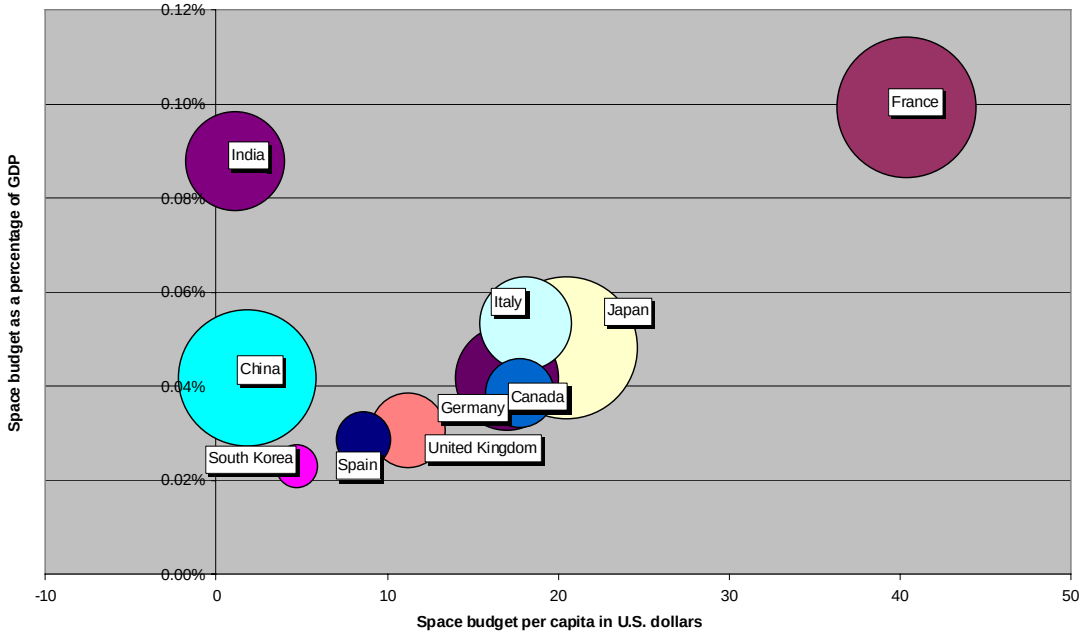


Figure 2.5: Public space budgets as a share of GDP mapped against space budgets per capita in 2010. The bubble size indicates the absolute space budget (Based on Euroconsult data)

## 2.3 Overview of Commercial Space Markets

The following section presents key figures and data on commercial space activities divided by field of activity.

### 2.3.1 Satellite Services

In 2010 and 2011 the satellite services industry has shown remarkable resilience to the adverse global financial conditions. It has been able to maintain its upward trend mostly thanks to its inherently global nature, which has allowed it to profit from the quick economic recovery of emerging markets, especially in the SE Asia and South America regions. Booming demand in developing regions has allowed for a sustained expansion of satellite capacity and corporate revenues. Worldwide satellite capacity rose above 7,000 36 MHZ transponder equivalents in 2010, while revenues are expected to have exceeded the over $160 billion figure of 2009[38].

In light of this positive outcome, the industry has seized the opportunity to expand its technology development programmes, especially in the field of the development and launch of Ka-band spacecraft. Further investments were made in consolidating capabilities through the ordering or launch of larger spacecrafts with enhanced signal power and transponder capacity. The way the industry has reacted to the challenge of the 2008 financial crisis clearly demonstrates an acute rate of responsiveness to the changing conditions, as well as an increased sense of extrovert corporate behaviour and confidence in the sector's future prospects. Achieving the right mixture of investing in innovating technologies and new services on the one hand, while consolidating current operations on the other has boosted the industry's revenues for one more consecutive year.

This innovative and proactive approach to the difficult overall financial conditions was also demonstrated in the development of the industry's business model. Creative and economical synergies with both public and corporate partners were increased, in search of optimising the development and use of their satellites and services. In the case of emerging markets this trend was supported by their continued expansion, as well as by subsidies provided for the coverage of underserved areas. In the case of developed regions it was primarily fuelled by the launch of new services (such as improved broadband connectivity), the support of public stimuli packages and the exploitation of the trend towards outsourcing government services to the private sector. Especially the latter is turning into a key plank in developed countries' space activities, either in the form of Public Private Partnerships (PPPs), or in the form of replacing government space services with long-term contracts to corporate space services' providers[39].

Significantly, the above mentioned development has encouraged a number of space related companies to expand their business into satellite service, in the hope of exploiting the increasing outsourcing trend, especially in the defence sector. Boeing Space & Intelligence System Division was such an example, as it created a unit, Boeing Commercial Satellite Services, to market commercial satellite services to the U.S. government and other satellite users. The initial focus was on meeting U.S. Defence Department needs, but the services unit was also set to address the needs of other agencies and governments, including in the area of non-communications services[40].

Below there is a breakdown of the industry's key developments and trends, according to the nature of the services provided.

#### Direct Broadcast Services

Direct Broadcast Services (DBS) refer to direct-to-home satellite television and radio broadcasts. This section of the industry showed considerable development in 2010 and 2010, fuelled by the quantitative expansion in emerging markets and the qualitative increase in new technologies and services in developed ones. Demand in the latter manifested signs of recovery comparing to the relatively flat revenues in 2009. In 2009 DBS revenues were increased form $64.9 billion to $71.8 billion, or over 10%. This trend was expected to continue into 2010 and 2011 as the number of HDTV channels has been growing exponentially (e.g. by 82% between 2008 and 2009)[41]. At the same time, accord-

[38] "2010 Futron Forecast of Global Satellite Services Demand: Executive Summary". 3 Nov. 2010. Futron 21 Feb. 2011 <http://www.futron.com/upload/wysiwyg/Resources/Briefs/2010_Futron_Forecast_of_Global_Satellite_Services_Demand_Exe_Summary.pdf>.

[39] "2010 Futron Forecast of Global Satellite Services Demand…"
Ostrove, William N. "Commercial Satellite Growth Sustained By New Services." Aviation Week & Space Technology 24 Jan 2011: 167.

[40] Morring, Frank Jr. "Boeing Forms Unit To Market Commercial Satellite Services." Aviation Week & Space Technology 28 Feb 2011: 18.

[41] "State of the Satellite Industry Report". Aug. 2010. Satellite Industry Association and Futron Corp 5 Mar. 2011

ing to current projections the annual growth rate of DBS is expected to exceed that of the entire satellite services' sector as DBS will be replacing more traditional services such as video distribution[42].

As we have seen, all major satellite operators have increased their investments in new technologies and products, especially towards developed markets. Such an example was 3DTV, interest in which spread quickly after the World Cup football. Satellite operators increased their support to this broadcasting platform: Eutelsat, which has been running a 3DTV demo channel, provided capacity for the Paris Open broadcasts; Intelsat announced it would carry ESPN's 3DTV channel and Russian Satellite Communications Co. is planning the allocation of 25% capacity, to HD and 3DTV applications on its Express AT1 and 2 satellites. Despite present technical issues, the prediction is that by 2015 twenty million homes worldwide will be watching 3DTV. Concurrently, even non-commercial actors have demonstrated their interest, including the European Space Agency, which aims to demonstrate a complete 3DTV service offering and is also studying the end-to-end 3DTV chain and testing viable TV products, content and reception sites[43].

### Fixed Satellite Services

Fixed Satellite Services (FSS) refer to the use of spacecrafts that utilise land terminals in fixed positions to broadcast. They include broadband internet, communications and network televisions and radio broadcasts.

In 2010 and 2011 the fixed satellite service (FSS) outlook would remain buoyant, as operators continued to profit from previous investments in new capacity, as well as from the sustained demand for TV and broadband services.

Although some reports anticipate a drop-off in new satellite investment towards 2012-2013, the effect of the current boom in FSS is expected to continue throughout the decade. The industry-wide FSS revenues climbed 5.3% in 2009, to $10.3 billion and the prediction is that, between now and the end of the decade, they will grow by 50%, to $14.8 billion. The growth is explained by the insatiable demand for video and broadband. To meet this demand, 30 new FSS spacecrafts were ordered in 2009.Eutelsat revenues are a clear example of this upward trend. Revenues climbed to €1.05 billion and EBITDA to €827.8 million. In 2010-2011, revenues are expected to reach €1.12 billion and EBITDA will exceed €875 million. Hispasat also reported a solid performance in 2009-2010. Revenues rose 9.5% to €151 million, while EBITDA climbed 5% to €116.7 million[44].

As a result of increasing demand, most commercial operators have invested in technological upgrades that will allow them to absorb it in the most profitable way. For that purpose, a number of Ka-band satellite projects for broadband connectivity were announced in 2010 and 2011. For Example, Inmarsat confirmed the creation of a Ka-band broadband system named Global Xpress to complement its existing L-band satellites. The Inmarsat- 5 spacecraft, scheduled to orbit by 2014, will provide 10 times more speed than the Broadband Global Area Network (BGAN) service and will purvey major advantages in price per bit, antenna size and downsizing costs. Inmarsat predicts that the new system will be generating $500 million in revenues within 5 years of launch and estimates the system's full cost at $1.2 billion[45].

At the same time, the Global Xpress project, based on a deal between Inmarsat and Boeing Satellite Systems (BSS), marked a step forward in the latter's goal to return to the commercial satellite business. With the deployment of all three spacecraft foreseen by 2014, the Global Xpress satellites will give Boeing a foothold in the market for high-throughput commercial Ka-band satellites and offer a quick reply to the demand for broadband Internet access[46]. Finally, Inmarsat was evaluating air-interface technologies and ground segment suppliers for the Global Xpress broadband network. By the end of 2011, it was scheduled to have its channel management plan completed, so that marketing to government and military customers could start[47].

At the same time, its competitor Eutelsat launched its first KA-SAT satellite in December 2010, bringing back to life the International Launch service's Proton M. The KA-SAT

<http://www.sia.org/news_events/pressreleases/2010StateofSatelliteIndustryReport%28Final%29.pdf>.
"Satellite Industry Revenues Toped $160B Globally in 09 " Space News, 14 June 2010: 8.

[42] "2010 Futron Forecast of Global Satellite Services Demand…": 3.

[43] Taverna, Michael A. "Satellite Operators See New TV Standard as Next Holy Grail." Aviation Week & Space Technology 7 June 2010: 36.

[44] Taverna, Michael A. "Satellite Sector Revenues Expected To Double By 2020." Aviation Week & Space Technology 9 August 2010: 26.

[45] Taverna, Michael A. "Inmarsat Set To Provide High-Speed Internet Service." Aviation Week & Space Technology 16 August 2010: 27.

[46] Taverna, Michael A. "Sale Provides Opening In Fast-Growing Ka-Band Segment." Aviation Week & Space Technology 16 August 2010: 28.

[47] Morring, Frank Jr. "Inmarsat Advances On Global Xpress." Aviation Week & Space Technology 6 Dec 2010: 22.

spacecraft was the first of a new generation of high-throughput spacecraft that are expected to improve the competitiveness of satellite communications, compared to terrestrial cable networks. The second high-throughput satellite – ViaSat-1 – was scheduled for launch in 2012[48].

Apart, from investing in innovating technologies and services, FSS providers have moved to consolidate their market positions through better satellite and bandwidth management. For example SES announced that in the next five years it would be reconfiguring its orbital assets so that by 2015 it would have 30% more capacity spread over a fleet that would be reduced from 43 to 38 satellites in service today. Furthermore, SES expected to spend between €430 million and €495 million per year to replace capacity. The plan for 2011 was to spend €790 million on satellites and other projects. This investment should drop to below €390 million by 2014 and remain stable for some years. The company has currently 16 satellites under construction, including its share on the Yahsat satellite for the United Arab Emirates. Significantly, only four of these will occupy new orbital slots and will be directed to new markets. The remaining 12 will be satellites large enough to replace existing spacecraft while still offering expansion capacity[49].

Smaller satellite operators on the other hand, have opted for more traditional commercial strategies. One such case was Asia Broadcast Satellite (ABS), which pursued the low-risk expansion strategy of acquiring aging spacecraft from other operators. For exampled, it purchased the Koreasat-3 spacecraft from Korea Telecom Corp. of S. Korea, renamed ABS-7, in order to provide Ku – and Ka-band VSAT cellular backhaul, broadband and government services to the Middle East. In July 2009, it had acquired KT Corp's Koreasat- 2, also to serve the Middle East market, and in November 2009 it acquired Mabuhay Sat Corp. of Manila, along with its Agila- 2 satellite and extensive ground facilities, renamed ABS-5. This more conservative approach intended to provide market growth and cash flow until the company's first all-new satellite – ABS-2, expected to be launched in 2012[50].

### Remote Sensing

Remote sensing refers to commercial companies that provide optical and radar images to the open market, mostly to government entities that have been increasingly outsourcing such capabilities over the past few years. After an impressive 37% increase in 2009, commercial remote sensing revenues continued to grow in 2010 and crossed the $1 billion benchmark. Although the share of the sector's private clients has been on the rise, government (and particularly military) demand was again instrumental in boosting remote sensing services' providers revenues.

For example, in an effort to boost the U.S. industry's global competitiveness, the U.S. government undertook an important initiative to deliver more work to remote sensing companies. On August 2010, the National Geospatial-Intelligence Agency (NGA) awarded ten year contracts totalling $7.3 billion to two publicly traded satellite operators, in order to supply imagery for the U.S. intelligence community and Defence Department. DigitalGlobe Inc. received a $3.5 billion contract, while GeoEye Inc. a $3.8 billion contract[51]. Both deals were unprecedented in scale and contract duration providing an important cash flow base for their respective contractors.

Such government contracts effectively secure the industry's investment projects, allowing them to expand their activities. RapidEye for example was searching for a new investor to help sustain it until the business model for its system could be shown to be viable. The company's five satellite fleet provides imagery in five spectral bands and the project is mainly funded by the private sector. The company is seeking $200 million in equity to fund new products and applications, as well as to design a follow-on constellation to be launched by 2014-2015. In this case also, the U.S. government stepped in with a $337 million help to defray the cost of building and launching GeoEye2, which is estimated at a total of $800 million[52].

### Mobile Satellite Services

To prevent geostationary commercial communications satellites from colliding or causing signal interference, a new cooperative data tool, Space Data Centre (SDC), had been developed. This new Space Data Centre automatically plots conjunctions in the orbits of satellites owned by participating operators

[48] Taverna, Michael A. "Eutelsat Spacecraft Is First With High-Throughput Internet Access." Aviation Week & Space Technology 3 Jan 2011: 29.
[49] De Selding, Peter B."SES Expansion Program to Raise Capacity 30 Percent." Space News, 7 June 2010: 6.
[50] Taverna, Michael A. "Deal Is Hong Kong Operator's Fourth In Past Year." Aviation Week & Space Technology 5 Jul 2010: 41.
[51] Anselmo, Joseph C. "Big Government Contracts Bolster Satellite Imagery Companies." Aviation Week & Space Technology 16 August 2010: 10.
[52] Taverna, Michael A. "EO Sector Needs More Public Support To Stand On Its Own." Aviation Week & Space Technology 4 Oct 2010: 77.

and alerts their control centres to the problem. The organization that runs the system was in talks with the U.S. Strategy Command (Stratcom), to trade the data it has for better space-debris ephemera and a heads-up when a commercial spacecraft in the system is in the way of a military spacecraft[53].

Tests are planned to determine the potential for interference and identify ways to prevent jamming of GPS signals. The result of those tests will have an effect in a Federal Communications Commission (FCC) decision to grant LightSquared conditional approval to deploy 40.000 terrestrial base stations to augment its mobile satellite service capacity. Lightsquared closed a $586 million additional debt to help fund the $7 billion project[54].

RascomStar-QAF, an African Operator, in partnership with ViaSat, is introducing a low-power portable GSM cellular uplink station. This new cellular system intends to reduce satellite price disparities with respect to terrestrial networks and will permit a lower cost for serving cell-phone customers in rural areas. Mainly, it will benefit Africa and other areas with insufficient terrestrial communications infrastructure[55].

On June 2010, Iridium Communications awarded Thales Alenia Space of France with a $2.1 billion contract, in order to build Iridium's next- generation constellation of low-orbiting voice and data communications satellite. On June, the financial guarantee by Coface, one of the most active export credit agencies, was just a promise and to immediately start working on the project, Iridium and Thales Alenia signed a $53 million authorization. The Coface's loan covers 95% of a $1.8 billion credit. This new constellation will feature intersatellite links, a feature that will permit Iridium to be less dependent on ground stations to relay signals[56].

Iridium faced several challenges that industry officials said to make Iridium just as much of a high-wire act today as it was when it began operating. Three serious challenges were identified was remaining in front of the company, as it was starting to build its second-generation constellation of 72 in-orbit satellites. There were three areas related to the financing of the Iridium Next project outside the Coface-enabled package; the feasibility of the satellite-delivery schedule and whether Iridium has accurately assessed the commercial satellite-launch market. Iridium awarded a $2.1 billion contract to Thales Alenia Space of France, to start delivering spacecrafts in 2015[57].

### 2.3.2 Satellite Manufacturing

The satellite manufacturing revenues in 2010 experienced an increase compared to 2009. The total revenues of satellite manufacturers that have built satellites both for governmental and commercial launches are estimated to have reached $14.5 billion in 2010[58] which indicates a rise by 7% from the $13.5 billions gained in 2009[59]. It can be observed in Figure 2.6 that this augmentation marks a substantial increase after the abrupt end in 2009 to the trend of slightly decreasing revenues from 2006 on. The actual predictions forecast a regular increase of the revenues to reach $15 billion in 2013[60]. It is expected that the demand by region be stable to 2019 with a distribution hardly different from 2009 except the growing market in South Asia.

### 2.3.3 Launch Sector

In 2010 there were a total of 23 commercially contracted launches, carrying 44 payloads into orbit, out of which 31 for commercial operators. Russian companies had again the lion's share with a total of 13, or 57% followed their European (26%) and U.S. (17%) competitors. All 23 launches accounted for approximately $2.45 billion in revenues, only slightly increased from 2009 by $43 million. European revenues were again the highest reaching $1.32 billion, followed by Russian ($826 million) and the U.S. ($307 million). In spite of the marginal increase in the industry's revenues, all launch service providers increased their net profits thanks to the absence of Chinese or multinational commercial launches in 2010. However, since these figures take into account the value of the past year's activity they should only be considered

[53] Morring, Frank Jr. "Satellite Operators Now Tracking Each Other's Spacecraft." Aviation Week & Space Technology 9 August 2010: 50.
[54] Warwick, Graham and Taverna, Michael A. "Tests Planned On Cell-Phone Jamming Of GPS." Aviation Week & Space Technology 28 Feb 2011: 48.
[55] Taverna, Michael A. "New Cellular System Will Debut In Africa." Aviation Week & Space Technology 28 Feb 2011: 49.
[56] De Selding, Peter B."Iridium Selects Thales Alenia To Build Iridium Next Constellation." Space News, 7 June 2010: 5.
[57] De Selding, Peter B."Major Challenges Lie Ahead For Mobile Satellite Services Operator." Space News, 7 June 2010: 5.
[58] 2010 Futron Forecast of Global Satellite Services Demand: Executive Summary". 3 Nov. 2010. Futron 21 Feb. 2011
[59] "State of the Satellite Industry Report.", SIA Jun 2010 <http://www.sia.org/news_events/2010_State_of_Satellite_Industry_Report.pdf>
[60] 2010 Futron Forecast of Global Satellite Services Demand: Executive Summary". 3 Nov. 2010. Futron 21 Feb. 2011

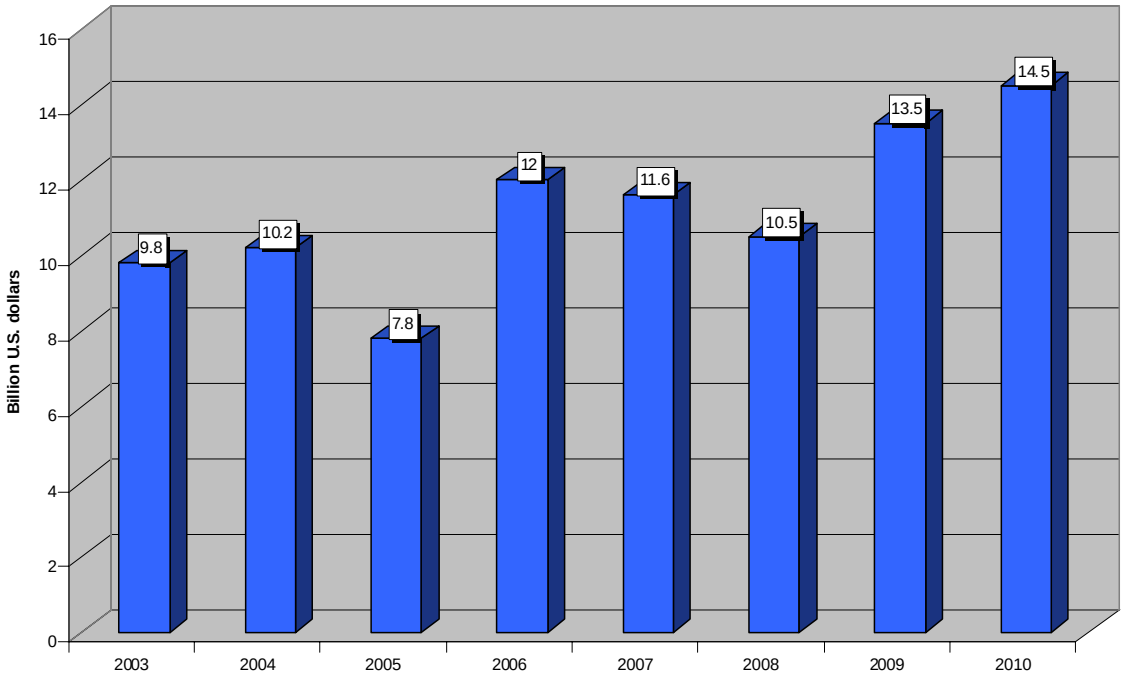


Figure 2.6: World satellite manufacturing revenues (Source: SIA/Futron/Space Foundation)

as indicative, since contracts are typically prepaid one to two years prior to launch[61].

All six European launches were carried out by Arianespace onboard Ariane 5 rockets. However, in the course of 2010 concerns were started to be raised regarding Arianespace's own financial survival. In October, the company warned the members of its supply chain and the European governments for the necessity to bear more of the operating costs, in order to build capacity for a launcher system expansion to deal with tough competition. The attention to competitiveness has led Arianespace to convene the manufacturers of the Ariane 5 and two new systems that are to enter service at its Kourou launch complex next year, to discuss measures to ensure it. NASA is doing a faster implementation of his new program to stimulate the private sector to develop commercial space transport services. With the first successful flight in December, SpaceX is pushing to dock with the ISS on the next launch in mid-2011. A new successful flight could mean the beginning of commercial cargo run to the ISS by year-end[62]. To ensure competitiveness, several different measures were analyzed to return Arianespace to profitability and to make it more efficient against new arrivals, such as SpaceX, Sea Launch and ILS[63].

### 2.3.4. Ground Equipment

Ground equipment revenues include infrastructure elements, such as mobile terminals, gateways and control stations, and consumer equipment, such as very small aperture terminals (VSAT), ultra small aperture terminals (USAT), DTH broadcast dishes, satellite phones and digital audio radio satellite (DARS) equipment. Portable Navigation Devices (PND) form one of the sub-segments of end-user electronics incorporating GPS chip sets. The PND market was continuing its regular increase with a notably slow down in comparison to 2008. The sharp augmentation of 34% previously experienced from 2007 to 2008 fell between 2008 and 2009 to 8% consolidating all the same a global turnover of $49.9 billion[64]. Ground equipment represented in 2009 31% of the world space business revenues[65] showing an increase of 3% in the global distribution of the past year.

The optimistic expectation concerning 2010 revenues for the two companies leading the market are partially met. After the fall of its revenues in 2009, the news is quite good for

[61] Federal Aviation Administration. Commercial Space transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011: 3.
[62] Warwick, Graham. "Commercial Space Transport Rockets On." Aviation Week & Space Technology 24 Jan 2011: 149.
[63] Taverna, Michael A. "Space Arianespace Says Its Long-Term Viability Is At Stake" Aviation Week & Space Technology 18 Oct 2010: 31.
[64] "State of Satellite_Industry_Report". SIA. Jun 2010 <http://www.sia.org/news_events/2010_State_of_Satellite_Industry_Report.pdf>
[65] Ibid.

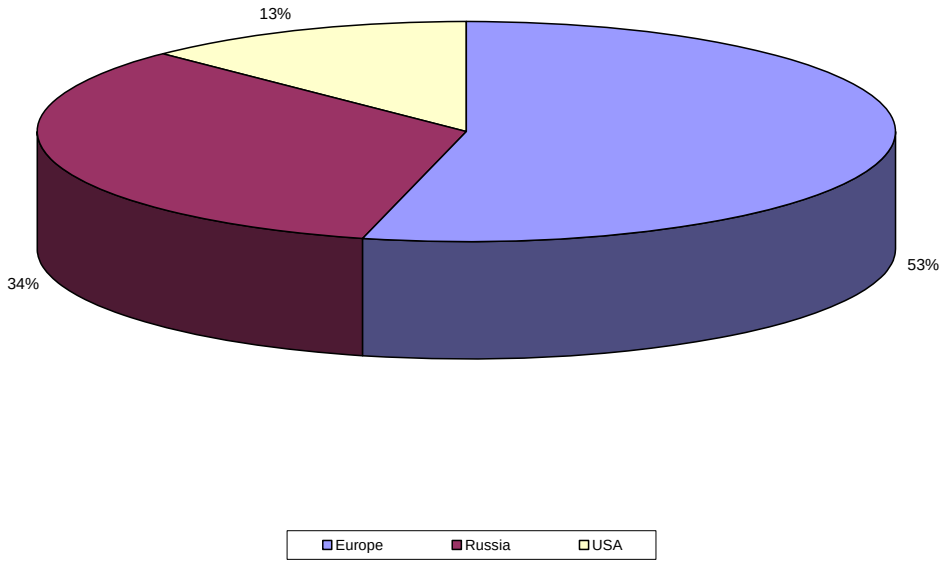


Figure 2.7: Commercial Launch Revenues by Country in 2010 (Source: FAA)

TomTom which announced a total revenues of $1.52 billion in 2010[66], representing an augmentation of 2.5%. The situation is less favourable for Garmin which experienced a decrease of its revenues from $2.95 billion in 2009 to 2.69 in 2010[67] meaning a noticeable drop of 9.6%.

To better understand these figures we will detail them by type of product and sale areas. Garmin which had a year 2010 particularly flat knew a decrease of its automotive products from $2.054,127 in 2009 to sink at $1.668,939 in 2010 whereas its segments related to marine, aviation and outdoor fitness progressed significantly without being able to hamper enough the leak. Meanwhile, TomTom augmented impressively its sales in automotive systems of 55.9% during the same period with a global revenue of $179 million in this market. Geographically speaking, Garmin reinforced its sales in Asia with an increase of 47% of its revenues there (representing an increase of $70 millions) but on the other hand lost 16.52% in the U.S. falling from $1.97 billion to $1.65 while it stays stable in Europe. TomTom is not particularly more successful in North America than its counterpart with a decrease of 7.54% of its sales in this area representing however a less impressive loss of $31 million. TomTom increased its revenues in Europe of 6.26% its core area, and 12.9 in the rest of the world. Europe and Asia seem to be currently particularly favourable for the PND market.

### 2.3.5 Insurance Sector

As the space industry continues to demonstrate increased hardware reliability, low accident rates and booming growth in recent years, insurance costs have been decreasing[68]. The market becoming safer and safer brings about more competition between the actors of space insurance and a change of behaviour from customers. The trend is now to take out an insurance two or three years beforehand the launch reducing therefore the price. The rates of space insurances has been progressively reducing throughout the 2000's entailing a withdraw of actors from this field. Number of company such as Swiss Re in 2010 did not deploy its entire insurance capacity. Given that commercial space launches are expected to grow in the following years and the technologies involved have proven their worth in practise, one can expect this trend to continue. To summarize Insurance rates for launch and in-orbit coverage are exceptionally low this year[69].This situation is mainly due to the few claims and substantial profits made by the underwriters. Indeed, the most important accident concerns the $343 million loss of Eutelsat W3B, insured by Space Consortium in London, part of Brit

[66] "TomTom Annual Report and Accounts 2010."23 May 2011. < http://ar2010.tomtom.com/home.html>
[67] "Garmin Anuual Report 2010." 23 May 2011. < http://www8.garmin.com/aboutGarmin/invRelations/reports/10K_2010.pdf>

[68] Peter B., de Selding. "Insurance Premiums Stay Flat Despite W3B Satellite Failure." Space News, 20 May 2011 <http://www.spacenews.com/satellite_telecom/110520-insurance-premiums-flat.html>
[69] De Selding, Peter B."Satellite Insurers on Track for Highly Profitable 2010." Space News 3 Sept. 2010 <http://www.spacenews.com/satellite_telecom/100903-satellite-insurers-profitable.html>

Insurance Holdings N.V, but this one is still notably isolated. The failure of a Proton-M launch carrying three Russian global orbiting navigation satellite system satellites in December was only covered for $3 million. The insurance rates are therefore expected to fall in 2011. [70]

## 2.4 Sectoral overview

### 2.4.1 Launch Sector

The launch sector is particularly crucial for the satellite industry. It is a key element of each independent space policy. However, the revenues it generates are far less important than the ones originating from the satellite manufacturing and satellite services business.

The year 2010 is slightly less active for the launch sector than 2009, with a total of 74 launches conducted by launch providers from Russia, the United States, Europe, China, India, Japan, South Korea and Israel (Table 2.1). We can notice some important events this year, such as the two non-commercial launches failures, a Proton-M launch carrying three Russian global orbiting navigation satellite system satellites in December [71], and a second south Korean's KSLV I which would be caused by the Russian stage according to the South Korean official investigation[72]. The failure met by the Eutelsat´s satellite being mainly due to technical problem after the launching.[73]

When looking into specific countries, Russia was again the world leader in the number of launch, representing approximately 42% of the total number of launches. It was followed by the United States (app. 20.3% of the total), Europe (app. 8.1%), China (app. 20.3%), Japan (app. 2.7%), India (app. 4.1%), South Korea land Israel which launched one vehicle each, or approximately 1% of the total launch figure (Figure 5.5).[74]

Russia launched 31 vehicles using eleven different launch systems. Concerning the U.S. eight different launchers for a total of 18 launches, and China which with the same amount of launches use 6 models of launchers, India had recourse to a different launcher for each of its three launches. The exception is as often represented by Europe which has only employed the Ariane 5 launcher for 6 launches. Japan with two launches, Israel and South Korea with one had recourse to one. The total of different systems of launchers employed is up to 32 for 2010 showing an increase of three compared to 2009.

| Launchers | Number of launch systems | Total number of launches |
|---|---|---|
| Russia | 11 | 31 |
| USA | 8 | 15 |
| China | 6 | 15 |
| Europe | 1 | 6 |
| India | 3 | 3 |
| Japan | 1 | 2 |
| Israel | 1 | 1 |
| South Korea | 1 | 1 |
| **Total** | **32** | **74** |

Table 2.1: Worldwide launches per country and number of launched systems used in 2010 (Source FAA)

The commercial launches market is shared between three actors namely Russia 56.5%, Europe 26.1% and U.S. 17.4% (Figure 2.7). However these figures must be put into perspective due the European launcher Ariane V carrying two payloads.

| Launchers | Commercial | Non-commercial | Total number of launches |
|---|---|---|---|
| Russia | 13 | 18 | 31 |
| USA | 4 | 11 | 15 |
| China | 0 | 15 | 15 |
| Europe | 6 | 0 | 6 |
| India | 0 | 3 | 3 |
| Japan | 0 | 2 | 2 |
| Israel | 0 | 1 | 1 |
| South Korea | 0 | 1 | 1 |
| **Total** | **23** | **51** | **74** |

[70] Collins, Stuart."Space insurance rates expected to fall in 2011." Space News 24 Feb. 2010 < ttp://www.businessinsurance.com/apps/pbcs.dll/article?AID=/20110213/ISSUE03/302139999>
[71] Ibid.
[72] K.S, Jayaraman. "ISRO Team Says Cable Rupture Caused Rocket Failure.
" Space News 31 Dec. 2010 <http://www.spacenews.com/launch/101231isro-team-says-cable-rupture-caused-rocket-failure.html>
[73] Peter B, de Selding, "Eutelsat W3B Declared Total Loss.", Space News 29 Oct. 2010 <http://www.spacenews.com/launch/101029-eutelsat-w3b-declared-total-loss.html>
[74] Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011.

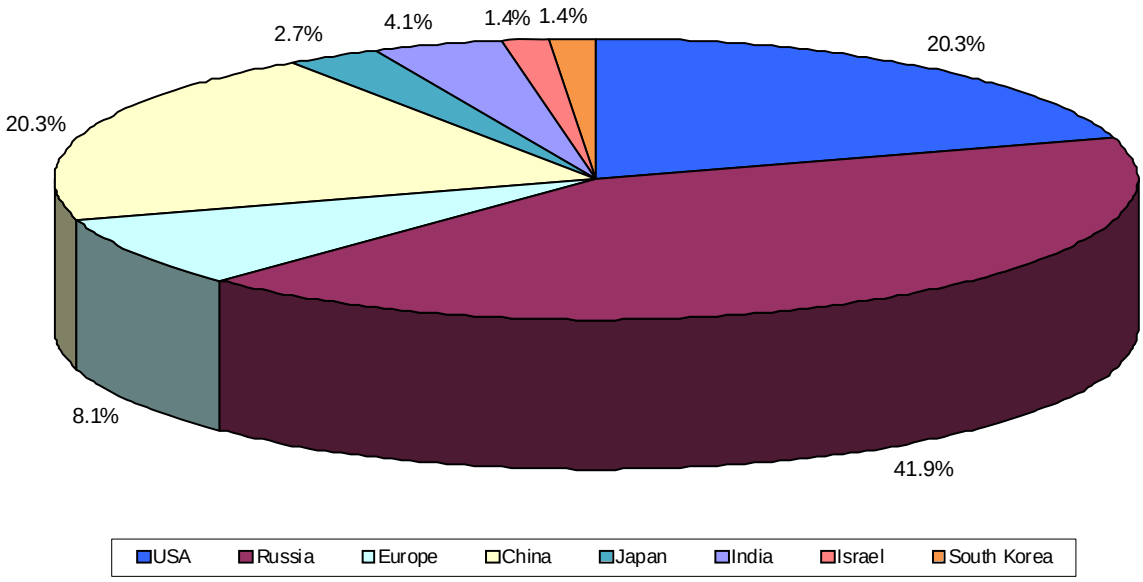


Figure 2.8: Worldwide launches by country in 2010 (Source: FAA)

Table 2.2: Worldwide launches in 2010 by country and commercial status (Source: FAA)

The activity between the two leaders of commercial launches (Europe and Russia) is thus nearby equivalent. Concerning only non commercial launches the dominance of Russia is not so obvious either. Indeed, other countries carried out intensive national programmes such as the U.S. with 21.6% of the non commercial activity and especially China with 29.4% not so far from Russia (35.3%).

The distribution between commercial and non commercial payload launched shows no significant rupture with the past year (Figure 2.2). 2010 confirms the vocation of Europe to commercial activities with 11 commercials payloads on twelve while India contrary to 2009 develops a commercial activity with two commercial payloads on its seven. In the other hand, Russia, China and the USA are focused on non–commercial activity. This is particularly true for China with its 15 non-commercial launches, a country which develops currently intensively its national programmes this year in remote sensing and especially the Beidou navigation system with 5 launches dedicated to this sole purpose in 2010. In the same manner but in a less extent, a lot of the 44 Russia's launches concerned non-commercial activity with 27 payloads destined to programme such as the achievement of Glonass system. The U.S.A commercial payloads are still marginal with 3 ones compared to the twenty non-commercials. This observation is valid for South Korea, Israel and Japan as well because their payloads were only non-commercial.

Regarding of the global share of payload launched in 2010 (Figure 2.9), the podium is composed by Russia that takes one more time the lead increasing its advantage of 2.2% compared to the last year, with 44 payload launched representing 40% at the worldwide scale. The share of USA slightly decreases with 23 payload and 20.9% in the contrary of the third China, that augments its share compared to 2009 with 15 payloads reaching 13%. We find just next Europe with 12 payloads and 10.9%. Japan and India totalize each of them 7 payloads. They stay thus in the same scope as last year with 6.4%. Finally South Korea and Israel send only one payload in orbit. The global number of payload is still globally stable with 2009 and the hierarchy between spaces power still the same as satellites launched.

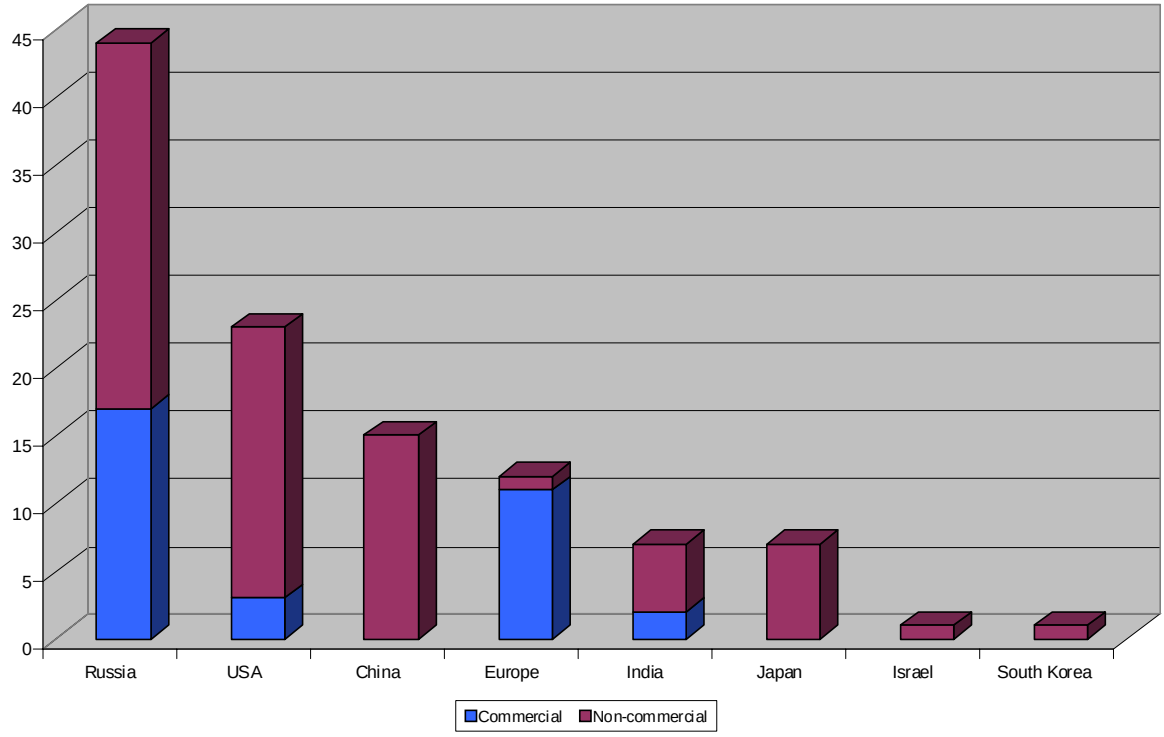


Figure 2.9: Payloads launched in 2010 by country and commercial status (Source: FAA)

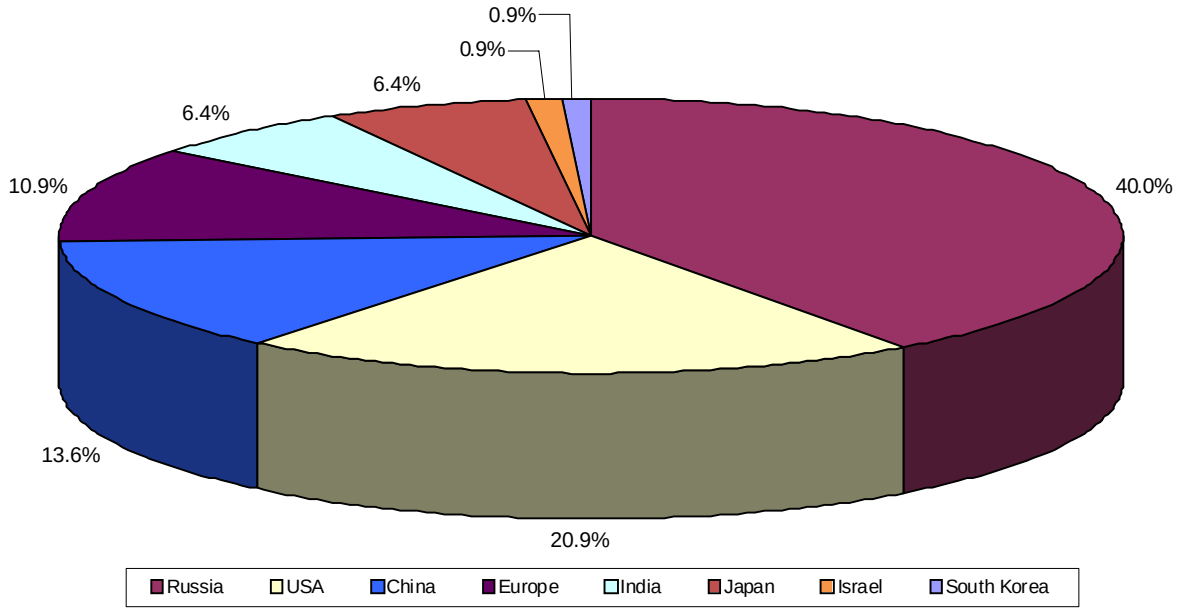


Figure 2.10: Share of total payloads launched in 2010 by country (Source: FAA)

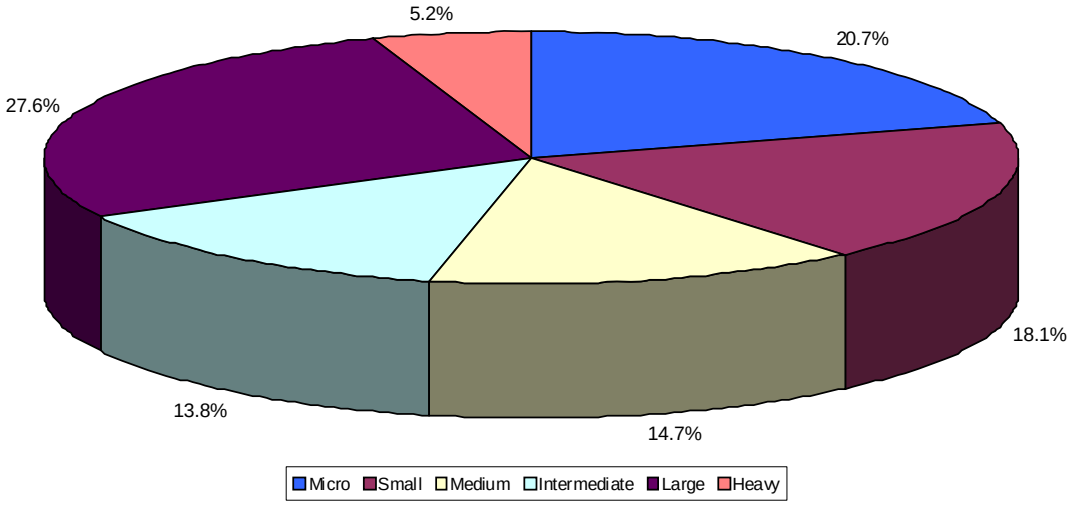


Figure 2.11: Distribution of the payloads launched in 2010 by mass class (Source: FAA)

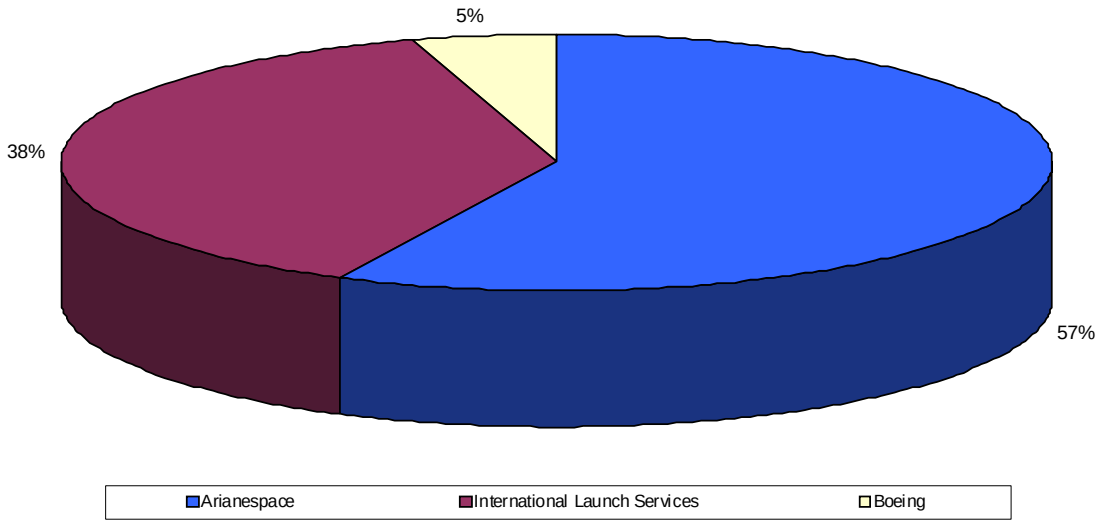


Figure 2.12: Share of launch contracts for GEO satellites in 2010 by launch service provider

Concerning the distribution of the payload we can remark some noticeable changes compared to 2009. All types of payloads are included in the distribution between 13 and 20 % apart from the heavy ones that fall to 5% and the large that rise by 15% to reach 27.6%. Micro payloads are mainly science satellites, technological demonstrators or small communications satellites, like the Orbcomm series. Small payloads are very often Earth Observation satellites, such as SAR-Lupe, Jason or the RapidEye series. Medium payloads feature the most diverse set of satellites, including small satcoms in geostationary orbit, Earth Observation satellites, and most of the Russian military satellites from the Kosmos series. Intermediate payloads encompass medium satcoms and big scientific satellites. Large payloads refer to big satcoms, as well as to the Soyuz and Progress spacecrafts flying to the ISS. Lastly, heavy payloads are all linked to the ISS: the modules Kibo and Columbus, as well as the cargo spacecrafts ATV and Leonardo[75]. 2010 has seen 9 missions to the ISS what explains the increase of heavy whereas heavy payload all related to the ISS were in 2010 rather rare.

[75] According to the mass classification of payloads of the FAA: Micro: 0 to 91 kg. (0 to 200 lbs.); Small: 92 to 907 kg. (201 to 2000 lbs.); Medium: 908 to 2268 kg. (2001 to 5000 lbs.); Intermediate: 2269 to 4536 kg. (5001 to 10000 lbs.): Large: 4537 to 9072 kg. (10001 to 20000 lbs.); Heavy: over 9072 kg. (20000 lbs.). Federal Aviation Administration. Semi-Annual Launch Report: Second Half of 2010. Washington DC: FAA, 2010. <http://www.faa.gov/about/office_org/headquarters_offices/ast/media/10998.pdf>

The market of launchers for GEO satellite has seen in 2010 the number of its actors considerably narrowed (Figure 2.12). Indeed, we have this year only three protagonists while they were 5 during the past year with China Aerospace Corporation and Mitsubishi Heavy Industries. As in 2009, Arianespace takes the Lion share with its Ariane V ECA dominated the market with about 57% of share market concerning mainly telecommunication satellite such as Hispasat, Rascom, Astra 3B and so on[76]. In 2010, the Arianespace's sales company are estimated at €900 million. At the beginning of this year, Arianespace announced that 2 from the 6 launches that are scheduled for 2011[77] have been successfully accomplished. The second company ILS operating the Proton M drags the rest with 38% letting just 4.8% to Boeing with the Goes P satellite. The commercial competition is therefore mainly between Russia and Europe. If Europe takes the lead in 2010 concerning the GEO launch this is not the case for the other orbits.

Indeed, International Launch Service with 8 Proton M, International Space company kosmostras 3 Dnepr in LEO and Eurockot only one Rockot have operated eleven launches while Arianespace only 6. Vega a smaller European launcher more suitable for low orbit is also expected to be operational during 2011 in spite of repeated delays due to export controls concerns with France[78]. Moreover, Ariane V can take two payloads and GEO launches are more profitable than LEO. This advantage can quickly turns to flaw in case of delay or accident but the Ariane V launcher has proved its reliability so far with no accident listed linked to the launcher. Indeed, Arianespace has won more than 60% of the commercial launch contracts worldwide in the last two years[79]. In 2010 it placed 12 payloads into orbit in six launches, totalling 41 successes in eight years and confirming its technological maturity[80]. However Arianespace's revenue for 2010 dropped by about 10 percent compared to 2009 requesting some subsidiaries from governments and ESA. This predicament entails thus crucial questions about the future European strategies concerning launchers. The situation of the market could change with the arrival and the improvement of the U.S. launcher Falcon 9 from SpaceX which has carried out in 2010 one successful launch transporting to NGSO light charges such as Dragon COTS 1, SMDC ONE, QbX-1 and 2, Perseus 0, 1, 2 and 3, Mayflower & CAERUS during one launch.

Revenues from the 23 commercial launch events in 2010 amounted to an estimated

$2.45 billion, an increase of $43 million compared to 2009. The increase is therefore less impressive than last year but indicates nonetheless that the sector goes rather well. Europe confirms its advance with 1.32$ billions revenues while Russia and U.S. make respectively 826$ million and 307$[81].

### 2.4.2 Manufacturing sector

Satellite services represent the most mature and lucrative market in the space sector. Indeed, space based communications is the core business for satellite service providers and satellite manufacturers alike. Therefore, looking at the market share of satellites launched and ordered in a given year is not only a good indication of the vitality of domestic space industries, but it also helps assessing the global trends in the space industry.

In 2010 110 payloads were launched. 40% of the launched payloads were manufactured by Russia, 21% by the U.S. and 13.6% by China. Europe accounted for only 11% of the payloads launched, India and Japan 6.4% and Israel and South Korea around 1%(Figures 5.6 and 5.7)[82]. Beyond these figures it is important to distinguish the commercial and non commercial activity, because only 30% of the payloads were commercial, slightly more than in 2009, when they represented 23%. In commercial payloads, the leaders are Europe with 33.3 % and Russia 51.5%. The U.S. depends heavily on government programmes because only 9.1% were commercial.

[76] Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011

[77] Arianespace. Company Profile. Paris: Arianespace, Jan. 2010 <http://www.arianespace.com/Press-center/pdf /Company _Profile_EN_2010.pdf>.

[78] Peter B., de Selding. "Delays Continue To Affect Vega, European Soyuz Programs" Space News, 4 Mar. 2010 <http://www.spacenews.com/launch/100430-delays-vega-european-soyuz.html>

[79] Arianespace. Company Profile. Paris: Arianespace, Jan. 2011. <http://www.arianespace.com/Press-center/pdf/ Company_Profile_EN_2010.pdf>

[80] "Launch Log" 18 Dec. 2009. Arianespace 19 Mar 2010 <http://www.arianespace.com/news-launch-logs/2000-2010.asp>

[81] Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011

[82] Payloads are assigned to the nation that commissioned them, not according to the nationality of the manufacturer. Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2010. <http://www.faa.gov/about/office_org/head quarters_offices/ast/media/ year_in_review_2010.pdf>

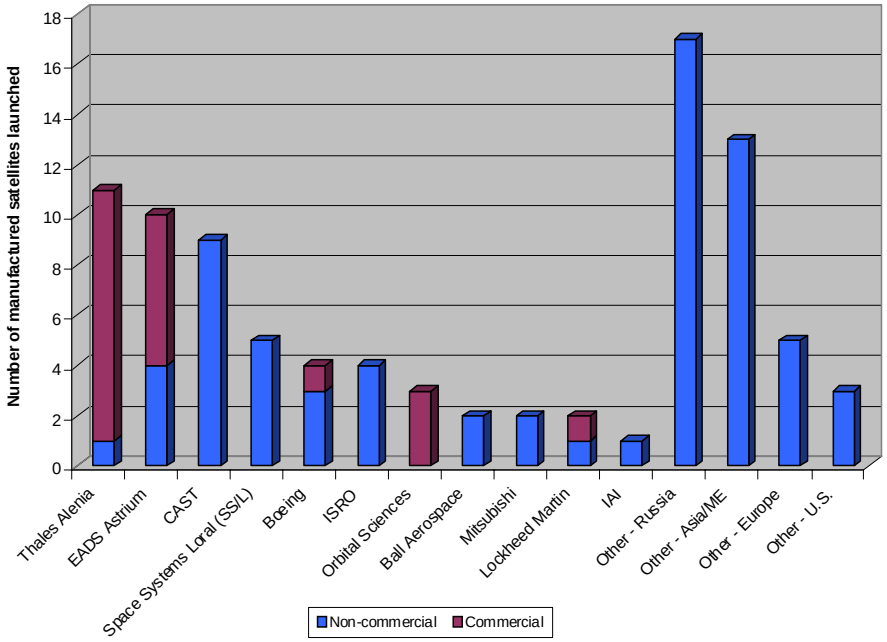


Figure 2.13: Satellites launched in 2010 by manufacturer and commercial status (Source: Futron)

To summarize (Figures 2.13), on 91 satellites launched in 2010, 70 were non-commercial. The European satellite manufacturers Thales Alenia and EADS Astrium take the lead with respectively eleven and ten satellites launches confirming their strength in this market. The both entities good figures are mainly due to commercial orders. Contrary to the direct followers namely CAST (9 satellites launched) SSL (5) and Boeing (4) whose satellites have mainly non-commercial origin. Orbital constitutes here the exception because its three satellites launched are commercial. OHB which is absent this year is due to come back quickly with the launches of Galileo regularly delayed and the Meteosat Third Generation[83]. The 17 Russia satellites are only destined to non-commercial activities[84] like the nine Chinese.

61.5% of the satellites launched were GEO satellites[85] (Figure 2.14). In this field 40% of the satellites manufactured come from the U.S. (5 by SS/L, 2 Boeing and three Orbital) while 28.6% from Europe (three by Thales Alenia Space and seven by EADS), 20% China (CAST) and only 3% for Russia focused on low orbit. In contrast concerning the non GEO orbit, Europe (9 Thales Alenia Space and three EADS Astrium), Russia and Asia manufacturers take the head with respectively 28.6% of the satellites launches followed by far by the USA with 8.9%. We can notice the strong influence of national programmes, for instance the Glonass constellation completion in MEO or Beidou navigation system in GEO for Chinese figures. Moreover Thales Alenia awarded in 2010 a significant contract with Iridium to build the Iridium Next constellation of low-orbiting mobile communications satellites for $2.1[86].

2009 was a prodigious but unique year in term of GEO satellite with 40 orders. Unfortunately 2010 is not as successful as this one. The figures are rather more in the continuation of 2008 (21 orders) with 26 contracts awarded in 2010. There are also only eight companies represented in this market whereas 2009 counted 11 different manufacturers. The U.S. companies Boeing and SS/L have awarded both five GEO satellites contracts while their direct followers Thales Alenia and EADS Astrium respectively four and three ones. This least won in 2010 a contract of 750$ million for the construction of four satellites destined to SES Luxembourg[87]. The success of Boeing is also due to Inmarsat of London contract to build three

[83] De Selding, Peter B. "OHB's Sales Rise on Galileo and Weather Satellite Work." Space News 9 Nov. 2010 <http://www.spacenews.com/earth_observation/101109-ohb-sales-rise.html>

[84] Futron Corporation. Launch report Year-end summary. Wisconsin: Futron, Dec 2010. <http://www.futron.com/upload/wysiwyg/Resources/FoF/2010/FutronLR2010-06.pdf>

[85] Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011. <http://www.faa.gov/about/office_org/head>

[86] Space News Staff." 2010: The Year in Review." Space News 13 Dec. 2010 <http://www.spacenews.com/civil/2010-year-review.html>

[87] Space News Staff."2010: The Year in Review" Space News 13 Dec. 2010 <http://www.spacenews.com/civil/2010-year-review.html>

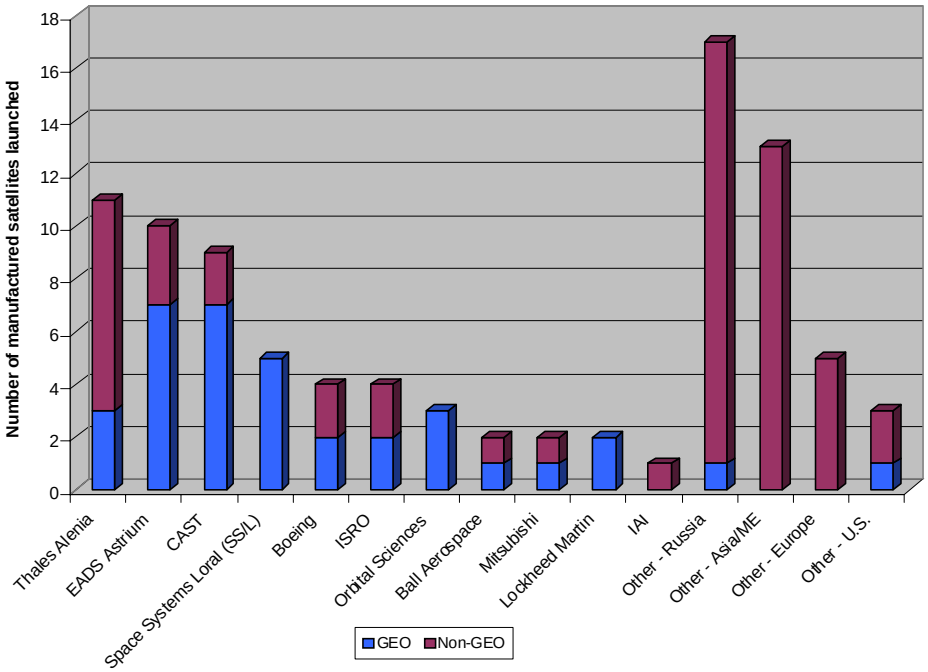


Figure 2.14: Satellites launched in 2010 by manufacturer and orbit type (Source: Futron)

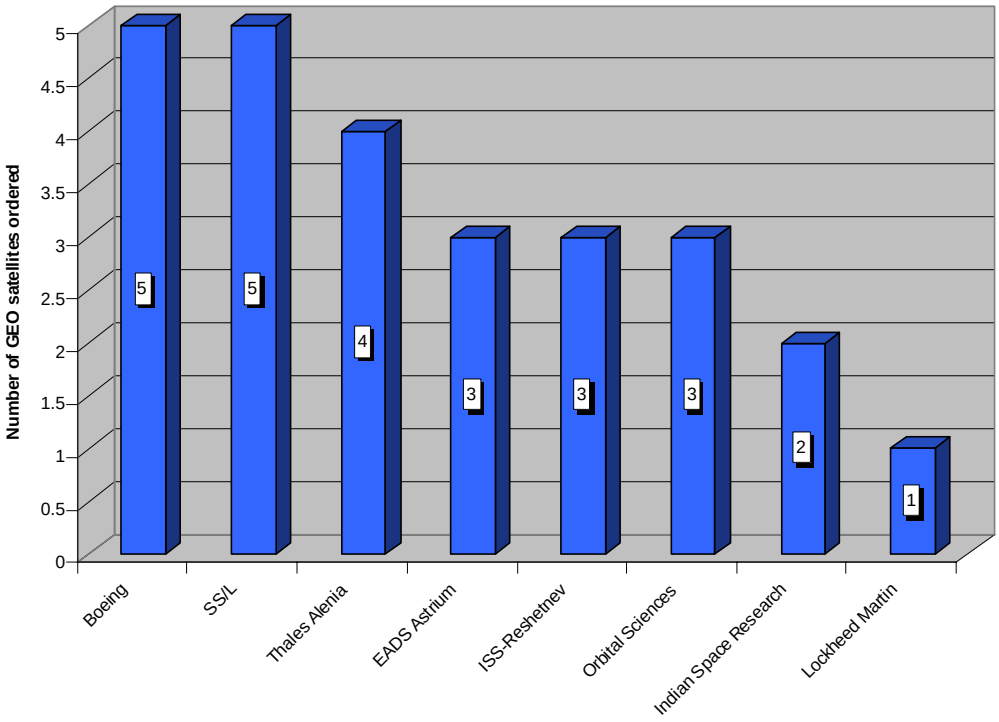


Figure 2.15: GEO satellite orders in 2010 by manufacturer

Ka-band satellites to cover the world's oceans and surrounding regions as part of a $1.2 billion investment in Inmarsat's Global Xpress system[88]. (Figure 2.15)

The ISS-Reshetnev took three satellites orders (Express-AM8, Express-AT1 and Express-AT2) but in association with Thales Alenia for the payload[89] and ISS Reshetnev will provide the satellite platforms. This association is going to be prolonged by Russia's

[88] Ibid.

[89] Peter B, de Selding."RSCC Expansion Continues with Three-satellite Order" Space News 22 Sept. 2010 <http://www.spacenews.com/satellite_telecom/100922-rscc-expansion-satellite-order.html>

Gazprom Space Systems, RSCC's principal Russian competitor that has ordered two large satellites from Thales Alenia Space, one of which includes major work by ISS Reshetnev[90]. The same amount as its U.S. counter part Orbital[91]. ISRO confirms its entrance in the market with two satellites ordered whereas it had just one last year and would not be penalized by its recent GEO launch failure[92]. The core of the competition is thus between the U.S. companies with 53.8% of the contracts awarded against 26.9 for the European ones. Most of these contracts are made with private entities and are not due to governmental orders what is often important to take into account especially with U.S. figures. In 2010 several contracts have been made between the U.S. Air force and satellite manufacturer such as Boeing for the seventh global Satcom satellite[93]. The main buyers are in 2010 with three satellites ordered, Eutelsat with models W6A, W5A, W3D, Inmarsat, and Mexsat. SES contrary to the busier last year ordered just one.

## 2.5 International sectoral Comparison

A lot of different indicators are needed to gauge accurately the dynamism and the strategy of the main space-faring nations. Thus the number and the type of missions in relation with the number of launches bring us crucial information.

### 2.5.1 Launch Sector

The possession of launch vehicles and spaceports is a central element enabling independence in space activities. Moreover, the number of launches and the level of activity on the space bases give an indication on the dynamism of a country in the space sector.

The year 2010 saw a total number of 74 orbital launches carried out by eight countries [94](Figure 2.16). It is slightly less than last year. The order is quite similar to 2009, Russia being uncontested first launcher. Then follow the U.S. with 15 launches, and China with the same amount which thus takes the third position to Europe that falls to 6.

Indeed China has had a busy year concerning space activities with the developments of its national programmes such as Beidou for the navigation or Yaogan for remote sensing[95]. The activity of India and Japan is still stable with respectively three and four launches. Israel operates one launch its military remote sensing satellite Ofeq 9 and finally the failure of the South Korean GSLV 1. The balance is therefore rather changed from last year between the protagonists especially between the second and third one with a growing Chinese activity while the U.S. launches brutally decrease from 24 in 2009 to 15 in 2010[96].

The launches by country October 2010 September 2011 allow us to have an insight of the future developments.[97] Russia confirms its supremacy while the U.S. with 21 launches outdistances China which comes close to Europe with respectively 14 and 12 launches. India keeps up with five launches while Iran operates three ones.

The number of mission provides an interesting point of view as well which is particularly useful to complete the launches information (Figure 2.17). Their number fell from 2009 to 2010 from 116 to 97. The podium of the number of missions launched is similar to 2009. The U.S. peaks with 26 missions followed by Russia with 18 missions, China 16. The second part of the graphic shows other important actors such as Japan with eight, France and India with four. USA represents by itself 28.6% of the missions launched in 2010, Russia 18.6, China 16.5, Japan 8.2, France and India respectively 4.1. The three major protagonists are thus well defined compared to the other ones, they concentrate 61.9% of the total amount of missions. Europe taken as a whole

[90] Ibid.
[91] Futron Corporation. Satellite order report. Wisconsin: Futron, Dec 2010. <http://www.futron.com/upload/wysiwyg/Resources/FutronSM2010-EOY.pdf>
[92] K.S, Jayaraman. "ISRO Team Says Cable Rupture Caused Rocket Failure. " Space News 31 Dec. 2010 <http://www.spacenews.com/launch/101231isro-team-says-cable-rupture-caused-rocket-failure.html>
[93] Turner, Brinton. "U.S. Talks with Allies About buying into WGS." Space News 10 Sept. 2010 <http://www.spacenews.com/military/talks-with-allies-about-wgs.html>
[94] Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011
[95] SpaceRef. "China Accelerates Military Space Program." Space News 9 Mar. 2011 <http://www.spacenews.com/commentaries/110309-fromwires-china-accelerates-military-space.html>
[96] Space News Staff."2010: The Year in Review." Space News 13 Dec. 2010 <http://www.spacenews.com/civil/2010-year-review.html>
[97] Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011

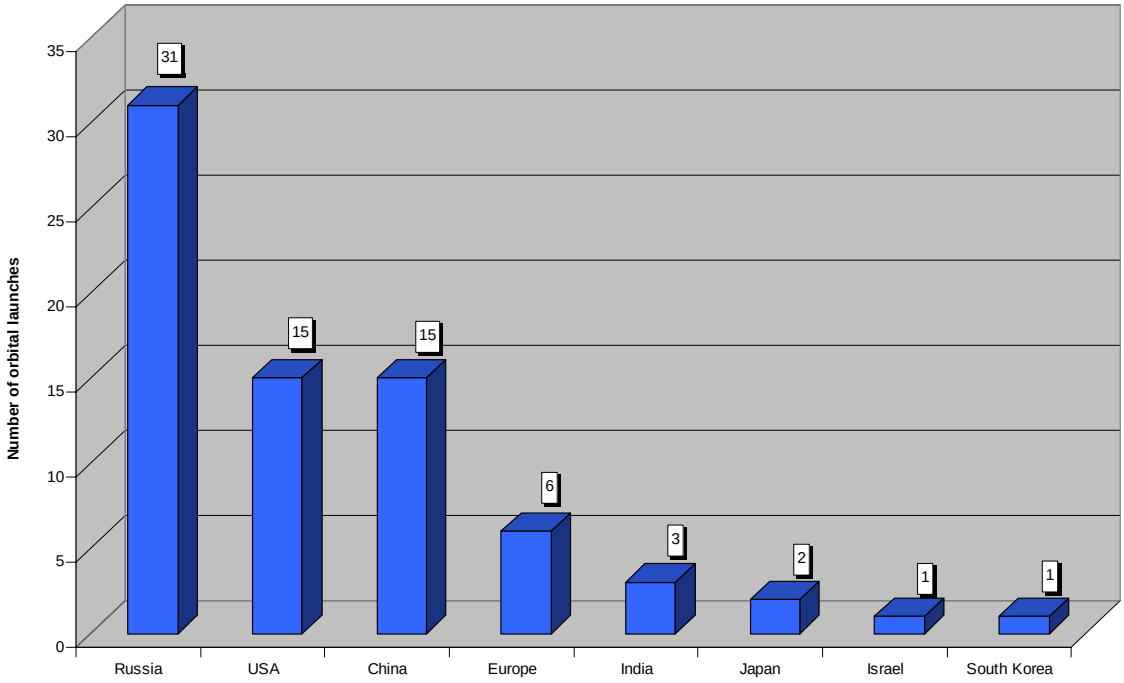


Figure 2.16: Total worldwide orbital launches per country in 2010 (Source: FAA)

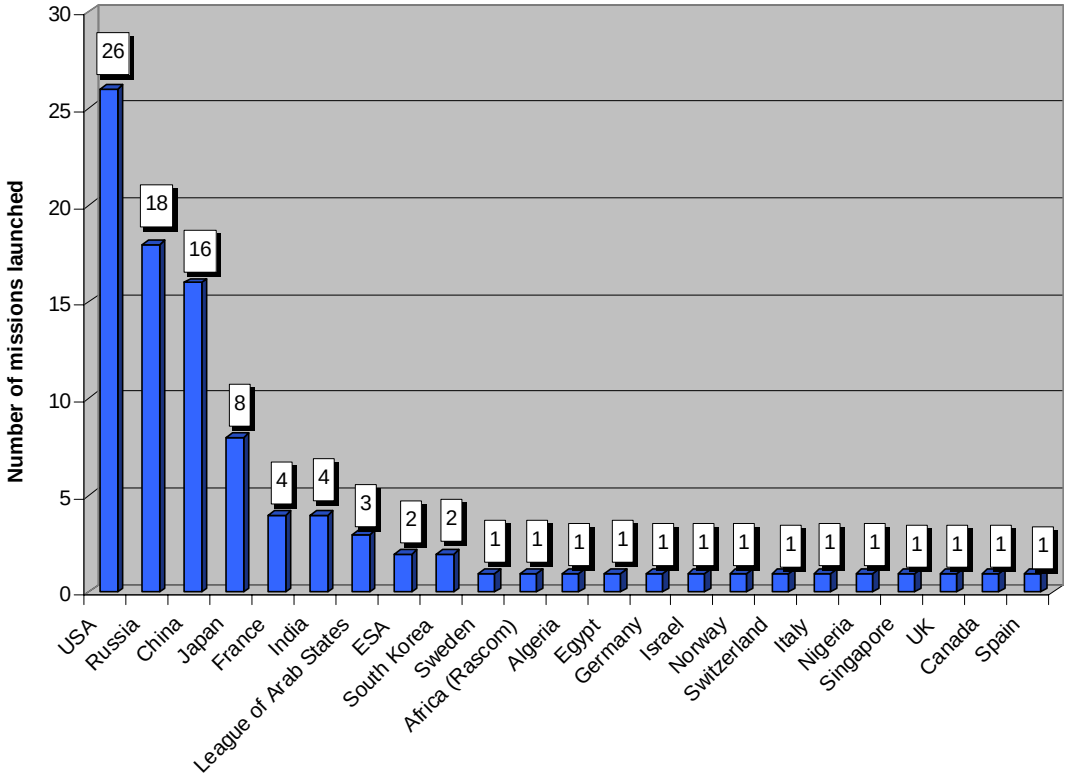


Figure 2.17: Number of missions launched into space by country/institution in 2010 (Source: FAA)

(including the ESA) reach hardly 13.4% placing itself just behind China. The major upheaval is constituted by the fall of the number of European missions compared to 2009 from 19.8% to 13.4 and on the contrary the rise of China's ones. Within Europe France keeps the head with its four missions in front of Sweden, Germany, Spain, the U.K, Norway, Switzerland and Italy with one. We can therefore notice that the hierarchy is slightly

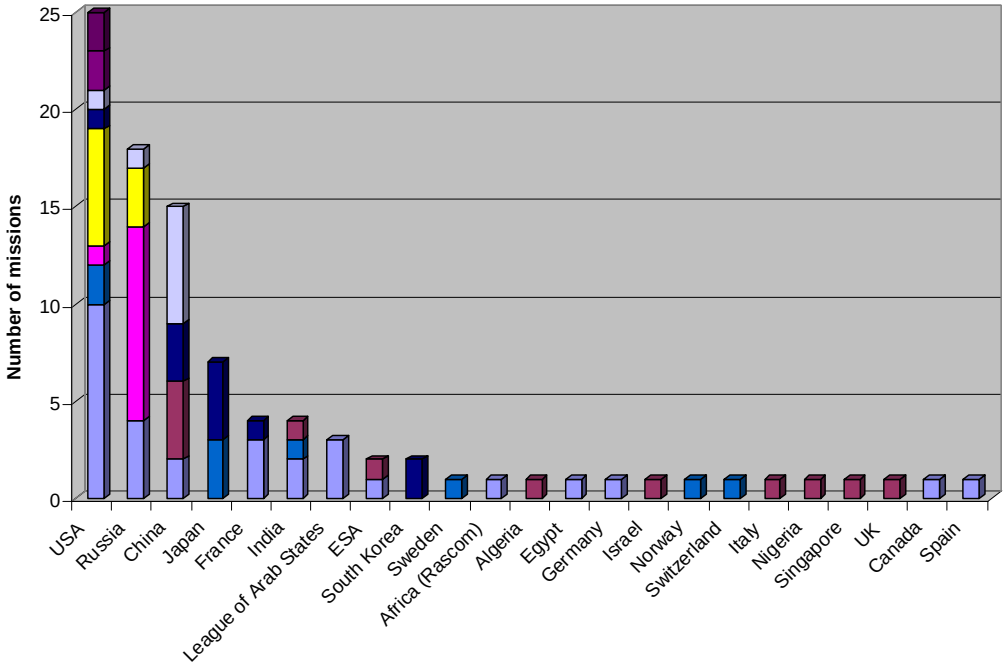


Figure 2.18: Types of missions launched into orbit in 2010 (Source: FAA)

different concerning the number of missions and launches, this is especially true on the top. U.S. is predominant on Russia in the number of missions, Japan and India are also more represented in this category than in Launch. The internal European activity is also more discernable by this perspective with France leading followed by the ESA and other European countries.

We can notice that the U.S. missions are particularly focused on communication purposes but also in classified activities related to military stakes[98](Figure 2.18). A large part of the Russian activity is devoted to the ISS resupplying. It was a crucial year to complete the Glonass constellation as well in spite of the failure which postponed the achievement of the navigation system previously expected by the end of 2010[99], Russia keeps also a significant number of classified launches what confirms that military purpose continues to play an important role in its space activity. The Chinese national programmes are clearly identifiable by the repartition of its missions predominately dispatched between navigation, remote sensing and meteorological (Fengyun 3B[100]). Japan's missions are mainly concerning development and scientific purposes far from the military concerns of the first ones. The activity of France and India is rather more developed around communication with a scientific satellite for France (Picard accompanied by the Swedish Prisma[101]) and a remote sensing satellite for India. We can mainly notice from the previous year the development of Chinese activity related to its ambitions concerning Space. Communication represents an important share of the missions (31.3%), followed by remote sensing 12.5%, ISS 11.5%, Classified activities and finally navigation with 8.3%.

The overall picture of a hierarchy in space activities was confirmed in 2010 especially concerning the top, however some shifts can be noticed. The United States and Russia remained the two dominant actors in space. Whereas Russia was still the world leader in the launch sector in 2010, the U.S. occupied first place in terms of missions launched.

[98] Ibid.
[99] Taverna, A., Michael. "Energia, Roscosmos Officials Sacked Over Glonass Crash." Aviation Week 30 Dec. 2010 <http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=AviationWeek.com&id=news/awx/2010/12/29/awx_12_29_2010_p0-279706.xml&headline=Energia,%20Roscosmos%20Officials%20Sacked%20Over%20Glonass%20Crash>

[100] Federal Aviation Administration. Commercial Space Transportation: 2010 Year in Review. Washington DC: FAA, Jan. 2011
[101] « Picard et Prisma-FFIORD, en orbite le 15 join. » CNES 8 Jun. 2010 <http://www.cnes.fr/web/CNES-fr/8543-picard-et-prisma-ffiord-en-orbite-le-15-juin.php>

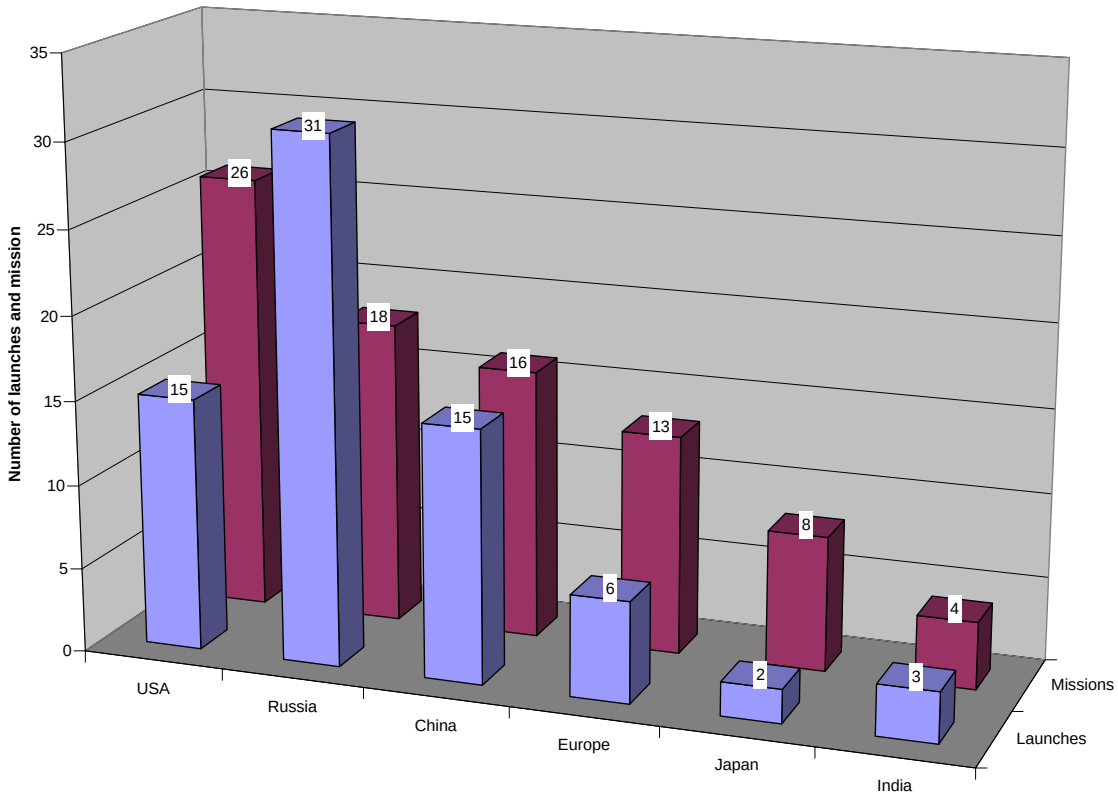


Figure 2.19: Assessment of major space powers' activities in 2010 (Source: FAA)

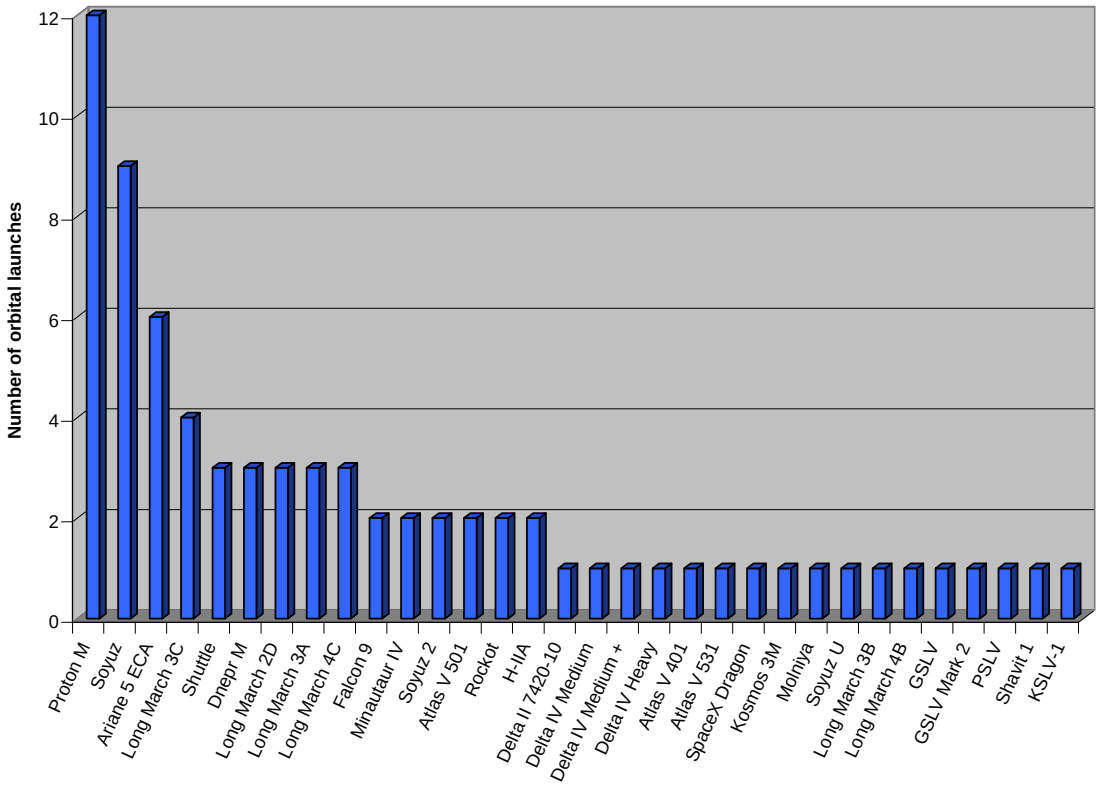


Figure 2.20: Worldwide orbital launches per launch system in 2010 (Source: FAA)

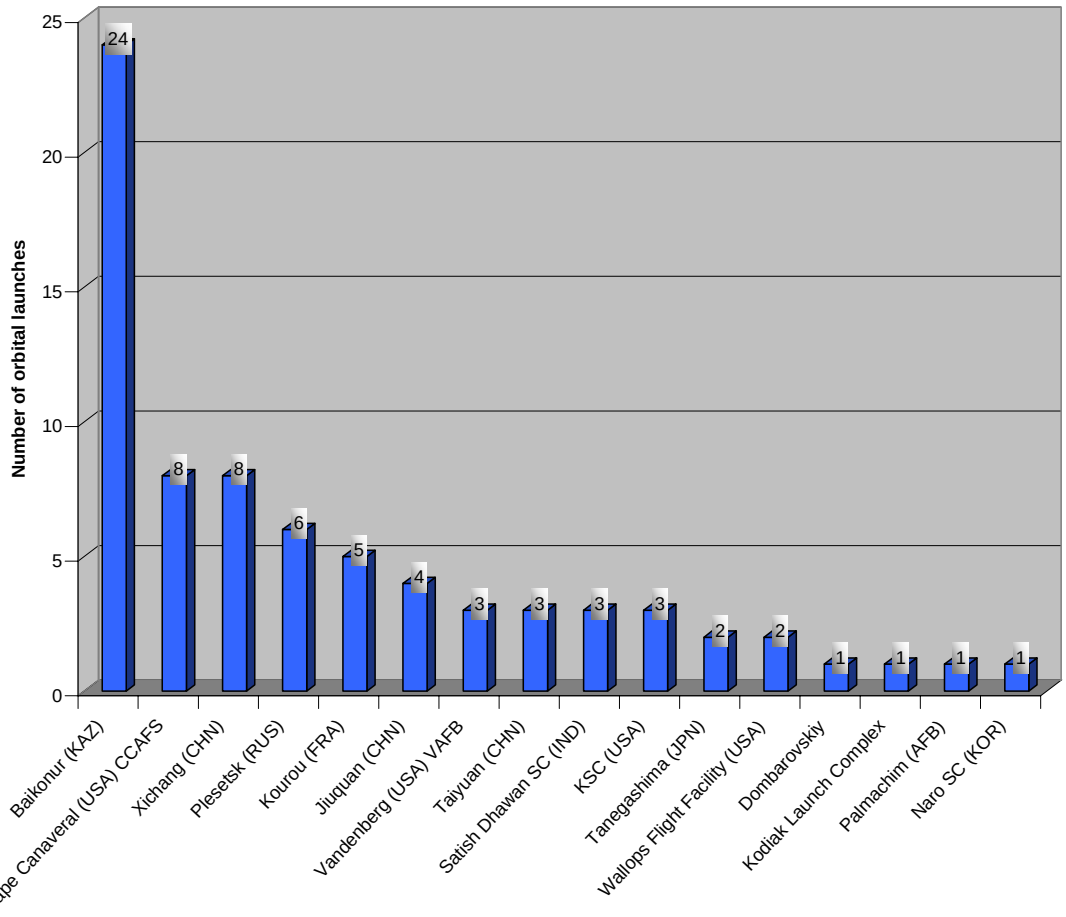


Figure 2.21: Worldwide orbital launches per launch site in 2010 (Source: FAA)

This is a situation very similar to the last year because the decrease of missions and launches are with a few exceptions equitably distributed within the protagonists of the space sector. The major shift concerns the third place between China and Europe. China puts into act its pretentions to become a crucial actor in space activities in 2010 (Figure 2.19), the rupture with the past year is easily noticeable. On the other hand if Europe stays relatively stable in its launches the number of launches falls sharply from 25 to 16 from 2009 to 2010. Japan and India increase progressively their activities to get closer to Europe especially concerning the number of mission.

In terms of number of launchers launched (Figure 2.20) the predominance of Russia stays persistent with 12 Protons M and nine Soyuz while there is in third position Ariane 5 ECA with six launches and long March 3C with four. We find then three launches for the Shuttle Dnepr M and the various models of Long March. The first U.S. models of rocket come behind with the Atlas V and the SpaceX´s Falcon 9. 41% of the launches have been done with Russian launchers spread in eight models (mainly Proton M, Soyuz and Dnepr M), 21.3% with U.S. rockets distributed in 11 variants (Falcon 9, Minotaur IV and various Atlas V and Delta IV). 20% with Chinese launchers (six models of long march) and finally Europe with the Ariane V 8%, a rocket which has the crucial advantage to carry two payloads putting into perspectives the figures enounced. The major changes from 2009 being the break-up of the U.S. activity into multiple launchers and the increase of Long March launched.

The total number of launchers rises between 2009 and 2010 from 29 to 31. The amount is however far less important if we take into account the multiple versions used in each system of launch. The system Delta IV and Atlas V being for instance concerning the U.S. divided each of them in three different versions.

The use of space transportation infrastructure is another indicator that helps assess the space capacity (Figure 2.21), as space bases are core assets for independent access to space. The number of space bases used by a country, as well as the frequency of launches conducted from its different spaceports, are

important indicators of the dynamism of a country's space activities.

Baikonur is one more time and by far the busiest place with 24 launches during 2010 and represents a third of the total launches. Cape Canaveral and Xichang follow with eight launches, Pletsek and Kourou six and finally a Chinese and U.S. site with Jiuquan and Vanderberg with four launches. Contrary to last year, Chinese sites challenge particularly their U.S. counterparts in term of activity. Kourou is still stable although more and more outdistanced by its competitors. This evolution being counterbalanced by the launchers Ariane V itself and is expected to change in the nearest future with the launches of Soyuz from Kourou[102]. The Russian sites hosted thus (including the Baikonur concession) 41.3% of the total launches followed by 21.3% for the U.S., 20% in China and 6.7 for Europe. The situation could well change in the next year due to the will of the Russian Prime Minister Vladimir Putin to invest more than $800 million in a new launch facility that will be ready by 2015 and be capable of supporting cosmonaut launches by 2018[103].

## 2.6 Transatlantic industrial comparison

Europe and the U.S. are unquestionably major actors and investor of space activities. They both possess a particularly varied and competitive industry which develop and use cutting edge technologies. It appears necessary to compare their respective structure in order to better understand their own characteristics beyond these common traits allowing us to asses their competitiveness.

### 2.6.1 State of the European industry

We will use long-term overviews in this paragraph to give a basic insight of European space industry developments and characters. The trends reviewed in this paragraph are mainly based on a report of the European Space Industry issued by ASD-Eurospace.[104]Unfortunately, data on the financial results of Europe's space industry for 2010 is only to be expected in the summer of 2010, which does not allow for final data to be included in this report.

The most obvious observation concerns the stop of the regular increase of the turnover

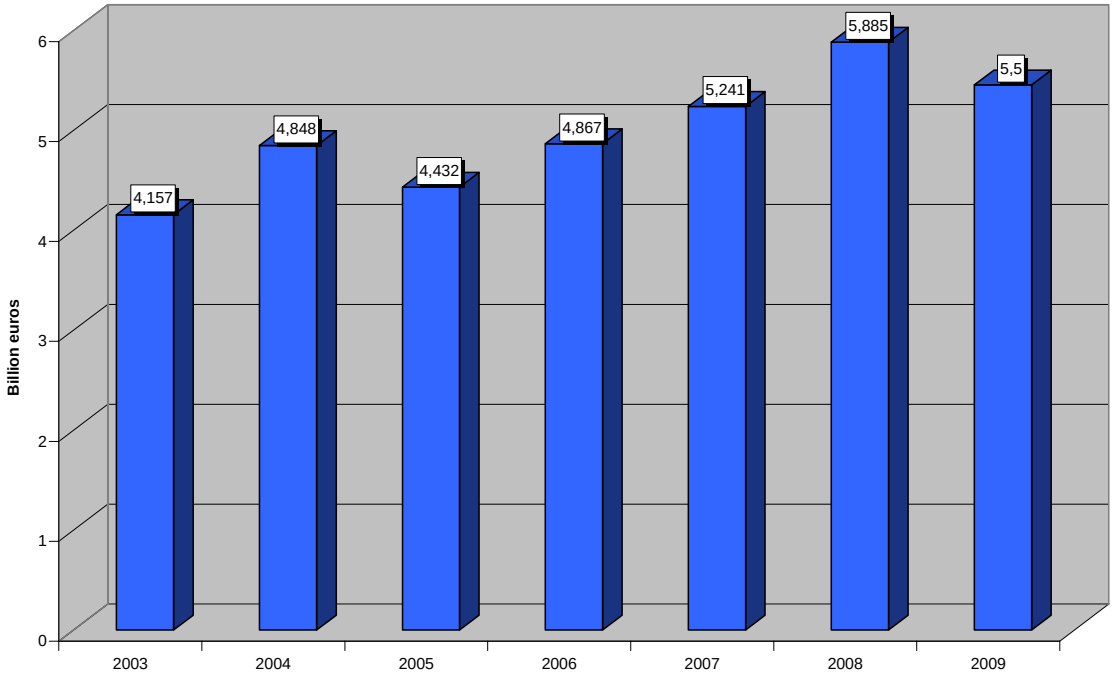


Figure 2.22: Estimated consolidated turnover of the European space sector (Source: ASD Eurospace)

[102] Peter B., de Selding. "First Flight of European Soyuz Delayed Again." 7 Sept. 2010 Space News <http://www.spacenews.com/launch/first-flight-european-soyuz-delayed-again.html>

[103] Katia, Moskvitch. "Russia to kick off construction of a new spaceport.." BBC 21 Jul. 2010 <http://www.bbc.co.uk/news/science-environment-10698433>

[104] ASD-Eurospace. "Facts & figures – The European Space Industry in 2009." 13th edition, rev. 2. July 2010.

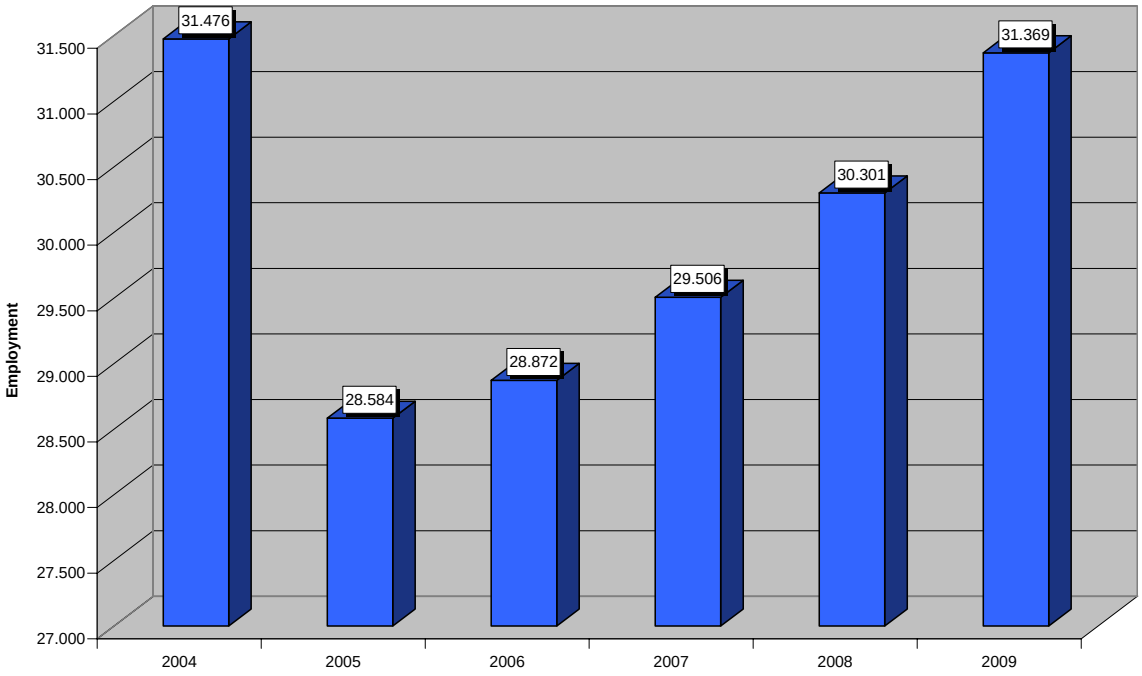


Figure 2.23: European space industry employment (Source: ASD Eurospace)

trend that we could observe the last few years since 2005 (Figure 2.22). Indeed it has slightly decreased from 2009 ($5.885 billion) to 2010 (5.5 billion). This estimation is related to the sluggish atmosphere of the space market whether it concerns launches or satellite manufacturing with a significant fall of 35% from the GEO satellites orders in 2010 compared to 2009 (which was a quite exceptional year) for instance.[105]

Employment is often a good indicator to gauge the strategy of the main company making up the space sector as well (Figure 2.23). The growing tendency is going on with a tiny progress of 68 jobs created within the year considered being very close to the level of 2004. It will be interesting to follow this evolution after this sluggish year in term of sales which had entailed a sharp decrease from 2004 to 2005 and which could have the same effect in 2010 in term of employment.

Concerning the estimated share of the European space industry it is worthy to note some evolutions such as the augmentation of the importance of institutional civil programmes at the expenses of the military ones. The importance of ESA has been growing steadily since 2004 while the orders from others public entities decline sharply in 2009 what could explain the reduction of the military role as a customer. Sales to European customers were 77% of final sales, while exports represented 23% of final sales[106]. Institutional programmes remained the main revenue source of European industry (58%), while commercial programmes generated 40% of final sales.[107]

The same tendency is observable with the growing share of the operational launchers while the commercial satellites decrease somewhat.

The figures of the European space industry by sector arise some interesting developments over the past year. As expected with the decrease of the turnover, (Figure 2.24) the drop reached differently the various sectors. Satellites applications (Navigation systems such as Galileo, EGNOS or telecommunications systems like Syracuse or Arabsat) suffered particularly from this loss and in a lesser extent the sector of launcher developments and production as well. On the other hand scientific programmes are stable while support and test contradicts the general trend announcing new developments open to impede future decreases.

[105] Futron Corporation. Satellite order report. Wisconsin: Futron, Dec. 2010. <http://www.futron.com/upload/wysiwyg/Resources/FutronSM2010-EOY.pdf>

[106] ASD-Eurospace. “Facts & figures – The European Space Industry in 2009.” 13th edition, rev. 2. July 2010.

[107] Ibid.

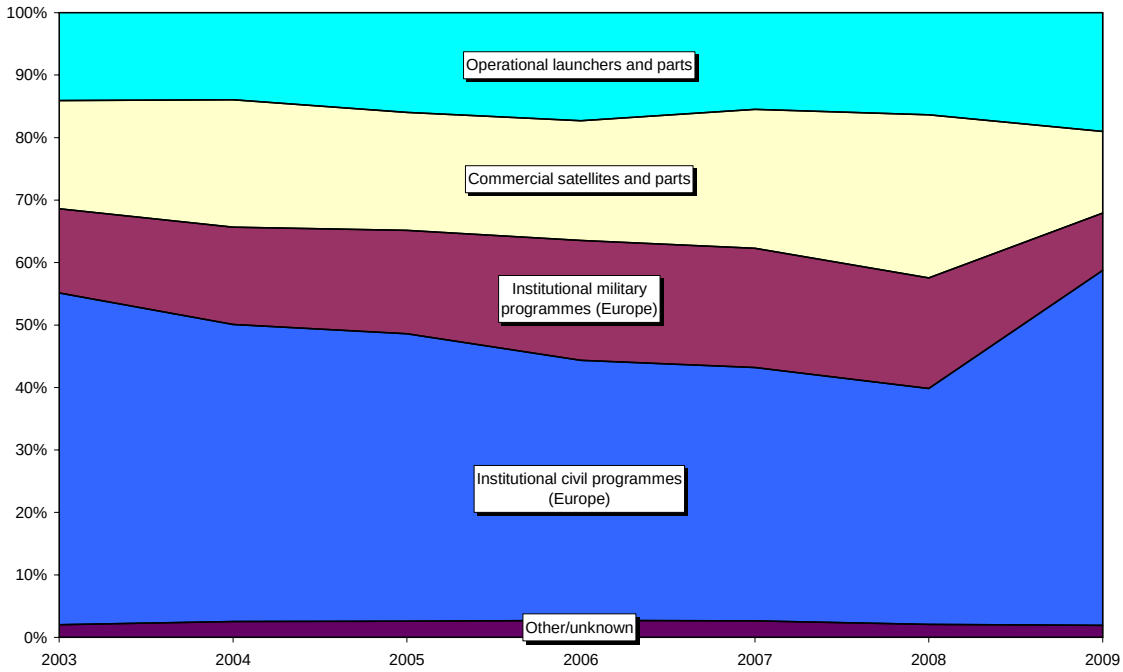


Figure 2.24: Estimated share of European space industry consolidated turnover per institutional customer (Source: ASD Eurospace)

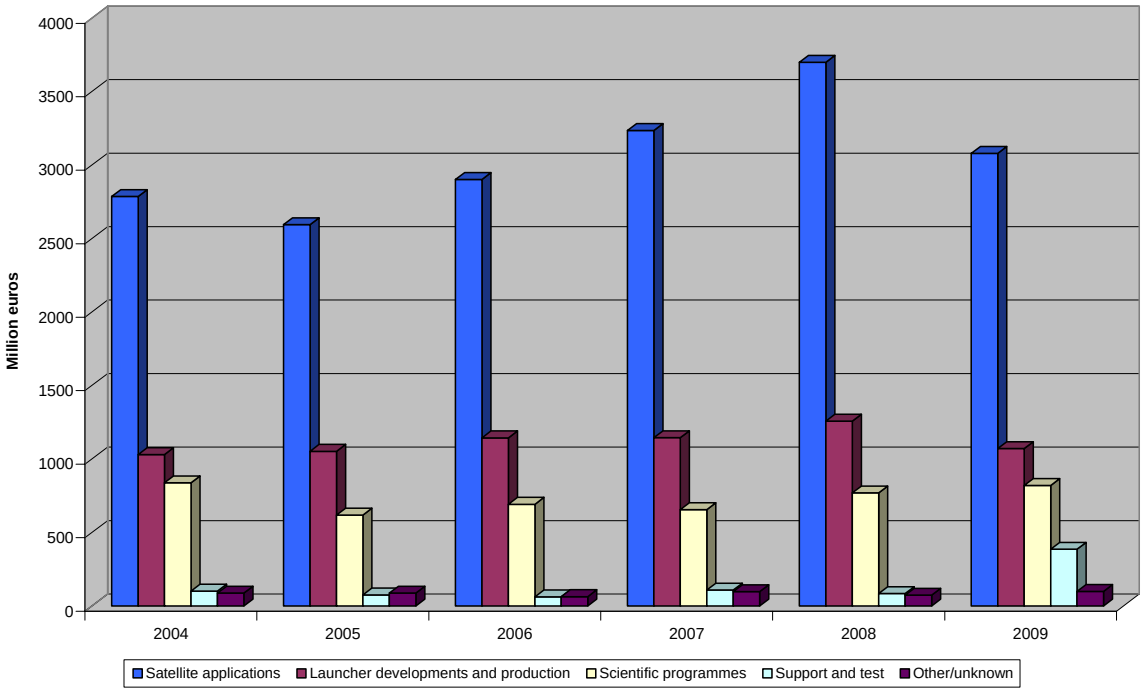


Figure 2.25: Estimated share of European space industry consolidated turnover per sector (Source: ASD Eurospace)

It is worth studying the situation in more details and going further into each category to assess the impact of such a decline (Figure 2.25). Thus the effect was not the same in the three parts which made up the category satellite applications. Telecommunication, navigation (including localisation and positioning) were badly affected while earth observation slightly increases. 55.5% of the customers for satellites applications and 42 commercial. Concerning the launcher developments and production we must distinguish the developments programmes founded almost exclusively by ESA. This part has been progressively diminishing throughout the years since 2000. The operation launcher programme falls brutally just underneath €800 Million entailing concerns about possible

loss for Arianespace for 2010 and a need of subsidies[108]. As explained in the chapter concerning the launches and satellite manufacturers, Europe has a special vocation for commercial activities that we can illustrate here again with 73.8% of sales destined to commercial customers and 26.6 for the institutional one. Scientific programmes remained strongly supported by ESA which is by far the main customer with 81.4% while civil public entities represent hardly 10.8% and export 6.5.

### 2.6.2 State of the United States space industry

Taken as a whole, the aerospace industry in the U.S. goes rather well with a constant augmentation of its sales especially between 2008 and 2009[109]. This movement is due to the slow down from 2009 to 2010 while persisting with a rise of $2 billion. It is a different situation concerning only space activity with only $50 million progression between the two years[110].

The predictions announce a promising new start for 2011 which will probably not concern the space sector according to these forecasts with even a slight decrease expected.

The number of employees confirms the sluggish figures of the American space industry which like its European counterpart experienced a decrease even more important in its case. In a lesser extent we can probably to expect to find the same effect concerning the European industry in 2010.

This economic situation can have two roots. The first and probably the most important given the characteristics of the U.S. space industry is related to the domestic market, and the second the state of exports. The situation of U.S. export is difficult to asses because the figures are only available for the aerospace taken as a whole. However we can notice that there is a sharp and constant reduction of the sales in this field from $82 264 million in 2008 to $69 317 in 2010. It is difficult to estimate in which proportion the space sector has been affected by this tendency but it is very likely to be. The military figures are more accurate and allow us to follow the contractions of the sales. The sales fell from $189 millions to 129 between 2009 and 2010 whereas meanwhile the total of military exports has grown.

This worrying situation has entailed a political reaction like the modification of the ITAR regulation to encourage the export of high technology material. A necessary review of the American export control system has been besides opened by the Obama administration[111].

The U.S. manufacturers depend on domestic market and figures confirm this natural tendency[112]. In 2009 70.6% of the sales of the U.S. aerospace sector were due to domestics market (NASA and other agencies with the Department of Defence orders), in 2010 72%. As we have just seen, the augmentation of the general sales revenues from the aerospace industry was tiny between 2009 and 2010 (about 0.9%). Meanwhile domestic market orders rose by 5.35% in 2010. To summarize, these figures indicate that the domestic plays a crucial role in the U.S. aerospace industry which is of course not a breaking news, but that shows clearly that the public expenditures must increase in an almost mandatory and increasing pace to cover the weakness of the market and assure a laborious augmentation of sale threatening to fall each year. The employment figures support strongly this observation because they show a significant and constant decrease of the number of employee[113] which contrasts with the rise of the sales even flat.

The U.S. space industry is therefore in a turning point after the recent political decisions. Both the choices to privatize a part of the NASA´s activity and the will to reform the set of U.S. export control rules could change this situation[114].

[108] Peter B, de Selding."Arianespace Needs aid to avoid loss in 2010." Space News 4 Jan. 2010 <http://www.spacenews.com/civil/110104-arianespace-needs-aid.html>

[109] Aerospace industry association, "Aerospace Industry Sales by Customer 1997-2011", 2011 < http://www.aia-aero-space.org/economics/year_end_review_and_forecast>

[110] Aerospace industry association, "Aerospace Industry Sales by Customer 1997-2011", 2011 < http://www.aia-aero-space.org/economics/year_end_review_and_forecast>

[111] Amy, Klamper."Official Reaffirms White House Support for ITAR Reform." Space News 14 Sept. 2009 <http://www.spacenews.com/policy/official-reaffirms-itar-reform.html>

[112] Aerospace industry association, "Aerospace Industry Sales by Customer 1997-2011.", 2011 < http://www.aia-aero-space.org/economics/year_end_review_and_forecast>

[113] Aerospace industry association, "Aerospace Related Employment 2002-2010.", 2011 < http://www.aia-aero-space.org/economics/year_end_review_and_forecast>

[114] Antonie, Boessenkool. "DoD: U.S. Space Industry May Lose Edge." Defense News 25 May 2010< http://www.defensenews.com/story.php?i=4641686>

# 3. Space Policies and Strategies around the World

## 3.1 European Union

The four-in-orbit validation (IOV) satellites, which are being constructed by a consortium led by Astrium Satellites and Thales Alenia Space, saw is launch adjourned. The IOV satellites were scheduled to be launch long before the initial launch of the operational constellation, whose 14 satellites are under construction by OHB Technology of Bremen, but the permanent adjournments hampers the deliver. One of the reasons for the IOV's slippage of several months was the removal of Chinese-built search-and-rescue payloads that had been placed on the four nearly complete IOV spacecraft, following a decision by the European Commission that non-European payloads would not be allowed on the Galileo spacecraft. The IOV satellites were scheduled for the end of 2010, for launch two at a time on European versions of Russia's Soyuz rocket[115].

An estimated $600 million short of what is need, is placing barriers to the complete development of the GMES satellite-based Earth observation programme. On June, ESA and the European Commission programme managers discussed the short-term problems that this programme was facing. GMES has already cost ESA and the European Commission €2.2 billion and the European Parliament add €107 million to that sum, trying to help pay programme expenses for 2011-2013. Although, €500 million in expenses were in need for funding. Other type of funding is being sought to stimulate services, augment existing ground-based facilities and pay for the system's early operations. One in orbit, in 2014, it will cost €600 million per year in operating and maintenance. ESA has funded 2/3 of the programme and the remaining has been funded by the European Commission. To permit the GMES absolute success, one last effort is seen has necessary: linking European and global third-party satellite programmes to the GMES system[116].

Satellite data access has been debated for many years and it has been discussed in what concerns data from Europe's future generation of Sentinel Earth observation satellites. ESA and the European Parliament endorsed the idea of free access to that data, possibly with the exception of imagery with a ground resolution sharper than 10 meters. About this subject, divergent positions appeared. Some argue that the private sector will not develop if a fee is not charged for the imagery. Others say that the best way to stimulate the use of data is offering it for free at the source and focusing the private-sector on value-added services. The U.S. Landsat that used to charge for the data access, increased is downloads since it became available free of charge in 2008[117].

The head of the GMES Space office at ESA, Aschbacher, is well-placed to estimate the costs for the GMES programme. Aschbacher had affirmed that ESA governments spent €790 million for Segment 1 of the GMES space component and Segment 2 totalled €830 million. The FP7 – European Commission's Seventh Framework Programme For Research, has already covered €630 million for the GMES development. Total of funds: €2.2 billion. Aschbacher also predicts that the European Commission will need to find €560 million for extra funding for the GMES for 2011-2014. ESA's role in GMES will be very restricted starting in 2014, only for researching and developing activities, which should average €170 million[118].

The European Environment Agency (EEA) was estimating the cost to design, install and maintain a network of ground-based sensors to work as part of GMES Earth observation system. EEA has 10 people working full-time on the GMES. EEA will be responsible for ensuring that the GMES data are assembled, archived and distributed in an accessible and understandable way, including the data collected by a large number of terrestrial sensors. The amount of satellite is expected to reach 27 petabytes by 2020. ESA's Earth observation strategy division referred a chal-

[115] "Galileo Validation Satellites Facing Another Launch Delay" Space News, 14 June 2010: 3.
[116] De Selding, Peter B. "European Earth Observation program Faces Big Funding Shortfall." Space News, 5 July 2010: 5.
[117] De Selding, Peter B. "European Officials Embrace Open Data Policy for GMES Satellites." Space News, 5 July 2010: 5.
[118] "GMES Chief Tallies Tab for Earth-monitoring System." Space News, 5 July 2010: 15.

lenge for ESA to secure funding to house and maintain data on a long-term basis. ESA's member states and the Canadian Space Agency agreed to a set of principles on long-term preservation[119].

The European Commission, following its Seventh Framework Programme for Research and Technological Development, planned to award a total of €8 million in 2011, to develop cubesats and other small satellites. To form an eligible consortium, each cubesat should include at least three independent European Organizations, such as universities, non profit organizations, from at least three European Union's member states. The proposals, which should had been submitted until November 25, 2010, should include space-based research experiments, likely environmental and climate change monitoring, biological and microgravity research. The cubesat initiative is part of a broad European Commission space research plan - €99 million –for a variety of projects[120].

On September 22, 2010, one cooperation agreement was signed between Norway and the European Union, to permit Norway to cooperate in the Galileo System: providing Galileo hardware and polar ground station (one on Norway's Svalband Island in the Arctic and another on Norwegian Antarctic territory) and a €70 million funding. Galileo, a 30-satellite constellation in medium Earth orbit, will launch a 14- satellite constellation until 2014, to provide initial service[121].

The E.U. new space undertakings depend on new sources of funding, including off-budget financing. This new funding sources are *conditio sine qua non* to the continuation of satellite navigation and operational Earth- observation programmes on course. The E.U is also analyzing ways to back climate-monitoring and anti-proliferation policies and, as well as, ways to help meet maritime security, air traffic and surface transport management needs and helping the maintenance of an independent European launch capability. To perform all those projects, the costs will exceed what planners had initially anticipated. For example, the €3.4 billion funding for Galileo was merely enough to pay for 18 of the 30 satellites in the constellation[122].

The U.S. public funding mechanisms for space services has been seen as a threat by the European space leaders. The industry managers had already clearly identified the threats. Among them is the financing structure put in place by the U.S. National Geospatial- Intelligence Agency (NGA) to ensure the availability of high-resolution imaging data and products for military and government use. Another threat was the rising chorus within the E.U. to lower the launch costs of the Galileo satellite navigation system and other E.U. space programmes by opening bids to international suppliers, as required by EU open-competition rules. However, several European officials are countering that the space industry does not operate in a true commercial context and that industry policy considerations should temper E.U. competition rules, except if there is some form of reciprocity[123].

European leaders sought for a partnership with the U.S. to build a global space-based surveillance network. This network – C-Sigma – would be able to provide early detection and identification of vessels engaged in piracy, contraband, illegal immigration and other sea-based threats. The C-Sigma would combine data from automatic identification system (AIS) receivers with imagery from commercial and government surveillance satellites, to create a near real-time maritime operational representation[124].

## 3.2 European Space Agency

On June 8, despite a growing debt crisis in the ESA's 18 member states, Jean-Jacques Dordain expected to maintain all the programmes previously agreed. Notwithstanding ESA's governments approval in 2008 for a €10 billion spending for the coming years, many doubts are now emerging, such as the ability of European Nations to service their debt without major spending cuts. Spain, Italy and Britain are facing severe government budget cuts. In order to keep his contributions, Spain has authorized ESA to take out loans on his behalf. Italy had the U.S. – European Mars exploration mission, in which was a major contributor and was asked to do more investment to maintain the operations

[119] "GMES Ground Component Poses Its Own Challenges". Space News 12 July 2010: 12.
[120] "Europe Solicits Ideas for Cubesat Launch Options". Space News 9 Aug. 2010: 8.
[121] "Norway Pledges 70M Euros As It joins Galileo Programme". Space News 27Sept. 2011: 8.
[122] Taverna, Michael A. "Existing EU Budget Structure "Unsuited" To Space Undertakings." Aviation Week & Space Technology 1 Nov 2010: 34.
[123] Taverna, Michael A. "Industry Says EU Open Competition Rules Should Not Apply To Space" Aviation Week & Space Technology 1 Nov 2010: 36.
[124] Taverna, Michael A. "Network Would Combine AIS And Imaging Satellite Capabilities." Aviation Week & Space Technology 20 Dec 2010: 86.

for the ISS. None of them has given signs to not comply with the programmes[125].

ESA announced the third four-year term election of Jean-Jacques Dordain that will now stay on until 2015. Germany was unable to set its own candidate but still hopes to find a new one for the next elections. Dordain identified several challenges for the agency. Among those, the relation development with the European Commission and the whether ESA will become a part of the E.U. is one issue that will take years to solve[126].

The praised idea of offering free and open access to almost all data from ESA and European Union Sentinel Earth Observation satellites is not shared by the private sector, whose business models are based on imagery sales. During the 2010 Living Planet Symposium, in Norway, Pedro Duque, managing director of Deimos Imaging of Spain, raised several questions, like if the EU would give away Sentinel data for free and if that behave would not compromise the emerging, competitive, profitable European observation data supplier industry, including Deimos Imaging of Spain. Apart from this company, also Spot Image of France, Infoterra of Britain and Germany and e-Geos in Italy, can see is business plans affected. Deimos launched in July 2009, its own small Earth observation satellite – Deimos-1 – that was integrated in the Disaster Monitoring Constellation. This satellite aimed at an agricultural market, overlapping with the markets targeted by the GMES programme. The mission manager for ESA's Soil Moisture and Ocean Salinity satellite said that ESA was facing an increased demand for data as part of a global scientific examination of climate change. The idea of dropping access fees was also championed by the Group on Earth observations. At that time, the European Commission had not delivered the final decision on data-access; however the decision is clearly predictable[127].

Arianespace was set to gain a capital injection and a new dollop of public price support, in early 2011. The company is taking measures needed to counter competition from lower-cost launch providers and to help defray the extra burden of operating two new launch vehicles. An €50 million arrangement was sought to cover, at least, the maintenance and continuation of expenditures. Twelve launches are planned for 2011: six for the Ariane 5, five for the Soyuz and the inaugural Vega mission[128].

## 3.3 EUMETSAT

ESA was waiting for final approval to build 6 meteorological satellites, with a $1.5 billion contract. The Meteosat Third Generation (MTG) programme leadership was on a standoff, threatening to do lasting damage to ESA and creating serious difficulties in relations between Germany and France. After a leadership war which lasted from 2008, Germany and France reached a compromise: to limit its ownership stake to 34%. But, actually, ESA is financing 25% of MTG programme and Germany the remaining part.

In this compromise, ESA was responsible for the MTG prime contractor's selection, with a subliminal justification: at that time; Germany was convinced that Astrium satellites was the only satellite builder able to get the prime contractor's role and this would guarantee the Germany's dominance in the programme. This belief led German government to refuse an Astrium proposal that the company make a bid with long-time Thales Alenia Space of France and Italy. However, Thales Alenia closed a deal with Germany's OHB Technology of Bremen, for an MTG bid. The bid of this partnership was less expensive than the one released by Astrium and that one was selected for an €1.18 billion contract.

The German Transport Ministry, refusing to accept the Thales-OHB and blocking the MTG programme at Eumetsat, demanded to ESA's Director-General a German prime contractor, in order to reassume the leading role. On June 14, the final compromise leaves the prime contractor's role with Thales Alenia Space of France but assures Astrium of German a greater share. The Astrium adding to the programme resulted in an €60 million increasing to the contract's final price, but still within the initial budget[129].

[125] De Selding, Peter B. "Dordain: Even With Gov't Cuts, ESA Programs Should Maintain Funding" Space News, 14 June 2010: 5.
[126] "ESA Chief Dordain Elected to Third Term." Space News, 21 June 2010: 3.
[127] "ESA Data Access Policy Draws Mixed Reviews". Space News 12 July 2010: 12.
[128] Taverna, Michael A. "New Ariane Financing Likely To Be Decided In March." Aviation Week & Space Technology 10 Jan 2011: 37.
[129] De Selding, Peter B. "European Weather Satellite Contract Dispute Appears Resolved." Space News, 28 June 2010: 5.

## 3.4 National Governments

### 3.4.1 France

The French aerospace research agency (Onera) has considered this time to a big leap forward for air transportation. The believe is that projecting 40 years away is the right timeframe to consider next generation, covering aircraft and propulsion systems, air traffic management, energy resources and environmental constraints. This position was clear in the "Research Paths for a Viable Air Transport Industry in 2050", where the Onera offered useful insights, saying that we should immediately present fresh conceptual and technological options for an 40 year time line[130].

French government accounting office had doubts on the vast French plan to sell off assets and outsource services to help compensate a drop in military procurement spending. The office is analyzing the proposal to sell and lease back Syracuse 3 secure satellite communications system and raised some questions, for example, whether the Syracuse sale strictly intended to improve operating efficiencies or if it is a purely financial mechanism to escape the budget restrictions[131].

Two Swedish formation-flying satellites and one French solar-weather spacecraft were placed into low Earth orbit, on June 15, by a Russian-Ukrainian Dnepr Rocket and they are healthy in orbit. This launch was delayed several times because of a dispute between Russia and Kazakhstan over the issue of rocket debris falling on Kazakh territory. The France's Picard satellite was developed by the French space agency, CNES, and it operates from a 725 km orbit for at least two years, in order to study the solar activity. The two Prisma satellite, Mango and Tango, were launched together and remained a single unit until August 3, when they were separated and started working and testing formation flying. Mango weights 140 kg and will spend 10 months manoeuvring around the 40kg Tango. The goal is to test technologies for the future, larger missions in Europe which requires precise positioning of satellites groups. CNES also had a role in the Prisma mission, proving the formation flying in-orbit ranging demonstration subsystem[132].

The $325 million generated by the French government bond issue initially directed for satellite broadband technologies and a Ka-band satellite, could be invested on locally managed subsidies for consumer broadband terminals. France's state secretary for development of the digital economy said that the government had the intention to spend that amount of money for broadband development. No mention was made to the Megasat advanced Ka-band broadband project. One consensus was expected in the government after the consultation with the Parliament, in order to select what kinds of broadband technologies and capabilities would be targeted for the investment[133].

### 3.4.2 Germany

The most important development in the field of German space policy in 2010 and 2011 has been the announcement of the country's new space strategy. The 30 page document offers a detailed analysis of the strategic environment in which German space activities are expected to evolve in the next decade, describing both the general strategic orientations and the specific objectives that the new policy would have to achieve in order to meet them. As far as the first are concerned, the new strategy adopts a utilitarian approach aimed at highlighting the specific benefits that space activities can achieve for society, insists on the principle of sustainability, maintaining a long term view on the development of space infrastructure and adheres to the importance and further development of international cooperation in space.[134] As far as the second are concerned, the new strategy describes in detail 10 key policy objectives that need to be addressed in the medium term. These include maintaining and expanding Germany's scientific expertise and industrial base related to space technologies and ensuring the continued growth and excellence of the country's space sector; creating a unified legal instrument for space activities and encouraging further European integration in this respect; incorporating space applications in the country's overall security strategy; shaping the distribution of roles in the European space sector; ensuring European independence in space technologies; maintaining

[130] Sparaco, Pierre. "Onera Offers 2050 Technology Road Map." Aviation Week & Space Technology 22 Nov 2010: 41.
[131] Morring, Frank Jr. "French Watchdog Agency Criticizes Syracuse 3 Sell-off." Aviation Week & Space Technology 14 Feb 2011: 22.
[132] "Dnepr Rocket Lofts Trio Of European Satellites." Space News, 21 June 2010: 9.
[133] "France Rethinks Plans for Megasat Broadband Satellite". Space News 2 Aug. 2010: 3.
[134] Federal Ministry of Economics and Technology. Making Germany's Space Sector Fit for the Future: The Space Strategy of the German Federal Government. Berlin: BMWI. November 2010: 9.

European flight capabilities and considering an unmanned mission to the Moon; and finally ensuring the sustainability of German space activities through promoting international cooperation. In conclusion, the new German strategy is a balanced document that seeks to uphold the country's leading position in European space activities, both from an institutional as well as industrial view point.

On May 26, the U.S. space agency's telescope – SOFIA – became operational. The first in-flight photos were captured, multicoloured infrared images of Jupiter and the galaxy M82. SOFIA is an extensively modified Boeing 747P jet aircraft with a 2.5 meter infrared reflecting telescope and is expected to provide a completely new astronomical science observations and Great observatory-class astronomical science.

NASA's Dryden Flight Research Centre, a joint venture of NASA and German Aerospace Centre, is overseeing the telescope's operations. The control is done by researchers flying along in a separate cabin inside the SOFIA aircraft, for a period of eight-hour, flying at 800 km per hour. The first infrared images of Jupiter and M82 were revealed. In Jupiter snapshot it was visible the gas giant planet's internal heat bleeding through holes in its thick bands of clouds. The infrared look at the M82 galaxy allowed astronomers to peer through the galaxy's interstellar dust clouds and spot several starburst knots, where infant stars are forming by the tens of thousands. The ten scientist inaugural crew included researchers from NASA, the Universities Space Research Association (USRA), the German SOFIA Institute (DSI) and Cornell University[135].

France and Germany have agreed to renew for a two or four years, Jean-Jacques Dordain's term, that ends in mid-2011, and the Head of the German Aerospace Centre, DLR, has taken himself out of the running to become ESA's Director-General in 2011. However, the final decision about the future of ESA's Director-General, belongs to the Council[136].

After twenty years of abstinence, the German Government was determined to promote investment in areas in which it can be leader, having China and India has new competitors. This determination also shows resilience to France dominant role in building large telecommunications satellites. The new investment has a near-term goal: providing economic benefits, to be a money-spinner. Germany sought for developing a value chain using ESA and its programme to develop telecommunications technologies – Artes Programme. Germany's government was pushed to fund new projects, mainly the Heinrich Hertz, a telecommunications demonstration satellite[137].

As part of the Germany's strategy of complementing radar observation satellites, the German government was looking for commercial and government partnerships to develop a high-resolution optical Earth observation satellite. During the ILA 2010 Berlin Air show, DLR officials said that Germany would leave optical imagery to France, because it no longer feels bounded by tacit agreements, and, as said by DLR member of the executive board, it is not possible to affirm that it existed in any formal sense. DLR's executive Chairman, Johann-Dietrich Woerner also confirmed this information. DLR and Astrium GmbH of Ottobrunn, co-financed work on the KompSat-3 satellite, an optical imager for South Korea. This satellite is to be launched during 2011 and it was designed to provide a 70m ground resolution. DLR and Germany industry, leaving the study already done, had been working on a High-resolution optical satellite, called, Hi-Ros, which would give Germany an in-house ability to fuse optical imagery and radar data from TerraSAR-X and the TanDEM-X satellites. French government officials and the French arms procurement agency, DGA, affirmed that a pan-European system that insists on developing technologies already in service cannot have a bright future, he said about the Hi-ROS system. Woerner affirmed that the Hi-ROS system is for civil and commercial customers[138].

During the Air Berlin Show, ILA 2010, NASA Deputy Administrator Lori Garver and DLR chairman Johann- Dietrich Woerner, signed the agreement to extend the GRACE satellite mission for two years. The Gravity Recovery and Climate Experiment (GRACE) satellites operate in low Earth Orbit's and are separated by 220 km. They measure small changes in the gravity field due to changes in mass in different areas of the Earth. DLR's share of GRACE operating costs is around €1.75 million, including data download and distribution[139].

Comsat Bw – 2, military communications satellite, was declared operational in orbit on July 9, and it was delivered to the German

[135] "SOFIA Airborne Telescope Returns First Scientific Images" Space News, 7 June 2010: 9.
[136] De Selding, Peter B. "German Space Agency Head Ends ESA Chief Candidacy, Backs New Term for Dordain" Space News, 7 June 2010: 10.
[137] "Germany Seeks Niche in Telecom Satellite Market." Space News, 14 June 2010: 12.
[138] "German Government Eyes High-Resolution Satellites." Space News, 14 June 2010: 13.
[139] "United States and Germany Agree to Extend GRACE Mission." Space News, 14 June 2010: 13.

military. ComsatBw-2 carries four SHF and five UHF channels and was designed to operate for 15 years, in operation nearly identical Comsat Bw-1. The ND Satcom of Germany is responsible for the ground segment and Astrium for the space segment, although the Comsat Bw satellites were built by Thales Alenia Space of Franca and Italy[140].

Research on in-orbit servicing to extend the lives of satellites or performing orbital manoeuvres are still a German government's commitment. DLR has been studying ways to refuel satellites in orbit using a rendezvous and docking technique[141].

### 3.4.3 Italy

Italy as well announced a new strategy plan for space that extended funding and programme visibility for the country's civil space programme to 10 years. The new strategy plan improves ASI's ability to reinforce existing initiatives and established new priorities. Among those priorities were: expanding Italy's radar Earth-observation know-how as well as science missions, and developing a new liquid upper stage and improved solid propulsion motors for the Vega light launcher. Another important priority is the reinforcement of the ties with other space agencies. The document also discusses the country's involvement in extending the operational life of the International Space Station (ISS) and the new opportunities for flying Italian instruments on NASA scientific missions[142]. At the same time, a new bilateral agreement between Italy and the U.K., centred on cooperation in space related R&D was under consideration.[143]

Private industry and public-private financing schemes are expected to be primordial in implementing the new Italian space strategy, while allowing for priority to national missions. Furthermore, in this 10 year period Italy expects to build a domestic high-speed broadband satellite system, expand remote sensing capability into the hyper spectral optical domain and expand space launcher know-how beyond rocket motors and boosters, among other specific goals[144].

[140] "German Comsat Bw-2 Declared Operational". Space News 19 July 2010: 9.
[141] "Germany Still Committed to In-space Satellite Servicing". Space News 26 July 2010: 12.
[142] Italian Space Agency. Strategic Vision 2010-2020. Rome: ASI, 2010.
[143] Nativi, Andy and Taverna, Michael A. "Rome, London Seek ways To Compensate For Limited Space Budgets." Aviation Week & Space Technology 26 Jul 2010: 44.
[144] Taverna, Michael A. "Italy's Plan To Favor National Missions Over ESA." Aviation Week & Space Technology 3 Jan 2011: 28.

### 3.4.4 United Kingdom

Like Italy, the U.K. focuses attention on inter-agency and industry collaboration, for the new space strategy. One first step was to conclude a new bilateral agreement with Russia, focused on commercial duties, such as reducing Russian import duties and promoting the use of Britain's small satellite technology. The U.K.'s top priorities included examining how satellites could help improve broadband access in rural areas and, in particular, seeing if it is in need for its own operational Earth-observation network. The initiative is supported by a $7.6 million Earth-observation clearinghouse[145].

To this effect, a consortium led by Astrium was selected by the British government to create an Earth observation satellite operations and data processing centre in Britain – EO Hub. It was scheduled for March 2011 and cost $7.5 million. ESA said that building a facility in Britain could stimulate space investment in the country, which could reflect on future British contributions to the agency. The EO Hub was installed at the International Space Innovation Centre; being part of an effort to make the Centre a link between regional space capabilities. On July 20, Astrium (responsible for the Centre's creation) announced that its Infoterra division bought download and process data from the ERA-2 and Evisat radar Earth observation satellite for $9.7 million. Under this contract, Infoterra is responsible for manage downloading and processing images from ESA's Swarm satellites[146].

## 3.5 United States of America

The most significant development in the U.S. during the reporting period has been the announcement of a new Space Policy, on 28 June 2010. This was a document describing the general strategic and policy guidelines and priorities that all the different U.S. government agencies delegated to conduct space activities should follow. All U.S. Presidents since Eisenhower have issued such policy papers, recognising the unique place and importance of space activities to their country's international standing, economic development, scientific advancement and national security.

The announcement of the Obama space policy did not come as a surprise. Soon after his

[145] Nativi, Andy and Taverna, Michael A. "Rome, London Seek ways To Compensate For Limited Space Budgets." Aviation Week & Space Technology 26 Jul 2010: 44.
[146] "Astrium-led Group to Build Satellite Center in Britain". Space News 26 July 2010: 8.

election, the new administration officials and the President himself identified space activities as an area of great significance to U.S. policy, attributing to it a high priority within its working plan. Interagency consultations on the drafting of the policy began already in the summer of 2009, one year prior to its release, based on the authorisation of the Presidential Study Directive No 3. Consultations on the policy's content were not limited within the U.S. government, but on the contrary included inputs from close friends and allies among space-faring nations. During this process, separate talks were held with EU authorities, which underlined the latter's increasing competence in the field of space policy[147]. At a later stage of the review process, other important space actors such as Russia, China and India were informed of its outline, making international cooperation one of the new policy's key elements, already during its making.

The new U.S. space policy itself is a 14 page document with a carefully balanced structure. The first 4 pages include a brief introduction and a 2 page declaration of the policy's key strategic orientations and objectives, labelled "principles" and "goals" respectively. Then, the rest of the paper is evenly divided into two parts. The first provides the broad policy guidelines that all government authorities conducting activities in space should observe ("intersector guidelines"). The second part lays down the more specific actions that they should undertake in order to achieve the policy's objectives, divided into three fields of activity: commercial, civil and national security ("sector guidelines"). In short, the new policy demonstrates a very clear and articulate methodological approach, moving from its broad strategic orientations to the narrower policy guidelines and then to the specific objectives that should be met in every sector[148].

The key strategic orientations of the new U.S. policy include: the creation of a sustainable, stable and freely accessible near space environment for all nations; the reiteration of the U.S. leading role in space activities; the expansion of international cooperation in space; the improvement of the space industry's manufacturing and commercial competitiveness; the increase of U.S. space assets' resilience against interference; and the implementation of innovative scientific research and development, including exploration and space applications programmes, with a particular focus on Earth observation missions. "Intersector guidelines" in the policy address an important number of key issues, such as: maintaining and enhancing U.S. space capabilities; fostering international cooperation; preserving near space environment through the promotion of a more responsible use of space; implementing more effective export policies to the benefit of the country's industries; advancing research on space nuclear power; improving the management of radiofrequency spectrum and protecting national space assets from interference; and finally increasing the resilience of mission-essential capabilities.

If one takes a closer look at the various policy guidelines presented above, it appears that they all evolve around three principal thematic areas. The first is protecting and improving U.S. space scientific and industrial competitiveness. This prerogative includes reviewing barriers to the private space sector's development, such as strenuous and counterproductive export control procedures. This point is linked to the overall Obama administration policy that seeks to mitigate the effects of the present economic crisis by increasing U.S. exports, including a review of the State Department's International Traffic in Arms Regulations (ITAR)[149]. The ITAR list includes most of space system's components and preparations for its revision have started at the same time as the consultations for the drafting of the new space policy. In the framework of the same effort to revitalise the country's space industry and to reduce its dependence from government expenditures, the new space policy also calls for increasing government funding into innovative research and development, modernising infrastructure in a targeted manner (for example giving priority to space launch capabilities) and relying as much as possible on commercial services for government space operations. In general, the new policy clearly sees the current publicly managed space business model as problematic (perhaps in view of the recent financial turmoil) and it clearly indicates a preference for private investments, or public-private partnerships in space that it regards as more cost-effective.

The second tier of the Obama administration's strategic vision for space is that of an

[147] "Briefing by Senior Administration Officials on the President's National Space Policy via Teleconference". 28 June 2010. U.S. Department of State 20 Dec. 2010< http://www.state.gov/r/pa/prs/ps/2010/06/143752.htm>.

[148] "National Space Policy of the United States of America". 28 June 2010. The White House 20 Dec. 2010 <http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf>.

[149] Ibid: 8.
"Briefing by Senior Administration Officials…"
See also: "Space Foundation Statement on New U.S. national Space Policy". 28 June 2010. Space Foundation 20 Dec.2010
<http://www.spacefoundation.org/news/story.php?id=973>.

increased international cooperation. Cooperation in space activities has always been appreciated by the country's space policies, since it was considered as a stabilising factor in international relations and a field where the U.S. could leverage its technological advancement into an increased diplomatic status and recognition of its global leadership role. International cooperation is envisaged for all areas of space activities: space science, research and exploration, space transportation and especially nuclear power related research. Furthermore, the new policy pays particular attention to two areas of cooperation: preserving near space environment and developing transparency and confidence-building measures (TCBMs) in space[150].

Regarding the first issue, it calls for respecting the UN Space Debris Mitigation Guidelines, encouraging international cooperation in Space Situational Awareness (SSA) information, developing new in-orbit debris removal technologies and finally promoting Global Navigation Satellite Systems' (GNSS) interoperability, even including soliciting foreign GNSS to strengthen GPS resiliency. Regarding the second issue, it seeks to foster international consultations and encourage the responsible and peaceful use of space. In this respect, it does not exclude considering arms control concepts in space, provided that they are equitable, effectively verifiable and not detrimental to U.S. security interests. This point reverses the previous administration's policy of considering TCBMs as unnecessary restrictions to the U.S. freedom of action in space and brings its position back to where it stood under the Clinton and previous administrations.

The third and final tier of the U.S. space strategy is to assure and enhance current U.S. capabilities in space. This aspect of the policy mostly relates to the concept of Operationally Responsive Space (ORS), which is not explicitly stated in the document, but it is however described as the ability to operate in a "degraded, disrupted or denied space environment"[151]. The ORS concept is also implied when the policy calls for assuring the mission-essential functions that are indispensable to meet the minimum U.S. government operational requirements, together with increasing space infrastructure protection measures. Finally, the new policy pays particular attention to improving the management of radiofrequency spectrum and limiting intentional or not interference, in close cooperation with international partners.

The general strategic principles part of the new policy is followed by a second half that presents the specific guidelines for its implementation along three activity areas: commercial, civil and national security space, which appear in that order in the text and are most likely prioritised as such. The new U.S. commercial space policy seeks to outsource to the private sector as much of government space activities as possible. In the pursuit of that objective, it does not simply envisage the use of currently available commercial capabilities, but it aspires to actively build upon and modify them in order to create new possibilities. For that purpose, it states its readiness to assume part of the investment risks through PPP funding mechanisms. Furthermore, it refrains from developing government space capabilities that could antagonise with their commercial counterparts. Finally, it places all existing government space infrastructure to the service of commercial users on a reimbursable but equitable basis with government agencies. Most importantly, the policy does not exclude using foreign commercial services' providers for government missions, or hosting public payloads on commercial spacecraft. Finally, it aspires to foster a global open trade environment for space services by encouraging U.S. companies to be more extroverted and minimising regulatory burdens that might hinder activities abroad[152].

Civil space guidelines, on the other hand, are divided into three categories: a) space science, exploration and discovery, b) environmental and weather Earth observation (EO) and c) land remote sensing. As far as the first is concerned, the policy mostly sets long term objectives, perhaps in the light of the U.S. government's previous decision to cancel the Constellation project. They include keeping up with robotic exploration missions, developing next generation space launch systems capable of supporting human missions to Mars by the mid 2030's, continuing ISS operations at least until 2020 and further pursuing scientific missions to explore the Sun and accurately catalogue Near Earth Objects (NEOs). Finally, it calls once more for the creation of PPPs to develop private spaceflight capabilities and invest in advanced space technologies. With regard to EO mis-

[150] "Press Conference: Deputy Assistant Secretary Frank A. Rose -U.S. National Space Policy 2010". 13 July 2010. U.S. Mission to the U.N. in Geneva 20 Dec. 2010. <http://geneva.usmission.gov/2010/07/13/rose-press-briefing/>.
See also: Robinson, Jana. The Role of Transparency and Confidence-Building Measures in Advancing Space Security. ESPI Report 28. Sept. 2008.

[151] See also: Remuss, Nina. Responsive Space for Europe. ESPI Report 22. Feb. 2010.

[152] "National Space Policy of the United States of America". 28 June 2010…: 10.

sions, the Obama space policy divides them into environmental (including weather) monitoring and land observation. With respect to the first, it underlines the importance of satellite assets to sustained global climate change monitoring and stresses the need for international cooperation in this field as well[153]. Furthermore, it evenly divides the labour for polar-orbiting satellite based weather monitoring between NOAA and the Department of Defence. Concerning land observations, the document clarifies the competencies of the different services using space assets and calls for the increase of government EO data openness, availability and compatibility for commercial use.

Finally, the new U.S. space policy is concluded with the country's national security space guidelines, which follow almost entirely the lines of previous policies. They focus on maintaining crucial space capabilities relevant to defence and intelligence missions, including measures to increase the survivability of satellites in a cost-effective fashion, improve rapid replacement capabilities (according to the ORS concept) and assure strategic independence by supporting the domestic space equipment supplier base. Further priorities call upon increasing SSA integration and effectiveness through inter-agency and wider international cooperation, with special focus on keeping existing capabilities in pace with the constant growth of the satellite population and maintaining the capability to attribute disturbances to U.S. space assets. At the same time, the document attributes space related competencies and responsibilities to the Department of Defence and the Director of National Intelligence indentifying their mission areas without any significant departures from the views established by previous administrations.

This chapter will present a brief analysis of the Obama national space policy and comparison to these published by the Bush (2006) and Clinton (1996) administrations. A similarly comparative approach was also adopted by administration officials in promoting the new policy, which they described as returning in many aspects to the spirit of the Clinton space policy[154]. Given the limited scope of this paper, previous policies will not be presented in detail.

First of all, it seems pertinent to assume that the order in which sector guidelines are presented is significant of each administration's priorities. Indeed, in the Clinton policy civil space guidelines were given first, followed by national security and commercial activities, whereas in the Bush policy national security came first, followed by civil and commercial space[155]. In short, the new U.S. space policy is the first to place commercial activities first and national security last. Clearly, this is a sign of the increased importance that the current President attributes to the commercial sector, which appears at the top of the list for the first time in history. According to this analysis, the increased importance attributed to commercial space does not perhaps signify a change of paradigm in the U.S. space policy, but it clearly indicates the administration's changed priorities.

Indeed, encouraging private entrepreneurship in space is clearly the new policy's top priority. Although the Clinton administration also attempted to exploit the competitive advantage held by U.S. commercial companies in space activities, the Obama policy adopts a more energetic approach and seeks to actively support their further development. In order to do so, it accepts to finance part of their R&D costs through PPP funding mechanisms, something that was explicitly ruled out by the last two administrations[156]. Furthermore, it demonstrates a preference to purchasing commercial services to the fullest extent possible (depending on their affordability), instead of using their government owned counterparts. To that effect, it does not exclude the utilisation of foreign based services.

Through this policy, the U.S. government apparently seeks to create new commercial markets, as for example in the case of the private human spaceflight industry. In addition to this, it recognises the profound change that the global space policy environment has witnessed over the past years, marked by the constantly increasing proliferation of space capabilities and actors. In establishing adequate policy lines to meet the globalisation of the commercial space market, the Obama administration abandons the approach of its immediate predecessor that sought to protect the U.S. "advantage" in space through tight security measures and strict export controls. On the contrary, it returns to the principle of "open doors" and free trade in space of the Clinton era. Furthermore, it exceeds the latter in recognising that, under the present circumstances, the U.S. space industry needs a competitive

[153] Ibid: 12.
[154] "Briefing by Senior Administration Officials…"

[155] "U.S. National Space Policy". 31 Aug. 2006. The White House 20 Dec. 2010 <http://www.whitehouse.gov/sites/default/files/microsites/ostp/national-space-policy-2006.pd f>.
"Fact Sheet: National Space Policy". 19 Sept. 1996. NASA 20 Dec. 2010 <http://history.nasa.gov/appf2.pdf>.
[156] "U.S. National Space Policy". 31 Aug. 2006: 7.
"Fact Sheet: National Space Policy". 19 Sept. 1996: 5.

boost from the government to face up to constantly increased competition.

It appears that the approach presented above also determines the administration's stance towards export control measures. Several government officials have linked the new policy to the revision of the export control regime on space-related items, which currently poses restrictions upon their free commercialisation. It remains to be seen if a significant number of such items will be removed from ITAR. Nevertheless, it is clear that such a decision would be dictated by the administration's favourable view of an open and extroverted commercial space industry, as the only way to ensure its competitiveness on the long term. This attitude constitutes a clear return to Clinton policies, prior to the inclusion of space technologies to the ITAR list. It also differs from the Bush administration's introverted view of space technologies as a crucial national security and industrial asset, only to be shared with selected allies and "on a case-by-case basis"[157].

The second novel characteristic of the U.S. space policy is the fact that it does not limit itself to describing broad strategic outlines, but on the contrary it goes into specific details on how guidelines should be realised and objectives reached. This detailed approach is an indirect recognition of the increased complexity of the international space activities environment, with its multitude of emerging actors. It also implies that the administration was inclined to clarify the strategic vision on which related policy decisions were based, such as cancelling Constellation and providing a new direction for NASA[158]. The detailed nature of the new space policy was underlined by U.S. government officials. On the other hand, it has also raised some criticism to the fact that it fails to mention the budget required for its programmatic declarations[159].

Another key plank of the new policy is its focus on international cooperation and its consequent multilateral approach to space activities. This characteristic signifies a clear departure from the previous administration's more unilateral tone and it does seem to return to the views held by the Clinton policy, if not expanding them even further. Indeed, the thread of multilateralism runs through the entire policy document. For example, it manifests itself in the potential for GNSS cooperation, which was not present in the 2006 policy[160]. Furthermore, the administration approaches the space debris issue in a broader, more global and coherent way than its two predecessors. This is especially the case when it discusses international cooperation in SSA projects in a systematic and detailed fashion. By doing so, it moves the debate forward from simply dealing with the debris threat to creating a more sustainable space environment and engaging all space faring nations through the promotion of more responsible policies and behaviours in space. In this sense, it implies a truly global and long term vision, according to which multilateral, and not simply bilateral, cooperation in space could become a stabilising factor for international relations in general.

It is worth noting that the current administration's vision of international cooperation and security in space does not limit itself to describing U.S. policies towards it. On the contrary, it places its attitudes in the broader context of a new order in space activities, based on all nations' adherence to the principle of preserving a sustainable space environment and demonstrating a responsible behaviour in space in order to protect it. Consequently, contrary to the previous policy of protecting the nation's narrowly defined interests against foreign competition in space activities, the new one places the U.S. in the centre of a multipolar but stable international environment in space activities. Needless to say, the U.S. still reserves for itself a leading role in formulating the rules of international conduct in space. Nevertheless, it tacitly recognises the fact that an increasing number of emerging actors would have to accept them, if they were to be meaningful. In this sense, the U.S. space policy rediscovers the virtues of the Clinton era's *indirec*t strategic approach of "soft power".

Last but not least, one should note Europe's improved bearing upon the formulation of this new international setting. Administration officials have pointed out the consultations with EU authorities that preceded the publication of the policy. More importantly, they singled out the EU proposed Code of Conduct as a good starting point for discussing and implementing such rules of behaviour in space, albeit on a strictly voluntary basis[161]. This development was good news for Europe, as it demonstrated its own capacity to influence its strategic environment regarding space activities and constituted in itself a significant recognition of its standing.

[157] "U.S. National Space Policy". 31 Aug. 2006: 9.
[158] "A Bold new Approach for Space Exploration and Discovery". 1 Feb. 2010. The White House 20 Dec. 2010 <http://www.whitehouse.gov/files/documents/ostp/press_release_files/NASA%20OSTP%20Joint%20Fact%20Sheet%20FINAL%202020.pdf>.
[159] "Briefing by Senior Administration Officials…"
[160] "Obama's National Space Policy Authorizes Use of Foreign GNSS Services to Strengthen GPS". Inside GNSS July/Aug. 2010. 20 Dec. 2010 <http://www.insidegnss.com/node/2150>.
[161] "Briefing by Senior Administration Officials…"

However, in addition to the above the Obama space policy couples its multilateral approach with an acute sense of pragmatism when it discuses arms control initiatives. In fact, the new policy accepts in principle to consider arms control in space, provided that it serves the country's national interests. In doing so, it reiterates the Clinton administration's approach and reverses the previous policy of discarding such initiatives as restrictive to U.S. freedom of action in space. However, the new policy goes even further in this direction by considering the possibility of TCBMs in space, a tool so far related to strategic arms negotiations. By mentioning the possibility of TCBMs for the first time, the U.S. government adopts a space security approach that is more sophisticated than before. Furthermore, it builds upon the experience of bilateral strategic talks and advances them to a multilateral level for space security purposes. Finally, it creates a linkage between space security and ballistic missile defence, acknowledging that the two issues are related in sharing their operational medium[162].

In relation to space security and space defence missions as well, the new policy adopts a more pragmatic and sophisticated point of view than before. In doing so, it takes into account the increased number of emerging space actors and the proliferation of space capabilities and services. Admittedly, national security objectives in space remain unchanged and they represent a major constant throughout all three last U.S. space policies. Consequently, the Obama administration pays equal attention to protecting its own national space assets and capabilities as its predecessors. Nevertheless, when examining it in its entirety, the new policy clearly refines the Bush era's unilateral approach of security through space control and the right to deny access to space to adversaries. Instead of this, it emphasises the resilience of critical capabilities, which implies not only the ability to deter any attacks against space assets, but also to maintain core capabilities in the face of such an event. Consequently, it places ORS at the centre of its national space security concept, on an equal foot as deterrence and protection.

Finally, a less substantial but politically important change has occurred in the new policy's choice of words regarding counterspace operations. The Obama administration remains adamant in its right to actively protect its space assets in the face of threat. It considers this as inherent to its national sovereignty rights and consistent with the UN recognised principle of self defence. Nevertheless, the new space policy document states that such counterspace actions will be taken "if necessary", replacing the phrase "if directed" used by both previous administrations. It would be exaggerated to presume that this difference implies any kind of change to the rules of engagement applied in such a case. It does, however, create the impression that such operations (and especially of destructive nature) would be considered as a last resort, when deterrence or other options have failed[163].

Contrary to other policy areas, civil space activities guidelines remain mostly unchanged in the new policy. Extensive passages, such as the ones referring to the development of nuclear space capabilities or the use of EO missions for environment monitoring are taken almost word for word from previous policies. Space science R&D objectives and guidelines also remain the same, with the significant exception of a new access to space policy focused on the use of commercial services. However, the Obama administration goes into much more details in describing how its policies will be conducted and which government agency will be responsible for them, for the reasons described above. A new element in the policy is the direction to create data bases of environmental observations monitoring climate change consequences and to make them available for public use. In doing so, it emphasises the usefulness of space services for achieving sustainable development on Earth.

Finally, another example of improvement upon previous policies is the case of radiofrequency protection and counter interference measures, which seem to preoccupy the policy more than before. In this field as well, the administration demonstrates its preference for international cooperation in mitigating interference and its willingness to protect U.S. commercial providers from it too. Apparently, it recognises the fact that the growing number of space actors makes a cooperative approach to this issue more appealing than before. It also goes into length in describing U.S. actions in this policy area, which will seemingly become more and more important in the near future[164].

[162] "Deputy Assistant Secretary Frank Rose on U.S. National Space Policy". 13 July 2010. U.S. Mission to the U.N. in Geneva 20 Dec. 2010 <http://geneva.usmission.gov/2010/07/13/das-frank-rose-space-policy>.

[163] "National Space Policy of the United States of America". 28 June 2010: 14.
"U.S. National Space Policy". 31 Aug. 2006: 4.
"Fact Sheet: National Space Policy". 19 Sept. 1996: 4.

[164] "National Space Policy of the United States of America". 28 June 2010: 9.
"Deputy Assistant Secretary Frank Rose…"

Just like the ones that preceded it, the Obama administration's space policy is a product of its time. It recognises that the existence of a multitude of new government and commercial actors will create a radically new international space activities environment. It anticipates the emergence of a more pluralistic and multipolar order in space and attempts to prepare U.S. commercial and government entities to face the increased competition and complexity it will entail. It does not aspire to protect itself from this new reality by safeguarding its technological advantage and unilaterally protecting its narrow interests in space like the Bush policy did before. But it does, however, claim for itself the leading role in setting internationally accepted standards and rules of good conduct in space[165]. By doing so, it aspires to further extent its strategic influence and "soft power" in the field of space activities. In this sense, it finds itself closer to the Clinton policy. But in reality it moves further than this in proposing a coherent international cooperation model, based on a multilateral approach rather than the separate bilateral discussions held in the past. In conclusion, it does not simply seek to protect U.S. interests in space, but it regards a new international order in space activities *itself* as the highest U.S. national strategic interest in space.

At the same time, another issue that saw progress was the apparent undergoing reform of the U.S. export control regulations, which would have a direct effect to the commercial space activities, since most related hardware is concerned. Indeed, short time after the new Space Policy's announcement, the White House disclosed that it aimed to create an independent agency responsible for licensing exports of military and dual-use technologies, or a "single licensing agency". The agency was to be governed by a cabinet-level board of directors reporting to the president.

The U.S. National Security Advisor, James L. Jones did not give a date to the creation of the agency, but it will be part of the third and final phase of the administration's effort to reform an export control regime. The Administration also expressed its intention to create a tiered munitions list in order to allow the U.S government to prioritize export controls and process license application in a more efficient manner[166].

Another issue that stood out in 2010 and 2011 was the continuing advance of outsourcing public space services to the private sector, including defence related ones. This issue has generated considerable friction among the executive and legislative branches of the U.S. government, particularly due to the short term job losses in the public sector it could entail. Such an example was a provision of the Senate Defence bill that would restrict the kinds of commercial satellite imagery the Pentagon could purchase, which was objected by Obama's Administration.

Indeed, the administration's Defence Authorization Bill included a provision to bar the Pentagon entry into new imagery purchase after 2010, with the exception for the 1.5 meter telescopes[167]. Such a restriction could generate a negative impact to the commercial data providers, limit innovation in commercial technology and increase risks on future government contracts for commercial data services. All that, at a time when contracts were already awarded to DigitalGlobe of Longmont, Colo. and GeoEye of Dulles, of a total worth of $7.3 billion over 10 years to finance the development of a new 1.1 meter aperture satellite for 2012.

### 3.5.1 National Aeronautics and Space Administration (NASA)

The new push of the U.S. government towards cooperation in space was made evident in the public discourse of NASA officials immediately after the new space policy's announcement. For example, Lori Garver, NASA's Deputy Administrator said, during the Berlin Air Show that NASA would see is budget reduced in 50% if the Obama's Administration had not cancelled the Moon-focused Constellation programme. On the contrary, she appraised the new focus on international partnerships, which was very well received by its German audience and could be seen as intending to invite collaboration in space exploration in areas once reserved for U.S. technologies, including possible European contributions to a U.S. led space exploration programme. Garver affirmed that the policy to keep non-U.S. contributions off the critical technologies was not fully put into practice and one example was the fact that the U.S. will relay on Russia to ferry U.S. astronauts to the ISS. As she said, any definition on "critical path" would certainly include crew-transport systems. The Deputy Administrator also qualified the ISS's life extension as a nod to the concerns to the NASA's space station partners. European and Japanese laboratories were among the last major station components to be launched to

[165] "Ask a Diplomat: The International Elements of the National Space Policy". 29 June 2010. U.S. Department of State 20 Dec. 2010 <http://www.state.gov/t/avc/rls/143893.htm>.

[166] "White House Calls for Export Control Agency." Space News, 5 July 2010: 3.

[167] "White House Objects to Imagery Provision in Bill". Space News 27Sept. 2011: 3.

the orbital complex by the U.S. space shuttle and if the ISS life was not extended, they would have little time to operate facilities[168].

At the same time, NASA issued through its "Broad Area Announcement" (BAA) a call for "affordable" heavy-lift launch vehicle concepts that could be used by multiple entities, such as the Department of Defence, commercial corporations and international space agencies. Proposals should be presented until June 29. The total funding for the project was around $8 million and no single contract was expected to exceed $625,000. The final selection was expected 2015[169].

In conjunction to this, further ways to fully utilize the ISS facility until 2020 as a host platform for scientific payloads and for testing instrument technologies in orbit were sought by NASA. Several scientific disciplines, including astronomy, astrophysics, and planetary exploration could be involved in the research and it could be used for a variety of non-microgravity science and technology payloads because it offers mounting points for large instruments, moderate stability, ample power and high-bandwidth communications capabilities. A senior scientist for suborbital research in the astrophysics division of NASA's science Mission Directorate (SMD), said that these opportunities to use the ISS facilities were not new and many examples of such utilization were under way, including the Alpha-Magnetic Spectrometer, planned to be launched in early 2011. NASA choose to focus the station's resources primarily on the science related to long-duration human spaceflight, earlier this decade, and restrained the research to be conducted aboard the space station[170].

In a separate development, on August 5, the U.S. Senate passed a NASA authorization bill which added a space shuttle flight to 2011 as well as $1.3B for the proposed commercial crew initiative over 3 years. This bill required NASA to start working on a heavy-lift rocket capable of supporting manned mission beyond low Earth orbit. Sen. Jay Rockefeller, Chairman of the Senate Commerce, Science and Transportation Committee considered this bipartisan bill on help on refocusing and reinvigorating NASA. The House Science and Technology committee approved a $3.3B investment in a commercial crew transportation system over the next 3 years. This House Bill would also permit the continuation of much of the work being done under NASA's constellation programme, an effort to build new rockets and spacecrafts optimized for lunar missions[171].

On the other hand, however, efforts to increase space transportation commercialisation increased. For example, Armadillo Aerospace of Rockwell, Texas and Masten Space Systems of Mojave, Calif., were awarded a contract through NASA's commercial Reusable Suborbital Research Programme (CRuSR) (for a total of $475.000) to launch seven test flights. NASA officials considered this contract as the beginning of an innovative teaming relationship with the private industry, in order to provide affordable access to the space. Armadillo is currently building three unmanned launches of its Super-Mod vehicle from Spaceport America in New Mexico. Masten Space System's Xaero vehicle was expected to make four unmanned flights during the winter of 2010. Super-Mod and Xaero vehicles would use the global navigation satellite systems to determine their position. They are also able to broadcast position data to ground stations. In order to advance their technology and business, Masten inked a deal with XCOR Aerospace to develop unmanned launchers that could be used for Moon, Mars and asteroids missions. On the other hand, Armadillo struck a deal with Vienna, Va.-based Space Adventures which booked space tourism flights to the ISS; planning to offer seats on suborbital rocket ships that Armadillo started developing. Each trip would cost $102.000[172].

In the field of scientific research, NASA's Ice, Cloud and Land Elevation Satellite (ICESat) ended its mission on February, after the failure of the spacecraft's primary instrument. Some of its debris fell into the Barents Sea North of Norway and Russia. The satellite was important on the understanding in sheet and sea ice dynamics: led to scientific advances in measuring changes in the mass of the Greenland and Antarctic ice sheets, polar sea ice thickness, vegetation-canopy heights, and the heights of clouds and aerosols. With this data, scientists could identify a network of lakes beneath the Antarctic ice sheet. A Follow up mission, ICESat-2, is being planned for launch in 2015[173].

[168] "Garver: New NASA Direction Opens Door to Cooperation." Space News, 14 June 2010: 13.
[169] "NASA Seeks Affordable Heavy-lift Rocket Ideas." Space News, 5 July 2010: 8.
[170] Klamper, Amy. "SMD Urged to Use Station." Space News, 12 July 2010: 4.
[171] "NASA Authorization Bill Passes Senate." Space News 9 Aug. 2010: 3.
[172] "NASA Grants Aim To Foster Manned Suborbital Flights". Space News 6 Sept. 2011: 8.
[173] "NASA's ICESat Craft Safely Re-enters Over Barents Sea". Space News 6 Sept. 2011: 9.

### 3.5.2 National Oceanic and Atmospheric Administration (NOAA)

In February 2011, U.S. President Obama announced the FY 2012 budget for NOAA, for a total of $5.5 Billion. The proposed budget focused on investments to strengthen NOAA's most critical programs in order to ensure long-term economic growth, promote innovation and competitiveness and reduce government spending. This budget request represented a $749 Million increase compared to NOAA's enacted 2010 budget. Proposed spending focused on meeting program needs, identifying efficiencies and ensuring accountability. While the principal aim of the budget was to maintain NOAA's core functions and services, some increases were requested for the most critical programmes, necessary to meet the growing demand for NOAA's services[174].

In fact, NOAA's space programmes accounted for almost the entire requested budget increase, spearheaded by a $ 1.07 Billion request to fund the Joint Polar Satellite System (JPSS) weather satellite[175]. Indeed, providing critical investments in satellites and sensors to further NOAA's observational mission was acknowledged as one of the agency's top three strategic priorities, together with improving prediction of high impact weather and water forecasts and supporting sustainable oceans, fisheries, and communities[176]. From a wider point of view, the proposed budget furthers NOAA's commitment to strengthen science research throughout the agency, providing support for the next generation of scientific applications to meet the growing demand for NOAA's services and to drive U.S. economic recovery. Climate change, for example, represents a $737 million budget request for research and development related to climate, weather and ecosystem science and for infrastructure to support NOAA's R&D enterprise. In order to boost its existing climate services and meet rapidly growing climate related data and information demands, a proposal to reorganise the NOAA and to establish a centralized climate service within it was included in the budget. The reorganization was characterized as "budget neutral", as it would primarily be an internal restructuring exercise that was not expected to affect staffing levels, create new facilities or physically relocate any programmes or laboratories.

## 3.6 Russia

In 2010 and 2011 Russian space activities continued on the path of rapid development as in the previous year. The key element of the Russian space programme remains the rapid restoration of the country's space infrastructure across the board, to levels that would eventually rise to capabilities that existed prior to the 1990's. The principal characteristics of this effort remain its strong high level political backing and budgetary commitment on one hand, and the willingness to pursue the simultaneous development of almost all of the country's space capabilities rather than prioritising among them, on the other. Nevertheless, there are some programmes that clearly attract more funding than others, which would imply that they are at least perceived as relatively more important, or closer to operational maturity. These include the completion of the Glonass GNSS, the creation of a new spaceport on Russian territory, the renewal of the country's launcher fleet, and the further development of space related scientific research.

Indeed, the restoration of the Glonass GNSS constellation to its full operational capacity remained the Russian space programme's top priority in 2010 and 2011 as well. Between 2006 and 2010 related expenditures witnessed a fivefold increase, to reach $925 Million, or nearly one third of the country's space agency total budget. This impressive budgetary commitment lead Russian to the first place among all space faring countries in GNSS spending, surpassing the U.S. for the first time. The constellation was expected to reach full operational deployment in 2010, but the loss of three spacecraft during launch in December postponed this to 2011. At the same time, the Russian space agency is developing the new generation of GNSS satellites Glonass K, which are expected to improve the system's accuracy and resilience dramatically, bringing it to comparable levels to the GPS and Galileo constellations. Their deployment is scheduled to begin in 2013 and if they were to be launched at the same pace as their predecessors, the system could achieve full operational capability by 2016, constituting an important commercial competitor.

At the same time, the Russian government pursues its efforts to renew its launcher fleet, in spite of the existence of the aging but reli-

[174] National Oceanic and Atmospheric Administration. "FY 2012 Budget Highlights". May 2011 <http://www.corporateservices.noaa.gov/~nbo/fy12_budget_highlights/NOAA_Wide_FY12_%20One_pager.pdf>.
[175] Lubchenko, Jane. "FY 2012 NOAA Budget Summary". May 2011. <http://www.corporateservices.noaa.gov/~nbo/fy12_budget_highlights/FY12_Constituent_Briefing.pdf>.
[176] NOAA. "FY 2012 Budget Highlights: National Environmental Satellite Service". May 2011 <http://www.corporateservices.noaa.gov/~nbo/fy12_budget_highlights/NESS_FY12_One_pager.pdf>.

able Soyuz rocket. The programme's budget has experienced a tenfold increase over the past decade, bringing it to $617 Million in 2010, or over 20% of the total space budget. Furthermore, the programme's total expenditures are believed to be even higher, as it also receives funding from the military. The core of the programme consists of the simultaneous development of the new Angara launcher and the construction of a space port certified for human space launch at Vostochny, in the Russian Far East.[177] Significantly, the $800 million long-planned launch facility in Vostochny started its construction already in 2011, ahead of schedule, and was expected to be completed by 2015. Vostochny will provide an alternative to Baikonur Cosmodrome, allowing Russia to launch from its own territory[178]. On the other hand, after a long development period the Angara launcher is expected to fly for the first time in 2013. The rocket will incorporate significant improvements compared to its predecessors that will bring it closer to European and U.S. standards, such as a modular design easily adaptable to different mission and payload profiles, as well as integration of the latter on the launch pad. These improvements are expected to allow Russia to extend its lead in both government and commercial launch activities worldwide, by increasing its launching capabilities' performance and affordability.

Finally, as the country's satellite launch programme reaches maturity, more and more funding is diverted to space science and exploration programmes, allowing for the pursue of relative missions that have been placed on hold during the past decade due to the more pressing space infrastructure replenishment needs.

## 3.7 Japan

2010 and 2011 have been very active years for the Japanese space activities, especially in the field of scientific research and innovation. For example, the aforementioned period saw the success of the Ikaros satellite mission, with the deployment on June 11 of its experimental solar sail, made from a polyamide resin thinner than a human hair, but nevertheless measuring more than 20 meters in length. The satellite was launched on May 21, with the Venus-bound Akatsuki probe aboard an H-24 rocket from Japan's Tanegashima Space Centre. The spacecraft is positioned 770km above the Earth. The main idea, expressed by JAXA, was to acquire navigation technology through the solar sail. With this satellite they could start measuring and observing the power generating status of the thin film solar cells, accelerate the satellite by photon pressure and verifying the orbit control through acceleration[179].

At the same time however, efforts to further commercialise the service's sector in Japan also continued. The Japanese government was expected for example to reach a decision until the end of 2010 on whether to partially privatize Japan's Advanced Land Observing Satellite (ALOS) system, which could be of importance to the U.S. and European use of ALOS data. Agreements between JAXA, NASA and ESA were signed in order to permit free distribution of ALOS Data, which will expire in 2020. ESA has integrated ALOS into Europe's third-party mission network and financed development of an ALOS European data Node. An ALOS-2 satellite is being planned for 2013 but Japanese authorities invited industry to submit proposals to operate the satellite as a business. The form of this partnership could permit private sector operator to access the data[180].

On an institutional level, JAXA and the Asian Development Bank signed a letter of intent to improve cooperation. Under this agreement JAXA provides technical assistance to bank-supported projects using satellite data and they promote the use of satellite technology for disaster management, climate change mitigation and adaptation, forest monitoring and water resource management[181].

In a separate development, Japan's Space Activities Commission (SAC) produced a 33 page report which described the technical goals for a follow up Hayabusa-2 mission, recommended for launch before the end of March 2015. The reason was to deploy a miniature rover and collect and return a sample of a C-class asteroid that could give an insight to the formation of the solar system. The report also recommended the revision of JAXA's space programme, the development of the next-generation Epsilon solid-rocket that will replace the M-V. This rocket will be placed into low Earth orbit and the cost was estimated around 3.8B yen per launch. The budget for the Hayabusa-2 was valued around 16.4B yen ($190 million), not

[177] Based on Euroconsult estimates.
[178] "Russia to Break Ground In 2011 for Spaceport". Space News 30 Aug. 2010: 3.
[179] "Japan's Ikaros Spacecraft Unfurls Thin-Film Solar Sail" Space News, 14 June 2010: 3.
[180] "Partial Privatization Eyed for Japan's ALOS System." Space News, 5 July 2010: 15.
[181] "JAXA Agrees to Promote Satellite Use in Asia-Pacific". Space News 2 Aug. 2010: 9.

including the cost of the H-2A rocket that will launch it[182].

Regarding Japan's launching capabilities, a significant development arose when JAXA announced that it would be now able to use its Tanegashima Space Centre all year around, lifting longstanding restrictions that limited its activities there. This was the result of an agreement between the agency and local fishing unions, which were concerned about the spaceport's impact on their local fishing prairies. JAXA policy called for a re-examination of those restrictions, blamed for Japan's inability to be competitive in the global commercial launch market. However, a theoretical ceiling of 17 launches per year would be maintained, according to JAXA[183].

At the same time, Japanese budgetary allocation to space activities rose to 339.7 billion yen budget, requested by Japan's ministries and government agencies, for the financial year started on April 1, 2011. A supplementary request of 77.7 billion yen was in line, in order to fund programmes and initiatives that could help stimulate Japan's economy[184]. IN a separate development, Banri Kaieda was nominated as Japan's state minister in charge of space development by the Prime Minister Naoto Kan, replacing Seiji Maehara, who was appointed as foreign minister[185].

Japan's IGS-Radar 2 satellite stopped sending radar data on August 23, 2010, due to an undisclosed problem in the electrical system. This problem reduced Japan's fleet of reconnaissance satellites to two operational satellites and it will be without radar coverage until the launch of the next satellite in 2011. Japan's reconnaissance satellite programme was designed to provide coverage of North Korea and East Asia[186].

From Tanegashima Space Centre, Japan launched the Quasi-Zenith satellite in September 11, 2010. The satellite, built by Mitsubishi Electric Corp., was designed to re-broadcast enhanced GPS navigation signals to hard-to-reach areas in Japan. It was launched aboard a Mitsubishi Heavy Industries- built H2A rocket[187].

[182] "Japanese Panel to OK Hayabusa-2 Development." Space News 9 Aug. 2010: 8.
[183] "Deal Permits Year-round Launches from Japan". Space News 9 Aug. 2010: 9.
[184] "Japan's Space Budget Request Flat for 2011". Space News 6 Sept. 2011: 3.
[185] "Japanese Cabinet Reshuffle Installs New Space Minister". Space News 20 Sept. 2011: 3.
[186] "Japan's Spy Satellite Fleet Down to Two Operational Spacecraft". Space News 6 Sept. 2011: 9.
[187] "Japan's H2A Rocket Lofts Quasi-Zenith Sat". Space News 20 Sept. 2011: 8.

## 3.8 China

Chinese space activities continued their full expansion in scope and volume in 2010 and 2011. In August, Chinese authorities announced the completion of the first module of its space station, Tiangong-1. It weighs 8, 500 kg and was expected to be launched by the first half of 2011 on a Chinese long March 2F carrier rocket. The Shenzhu 8 vehicle is expected to launch after that. China's space programme includes the space station and, eventually, plans to manned spaceships to dock with Tiagong-1 and crews to the station. Tiagong-2 is scheduled to 2013, to be followed by the Tiangong-3 in between 2014 and 2016.Once fully assembled, the Chinese space station is expected to be operational for 3 years[188].

At the same time, China launched the Yaogan 10, a remote sensing satellite, from the Taiyuan Satellite Launch Centre aboard the Long March 4C rocket. Its main functions are crop monitoring, resource mapping, disaster mitigation and scientific missions. Its predecessor, Yaogan 9 was launched in March 2010 from the Jiquan Satellite Launch Centre[189].

Augusts' hectic launch activity was concluded with the launch of the Tianhui-1 Earth mapping satellite, developed by the China Aerospace Science and Technology Corp., on a Long March 2D rocket from Jiuquan Satellite Launch Centre. The satellite will perform scientific experiments, Earth mapping and carrying on land resource surveys[190].

## 3.9 India

Indian space policy in 2010 and 2011 evolved around the further development of the cooperation with the U.S., of the commercial services sector and of military space capabilities.

As far as the last was concerned, On May 25, India's Defence Ministry released the "Technology Perspective and Capability Roadmap" prepared by The Defence Research and Development Organisation (DRDO), which confirmed the country's plans to build ASAT weapons. Indeed, the roadmap included development of anti-satellite weapons, both for the electronic interference and physical destruction of satellites, as well as steps to protect the nation's own vital in-orbit assets

[188] "1st Piece of Chinese Station Assembled for 2011 Launch". Space News 23 Aug. 2010: 8.
[189] "Chinese Earth Observer Launched by Long March". Space News 23 Aug. 2010: 9.
[190] "Long March Rocket Lofts Chinese mapping Satellite". Space News 30 Aug. 2010: 9.

against such attacks. It also manifested the intention to develop satellite systems for intelligence, surveillance and reconnaissance, commencing from the design and building a microsatellite with an electronic intelligence payload.

Other projects included: the delivery of highly mobile, high data-rate satellite communications; the development of imaging satellites with sub-meter resolution and robust on-board data analysis capabilities; and the creation of precision-guided weapons compatible with India's regional satellite navigation system, as well as of a secure mobile network based on the Indian National Satellite System, in order to eliminate the country's dependence on foreign satellites for tactical and strategic communications. Other possible R&D target areas included nuclear, biological, and chemical defence capabilities, cyber security, hypersonic vehicles, directed energy weapons and smart materials[191].

As far as commercialising space ´services was concerned, on June 30 India's telecommunications regulator confirmed its support for raising the ceiling on foreign ownership of direct-to-home television broadcasters and aligning the foreign-owner-ship rules with those in place for telecommunications carriers. The Telecom Regulatory Authority of India (TRAI) intends to increase the percentage of foreign ownership allowed for satellite-television broadcasters as well as for the mobile-television providers, up to 74%. TRAI affirmed that no differences should be valid between telecommunications and broadcasting. Relaxing the limits for the foreign ownership was seen as a way to obtained substantial capital investment to move from analogue to digital. House-holds subscribing to cable on satellite television grew by 10%, to 95 million, in 2009 and the direct-to-home satellite rose from 11.1 million, in December 2009 to 21.3 million in March 2010[192].

On the other hand, reduced hardware reliability continued to plague India's commercial space sector. For example the Insat-4B telecommunications satellite, launched in March 2007, lost half its broadcast capacity following a failure of one of its solar arrays. Antrix, ISRO's commercial arm that had developed and built the satellite, was working to restore at least some of the capacity on the satellite. ISRO affirmed that had shut down half of the Ku-band and C-band capacity because of a power supply anomaly in one of the satellite's two solar panels. Insat-4B is based on ISRO's I-3K platform, the same platform that caused the failure of Eutelsat's W2M telecommunications satellite in 2009[193].

India's ambitious exploration programme however, would not be deterred by such setbacks. Indeed, in August Seven scientific payloads were selected for the 2013 lunar mission, which will be launch aboard India's Geosynchronous Satellite Launch Vehicle. India has finalized the instruments that the 2,650kg Chandrayaan-2 will carry. These are improved versions of instruments used in the previous mission. The chosen payloads were recommended by a committee of experts, including three completely new and two upgraded versions of payloads flown before, aboard the Chandrayaan-1. The 5 selected payloads were: a Large Area Soft X-ray spectrometer and Solar X-ray Monitor an L- and S-band synthetic aperture radar, an imaging Infrared Spectrometer, a Natural Mass Spectrometer, a Terrain Mapping Camera, a Laser Induced Breakdown Spectroscope and an Alpha Particle Induced X-ray Spectroscope[194].

In a similar development, the second test of the L110 liquid core stage was successfully completed by the Indian Space Research Organisation (ISRO) at the Mahendragiri facility. The L110 was set to a 200 seconds test but it stopped at 150 seconds due to an anomaly. The L110 was designed to lift communications satellites weighing 4,500 to 5,000 Kg. The test flight is scheduled for 2011[195].

Finally, the Indian space programme has improved its focus on bringing benefits of space to the common man and applying advanced technologies to the every day problems of man and society. The world's largest national constellation of Earth remote-sensing spacecraft is used to find the best places to fish, dig wells, plant crops and to provide diagnoses and treatment from skilled specialists to locals. All of those applications are accessible at the Indian Research Organization (ISRO) facilities, at 275 village Resource Centres, scattered across 16 Indian States. The system also helps central government planners forecast nationwide crop yields. ISRO is planning to orbit its own C-band synthetic aperture radar (SAR) on Ri-

[191] "Anti-Satellite Weapons Part Of Indian Technology Vision." Space News, 7 June 2010: 8.
[192] "Indian Telco Regulator OKs Foreign Capital." Space News, 5 July 2010: 3.
[193] "Power Glitch Hobbles India's Insat-4B Sat." Space News, 12 July 2010: 3.
[194] "India Finalises Payloads for Chandrayaan-2 Mission". Space News 6 Sept. 2011: 8.
[195] "India Tests GSLV-3 Liquid Core Stage". Space News 13 Sept. 2011: 16.

sat-1 spacecraft, possibly before the end of the year[196].

## 3.10 Emerging Space Actors

### 3.10.1 Africa

The South African Maritime Safety Authority has demonstrated the ability to improve security during the World Cup tournament through an ongoing trial of space-based ship detection[197].

### 3.10.2 Southeast Asia

On June 2, South Korea suffered a second space launch failure with the vehicle that was Russia's Khrunichev State Research and Production Space Centre. After 136 seconds into the flight, the telemetry data downlink was terminated which demonstrates that an-nominal event occurred. A senior government official said that the vehicle was believed to have exploded. The cause for this incident was investigated by Korean and Russian experts. The Korea Space Launch Vehicle (KSLV)-1 featured a Korean-developed second stage and payload fairing.

Korea's last launch was postponed for one day due to a fire suppression system malfunction at the Naro Space Centre launch site[198].

Measat, company that owns 4 in-orbit satellites and started expanding into southern and central Asia, announced in 2010 that a Malaysian billionaire wanted to purchase a portion of their satellite fleet, which valued around $500 million. Measat Global Network Systems Sdn. Bhd (MGNS) offered, at the time, 4.20 Malaysian ringgits per share, for 150 million shares. This price represented a 10% premium over the price trade no the Kuala Lumpur stock market. The company reported, in 2009, total revenue of 251 million ringgits, with EBITDA reaching 66% of revenue. Later 2010, Measat agreed with the government of Azerbaijan the purchase of a satellite to be launched into the orbital slot of 46 degrees east. This deal was not faced as an alternative to the MGNS offer[199].

Astrium Satellites signed a contract with the Vietnam Academy of Science and Technology, valued at €55.2 million, to build a medium-resolution optical Earth observation satellite. The VNREDSat-1 – Vietnam Natural Resources, Environment and Disaster Monitoring Satellite – would weigh about 150Kg at launch and it is expected to be launched in 2013. Similar programmes were established between Astrium and Thailand, South Korea, Algeria, Chile and Kazakhstan[200].

### 3.10.3 Middle East

On June 4, the Arabsat Badr-5 telecommunications satellite was placed into geostationary transfer orbit by an International Launch Services (ILS) Proton, co-located with the Badr-4 and 6. The Arabsat Badr-5 was built in a joint venture between Astrium Satellites and Thales Alenia Space of Europe. This satellite carries 56 Ku-and four Ka-band transponders and it was designed to provide 14 kilowatts of power to its payload. This launch was the fourth of a planned 7 commercial missions that ILS was planning for 2010.Khrunichev, ILS's owner and prime contractor for the Proton rocket, was producing at a rate to assure one launch per month[201].

Nilesat chief executive Salah Hamza said, during the World Satellite Business Week conference, that at least two different sources had intentionally jammed Egypt's Nilesat satellite operator, to block entry to Iran of new broadcasts from the BBC Persian television service and also the 2010 FIFA World Cup. The jamming was thought to be caused by the Iranian government. The International Telecommunications Union (ITU), a Geneva-based United Nations affiliate that regulates satellite slots and broadcasts frequencies was alerted in order to stop Iran. The claim had no results and no evidence was found against Iran[202].

EADS Astrium was selected to supply a new sitcom terminal for the United Arab Emirates' Yahsat sitcom network. Astrium will also provide operations and maintenance services to the UAE armed forces, including training and logistics support, for five-years. Astrium, in partnership with Thales Alenia Space, is, si-

[196] Morring, Frank Jr and Mathews, Neelam. "Indian Space Delivering On Promises To Villages." Aviation Week & Space Technology 14 June 2010: 66.
[197] Morris, Jefferson. "Satellite Tracking Of Ships Demonstrated." Aviation Week & Space Technology 23 August 2010: 22.
[198] "South Korean Rocket Fails For the Second Time" Space News, 14 June 2010: 3.
[199] "Measat Shareholder Bids For Remainder of Company". Space News 2 Aug. 2010: 3.
[200] "Astrium to Build Imaging Satellite for Vietnam". Space News 9 Aug. 2010: 9.
[201] "ILS Proton Rocket Launches Arabsat's Badr-5 satellite." Space News, 7 June 2010: 3.
[202] "TV Broadcasts Bound for Iran Intentionally Jammed". Space News 13 Sept. 2011: 14.

multaneously, building two satellites and the ground system[203].

### 3.10.4 Latin America

The AEB – Brazilian space agency – President has criticized the effort to create profit-making business out of the collection of satellite Earth observation data, defending, therefore, free access to data. These remarks were made during a roundtable session with the Canadian and German Space agencies, which had opposite behaviours, selling the data collected. The head of DLR said that the data collected from the TerraSAR-X and TanDem-X satellite is free of charge if the final purpose is science and research. On the other hand, the director-general for space science at the Canadian space agency was likely to modify its relationship with the private sector as the government was proceeding with the next-generation Radarsat Constellation mission, however the long-term data storage and retrievability was not available in the Radarsat system. This topic was also approached by ESA's director general; who underlined the importance of data collected Earth observation satellites storage[204]

[203] Morring, Frank Jr. "UAE, Canada Select Astrium Satcom Terminal." Aviation Week & Space Technology 28 Feb 2011: 18.

[204] "Brazil's Space Chief Slams Earth Science Privatization". Space News 26 July 2010: 12.

# 4. European Institutional Market

In this chapter, institutional space spending in Europe is described along distinct categories that are explained accordingly. The amounts are put into perspective and compared with each other. This enables the understanding of important ratios and proportions within European space activities. It also sets a basis for comparison with space actors outside Europe.

## 4.1 European Institutional Features

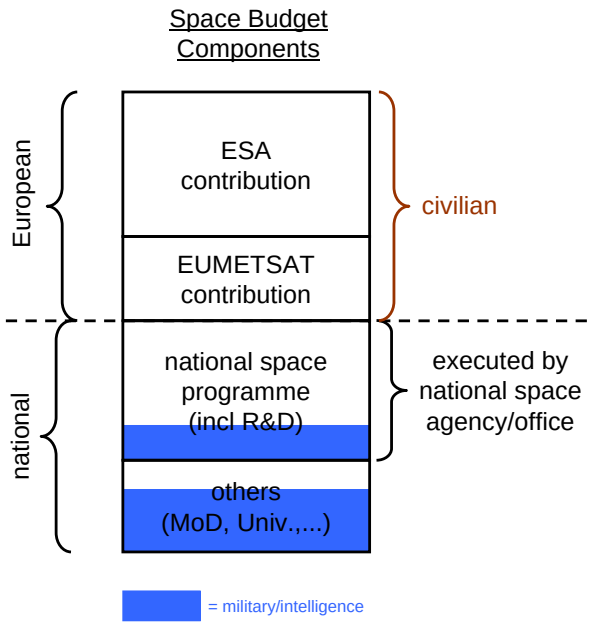


Figure 4.1: General structure of space budgets

European space programmes develop simultaneously on three distinct levels: national, intergovernmental (e.g. ESA, EUMETSAT) and supranational (European Union). This structure results in overlapping complementary budgetary lines, which are evident in the diagram shown in Figure 4.1.

## 4.2 Civilian Space Expenditure

As a result of the abovementioned structure, national space budgets in Europe usually have both a European and a national component. The first consists of contributions to ESA and EUMETSAT and is considered as civilian for the purposes of this report, as both organisations are broadly labelled as civilian in spite of the fact that their products and services are also of military usefulness. Direct Member States' contributions to the European Union do not officially have a space related designation and shall not be taken into account. Nevertheless, in recent years EU funds have been increasingly used to finance space activities.

National space budgets usually have three tiers: civilian, military and space related academic research. In the case of countries that have instituted national space agencies, these generally centrally fund the first and the third tiers, whereas the second remains under defence ministries' management. In countries that prefer less centralised approaches, as for example was the case in the United Kingdom until recently, budgetary lines are dispersed throughout government agencies, which makes them more difficult to account for.

Apart from this vertical delineation, space related budgets are also dispersed horizontally among national, bilateral and multilateral space cooperation agreements. For example, some European countries that are engaged in multinational cooperation through their participation in the European Space Agency (ESA) also have bilateral agreements on military space activities between them. In this way, the same or similar military space projects are simultaneously funded within European institutions (notably the EU Commission and the European Defence Agency) and outside them. These are represented in the blue area of Figure 4.1. The same applies to academic research and development projects that are channelled both through ESA and bilateral scientific cooperation agreements.

Not all European countries invest in military or intelligence space activities, and the lion's share of European institutional spending is dedicated to civilian activities. The total sum of European institutional spending on space in 2010 was around €7.26 billion which is around 700 millions more than in 2009. That will be detailed in the following sections. The sum is split into 89,4% for the civilian sector

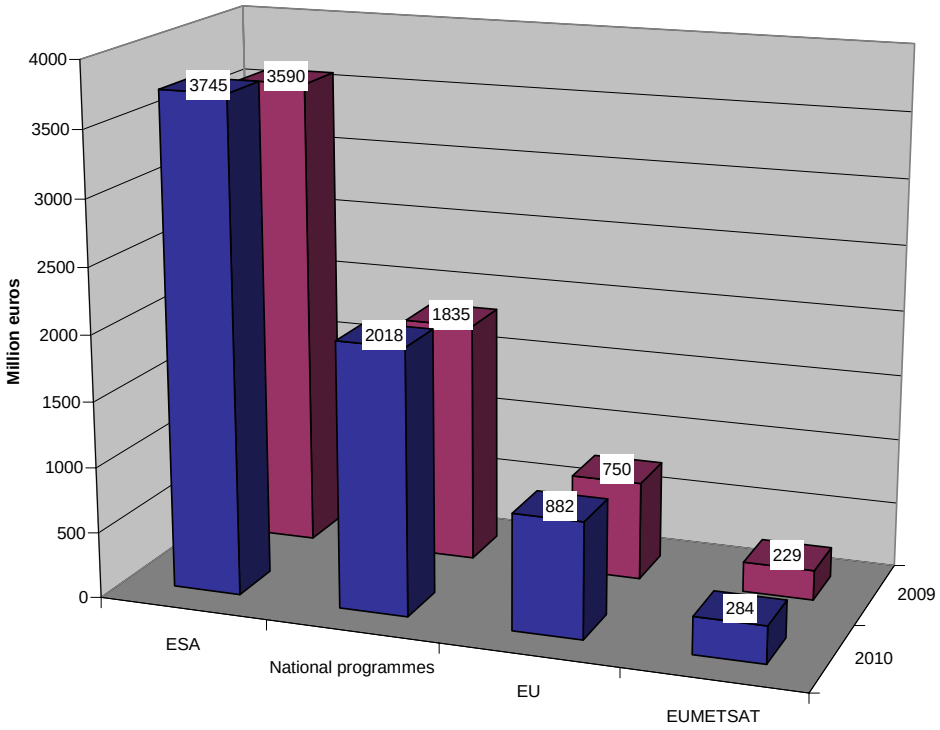


Figure 4.2: Estimated European civil public expenditures in 2010

and 10,6% for the military one, and indicates a situation relatively similar to 2009. Not only in relative numbers – the U.S. spends an estimated share of 58% on security-related space activities – but also in absolute numbers, these militarily used funds are significantly lower than those spent in the United States.

## 4.3 European Space Agency (ESA)

The European Space Agency's budget rose again in 2011 to €3.993 billion from €3.74 billion in the previous year. The year's budget depicted the change in budget allocations that are starting to occur because of ESA's involvement in the Galileo and GMES programmes. Indeed, the Earth observation and navigation budget lines were the most important, accounting for approximately 21,1% of the total each and surpassing launcher related expenditures (15,3%) and navigation 16,7%. Other areas of activity included science (11.6%), Human spaceflight (10.3%) and telecommunications[205].

In spite of the budget's increase, the difficult public finances conditions prevailing in Europe were the cause of some friction, especially among larger member countries, on the precise distribution of the funds. For example, the planned extension of the International Space Station (ISS) was such a case. The utilization of the ISS was budgeted through 2015 at €290 million a year, but how much each country will be willing to pay was not clear, apart form the formal commitments made by Germany (38%), Italy (27%) and France (19%). The discussion around the ISS life's extension also led to another debate, whether the European Space Agency should go forward with an Advanced Reentry Vehicle (ARV)[206].

The contemplated improvements for the Automated Transfer Vehicle (ATV) and the International Space Station (ISS) will increase drastically its cargo volume, while it offers a more realistic cost comparison with a proposed Advanced Reentry Vehicle (ARV) derivate. Thales Alenia Space had been working on modifications to the ATV's internal structure, for several reasons. Among them, a possible reduction in the re-boost capability of the ATV to enable NASA commercial Orbit

[205] "ESA Budget by Programme (2011). ESA 21 mar. 2011 http://esamultimedia.esa.int/multimedia/DG/ESA_2010_Budget.pdf>.

[206] Morring, Frank Jr. and Taverna, Michael A. "Fiscal Realities Complicate Advanced Reentry Vehicle Decision." Aviation Week & Space Technology 4 Oct 2010: 37.

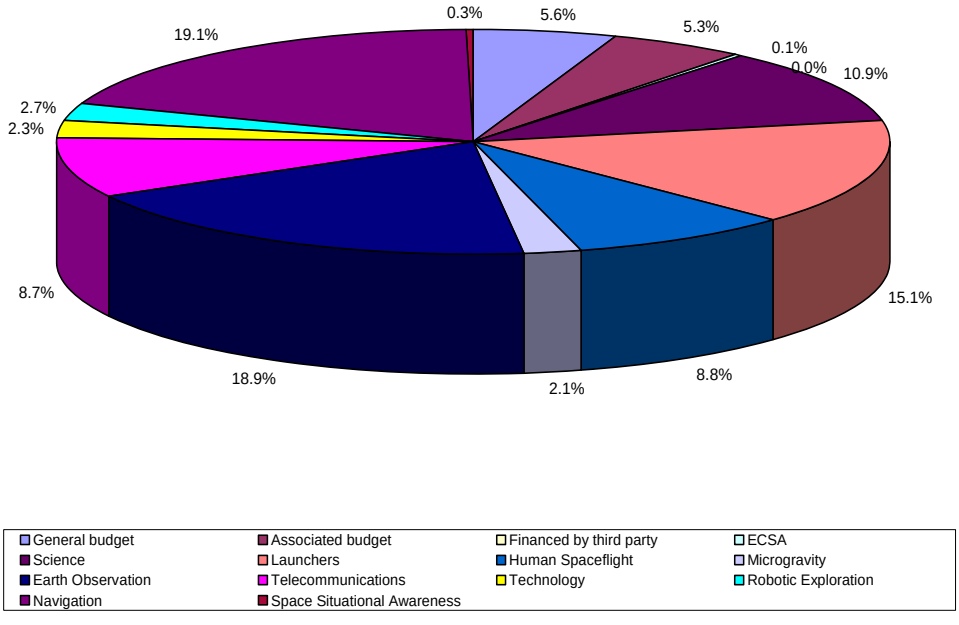


Figure 4.3: ESA Programmatic Budget Allocations for 2010 (Source: ESA)

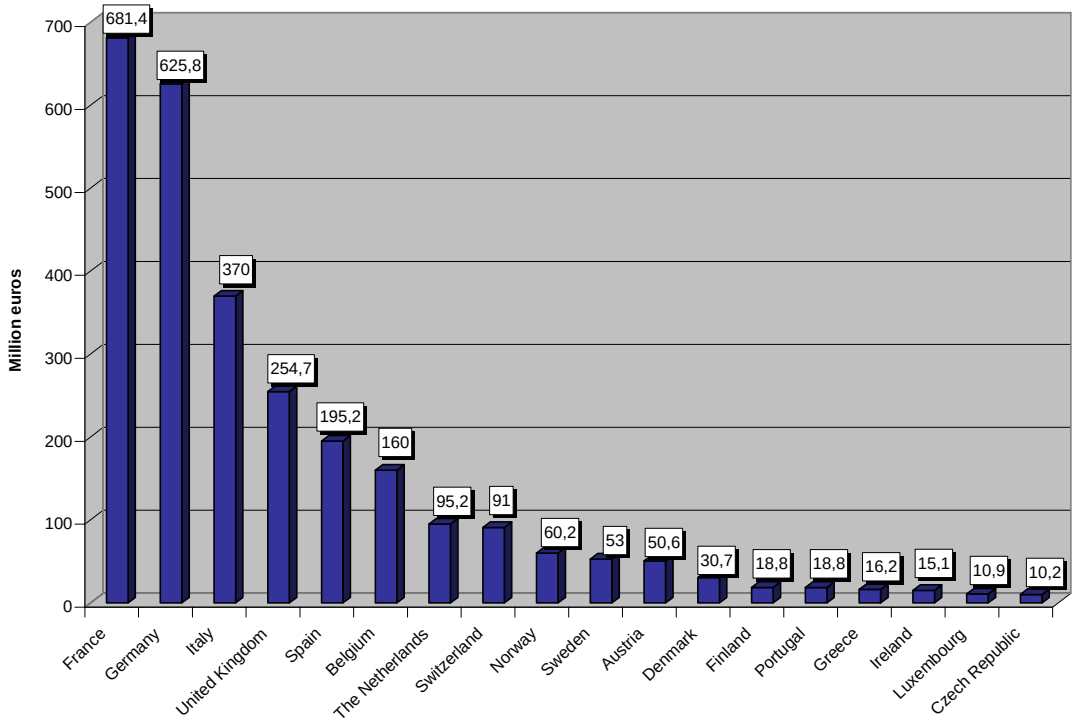


Figure 4.4: Member States' Contributions to ESA Budget for 2010 (Source: ESA)

Transportation Services spacecraft to dock at a lower altitude and a planned improvement in the ISS's life support system that would improve water recycling, reducing ATV water capacity requirements. These modifications are to be implemented on the ATV-3, 4 and 5[207].

The European Space Agency has been working with the International Telecommunica-

[207] Morring, Frank Jr. "Europe Eyeing ATV Upgrade." Aviation Week & Space Technology 11 Oct 2010: 22.

tions Union (ITU) and national governments in order to reduce interference that threatens to reduce the usefulness of data from its Soil Moisture and Ocean Salinity (SMOS) mission. The SMOS, launched in 2009, was equipped with an L-band interferometric radiometer that permits the measurement of microwave radiation from soil moisture and ocean salinity, which data assumes a paramount importance for water resource management and agriculture[208].

ESA's backlog for 2011 puts on top the increased support for European launchers as well as the ISS lifetime extension approval, despite a continued spending freeze. This year, ESA will start the development of the European Data Relay System (EDRS) and the liftoff of several important missions should take place, especially the second Automated Transfer Vehicle. Although, the freeze was compensated, partially, by the entry of Romania and Israel and some new funding was accomplished[209].

On June 8, despite a growing debt crisis in the ESA's 18 member states, Jean-Jacques Dordain expected to maintain all the programs previously agreed. Notwithstanding ESA's governments approval in 2008 for a €10 billion spending for the coming years, many doubts are now emerging, such as the ability of European Nations to service their debt without major spending cuts. Spain, Italy and Britain are facing severe government budget cuts. In order to keep his contributions, Spain has authorized ESA to take out loans on his behalf. Italy had the U.S. – European Mars exploration mission, in which was a major contributor and was asked to do more investment to maintain the operations for the ISS. None of them has given signs to not comply with the programs[210].

## 4.4 EUMETSAT

Eumetsat the European weather satellite operator, has given approval for the Meteosat Third Generation System (MTG). The MTG will be funded by 14 nations that approved and signed the resolution in principle to begin development. However, Germany and France are the principal bankrollers for the €3.3 billion six-satellites system. The Meteosat Third Generation System is intended to succeed the Meteosat geostationary, already in orbit, in 2016[211].

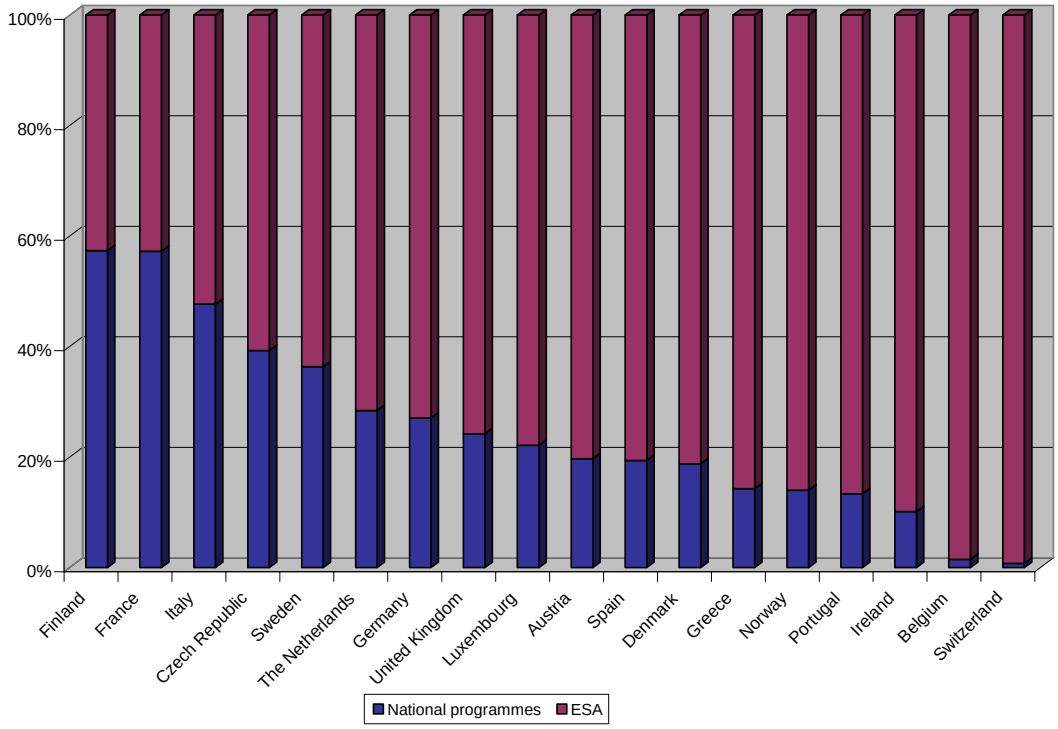


Figure 4.5: Estimated Shares of European National Institutional Investment in Civilian Space of ESA Members in 2010

[208] Morring, Frank Jr. "ESA Grappling With SMOS Interference." Aviation Week & Space Technology 18 Oct 2010: 22.
[209] Taverna, Michael A. "Spending Freeze Will Not Impact Major ESA Decisions." Aviation Week & Space Technology 24 Jan 2011: 40.
[210] De Selding, Peter B. "Dordain: Even With Gov't Cuts, ESA Programs Should Maintain Funding " Space News, 14 June 2010: 5.
[211] Taverna, Michael A. "German OK Paves Way For Weather Sat Program Launch." Aviation Week & Space Technology 28 June 2010: 32.

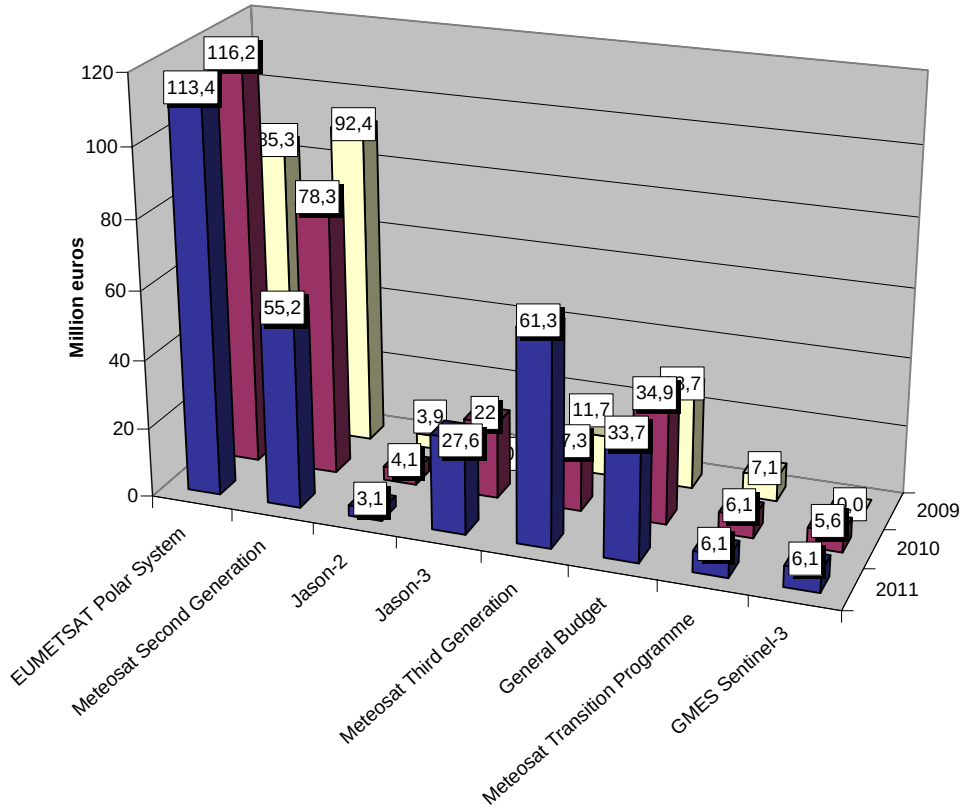


Figure 4.6: Major Programmatic Allocations of EUMETSAT 2009-2011

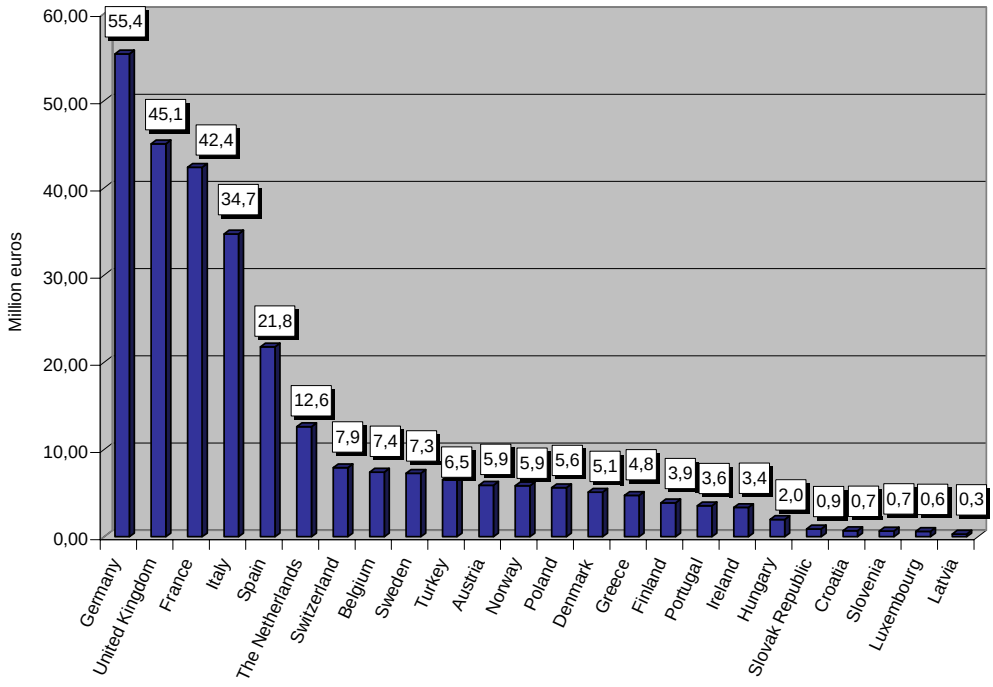


Figure 4.7: Member states' contributions to Eumetsat in 2010 (Source: Eumetsat)

The vast majority of EUMETSAT's budget comes from contributing member and cooperating states. Members' contributions are calculated on the basis of their Gross National Income (GNI), rather than GDP. In 2010 Germany was the largest contributor with 19.47%, followed by the UK with 15.84%, France with 14.9%, and Italy with 12.21%. We can also notice the substantial participation of Spain 7,66% and Netherlands 4,44%. These four countries accounted for 64.8% of the total (Figure 4.5). Poland has finally finalized its accession to EUMETSAT in 2009 with a participation of 1,98% after nine years of cooperation.

The general budget of EUMETSAT has progressively increased with the development of news programs which necessitate a substantial augmentation of participation like Jason-3[212] or even GMES Sentinel 3.[213]The main tendencies noticeable concern first of all new programmes such as Jason 3 and GMES sentinel 3 are due to take gradually more importance in the METEOSAT's budget during the next years. The EUMETSAT Polar system takes more and more importance in the budget increasing from €30,9 million from 2009 to 2010. The evolution is converse for the project Meteosat second generation which necessitate now less investment with a fall of €13,7 million and will let progressively place to the third generation which augments from €11,74 million in 2009 to 17,3 in 2010. 2011 should show rather logically a massive increase in investment in Meteosat third generation and GMES Sentinel 3 while the other programmes are going to stay stable or fall becoming fully operation or obsolete.

## 4.5 National Agencies

### 4.5.1 France

France and Germany have been sought for an agreement on a new price support mechanism for Arianespace, which can vary from the annual target of €120 million. Arianespace shareholders approved a €135 million capital injection to cover a €71 million loss declared in 2009 and a €64 million loss expected to be posted for 2010. At this point, Germany gained strong support for funding the ISS life-extension, but not the €380 million support it had sought. Furthermore, Germany raised domestic space spending to €242 million, up from €222 million last year. ESA contributions climbed to €714 million, from €654 million in 2010. France raised domestic space spending to €761 million, up from €749 million in 2010 and ESA contribution raised to €755 million, from €685 million[214].

The French space agency, CNES, was expecting to award contracts valued more than $900 million to develop new next-generation rockets, two Earth-observation satellites and satellite-delivered broadband. The funds were allocated to three different project categories. One third of the money was allocated to finance the demonstrators and early designs work on a next-generation launch vehicle, to replace today's heavy-lift Ariane5. A second category funded two environmental satellites. The first satellite to be built in partnership with Germany, dubbed Merlin, is a methane-measuring spacecraft. The second satellite – Surface Water Ocean Topography – SWOT – is a joint French-U.S. mission, in which CNES is going to invest €170 million. The third category was to extend broadband access to regions of France[215].

### 4.5.2 Germany

The position reinforcement in space radar and boost budding satellite communications and robotics know-how, were the new goals for German space leaders, as well as forging new capabilities in optical imaging, space exploration and environmental monitoring. German aerospace Centre DLR, as part of a new strategic plan, is developing an optical imaging satellite system to complement DLR's know-how in radar imaging. Three radar imaging systems are in place or in development: 1-meter resolution TerraSAR-X commercial satellite, Tandem-X and SARlupe. The planned optical imaging system – Hiros – would be targeted at dual-use civil and military requirements. The new strategic plan also involves the development of the know-how in broadband technology. Heinrich Hertz will be the vehicle for this and the launch is slated for 2014-2015.

A key vehicle to advance these objectives will be the European Data Relay System (EDRS), which permits near-real-time dissemination of Earth-science and other data from Earth observation satellites. The investment on the DLR's Institute of Robotics and Mechatronics for Germany's growing capabilities in space robotics is estimated on $145 million and it

[212] "Jason-3." CNES 21 Mar. 2011 < http://smsc.cnes.fr/JASON3/Fr/>
[213] "Eumetsat et l'ESA signent l'Accord-cadre GMES." Flashespace.com 20 Oct. 2009 <http://sentinelle3.com/sentinelle3/html/sent09.htm>
[214] Taverna, Michael A. "Common Position On ESA Programs Virtually Ensures Resolution." Aviation Week & Space Technology 7 Feb 2011: 35.
[215] "French Bond Issue To Fund Rocket, Satellite Projects." Space News, 7 June 2010: 3.

will lead to the ultimate goal: render the country as global leader in laser communications and a credible rival to U.S. small telecom satellite leader Orbital Sciences Corp[216].

### 4.5.3 Italy

The European Space Agency is preparing an initial demonstration of advanced concepts. The cargo-return capsule based on the Automated Transfer Vehicle (ATV), under study, can give a development go-ahead at the agency's ministerial summit in 2011- 2012. The new hypersonic re-entry demonstrators will feature more sophisticated configurations and non-ablative thermal protection. The Expert Return test bed, the first demonstrator to be launched in 2011, will improve computer models, particularly, flap efficiency/heating, high-temperature/gas chemistry effects and gas-surface interaction. Thales Alenia Space is the prime contractor for the €20-million project, which is being led by the Italian Space Agency ASI. The second demonstrator, entitled Intermediate Experimental Vehicle (IXV), will perform in-flight verifications of structures, guidance, materials and control systems. The IXV is to be orbited by Europe's Vega light launcher in 2013. ASI is again the main backer, with a 35% share, and Thales Alenia Space the prime, in the €120 million mission[217].

## 4.6 European Union (EU)

In 2010 and 2011 the European Union increased its engagement in space activities by tackling a number of outstanding issues regarding the development and deployment of the Galileo/EGNOS and GMES systems. Furthermore, the European Commission laid down the foundations for developing a long term European strategy in space, exploiting for the first time the extended competencies in this field that the Lisbon Treaty conferred to it.

As far as Galileo/EGNOS was concerned, the programme regained momentum after the selection of the contracting company OHB for the manufacturing of the first 14 satellites. The constellation's deployment was expected to begin in August 2011 with the orbiting of the first three satellites onboard a Soyuz rocket launched for the first time from the European space port at Kourou. The progress made and the challenges that lay ahead for the programme were described in detail in a mid-term review report from the European Commission to the European Parliament published in January 2011. As far as EGNOS was concerned, several milestones to the programme's operational use were reached, such as the certification of the ESSP under the single European sky regulations, as well as the activation of the Safety of Life service. Both developments were expected to enable the system to reach its full benefit potential to European transport services, despite the fact that its geographical coverage still does not include the entire EU region.[218]

With regard to the Galileo programme, the momentum that it had acquired with the signing of the manufacturing contracts for the first batch of satellites was picked up by negotiations regarding governance issues, as well as boosting the system's capacity to generate both upstream benefits and downstream services to the industry and the wider public respectively. However, Galileo still has a considerable number of hurdles to overcome in the near and medium term, particularly with respect to its security policy, future budgetary allocations, and of course the need to achieve initial operational capability without any further delays. On the short term, the most pressing challenge would be to complete the development of the system's ground segment in time for starting operations in 2014-2015. This step would entail arriving at definite solutions to the problem of the system's security parameters through an agreement among all the involved parties, especially in as much as PRS is concerned[219]. It would also necessitate the elimination prior to its initial operations of any future governance risks for the programme, and particularly of the complex legal liability issues that would arise from its use[220].

In the medium term, the most challenging task would be to arrive at a comprehensive arrangement that would allow the European Commission to plan and adequately fund long-term space programmes, the operational life of which may very well span over

[216] Taverna, Michael A. "New Plan Expected To Be Approved By Year-End." Aviation Week & Space Technology 14 June 2010: 38.
[217] Taverna, Michael A. "Italy Plays Lead Role In New Launcher Initiatives." Aviation Week & Space Technology 5 Jul 2010: 40.
[218] European Commission. Report from the Commission to the European Parliament and the Council: Mid-Term Review of the European Satellite Radio navigations Programmes. COM (2011) 5 Final of 18 Jan. 2011. Brussels: European Union.
[219] European Commission. Proposal for a Decision of the European Parliament and of the Council on the Detailed Rules for Access to the Public Regulated Service Offered by the Global Navigation Satellite System Established Under the Galileo Programme. COM (2010) 550 Final of 8 Oct. 2010. Brussels: European Union.
[220] European Commission. Report from the Commission to the European Parliament and the Council: Mid-Term Review…

several decades. Such a step would require dedicated EU budget lines to the operation, further fleet replenishment and applications' development of the system. It would particularly and pressingly entail securing the programme's funding beyond 2014, which would be necessary in order to achieve global coverage and capitalise on the investments already made. To this effect, the EC itself estimated the required funds to the level of €1.9 Billion for completing Galileo's full deployment, as well as an additional €800 Million for its operating costs on an average annual basis. On the long term, significant industrial policy issues would have to be resolved by improving coordination on the system's further development and manufacturing that would allow for its full integration on a European scale, particularly in the field of security[221].

However, the most crucial factor for the long term success of the entire programme would be its timely that would decrease the market risk of its commercial exploitation. Russia's competing Glonass GNSS that will reach full deployment this year, the new generation of Glonass satellites expected to be launched in increasing numbers over the next five years, and the increased launching pace of China's own GNSS satellites would significantly decrease Galileo's competitive advantage. Although the unquestionable need for a European GNSS would continue to drive the programme's further development, increased competition could erode Europe's negotiating position in the ongoing discussions on the issue of interoperability and frequency allocation among these systems, as well as Galileo's commercial service chances.

The increased realisation in Europe that space programmes constitute a wider strategic issue rather than an immediate policy matter, as well as the new competences vested to the EU in this field by the Lisbon Treaty, have accelerated the pace of deliberations on the formulation of a coherent space strategy among all parties involved and principally the EU Council and member states, the European Commission and ESA. Significantly, the European Commission laid out for the first time its own views on the outlines of such a strategy in a communication published in April 2011. In its first attempt, the European Commission laid out its strategic view on space activities as an instrument to achieve social, economic and strategic benefits for Europe. This approach described the prerequisites and objectives of an EU space policy focused on generating results both upstream in improving technological know how and industrial competitiveness, but also downstream by propagating the use of space applications to achieve societal benefits. In additions to this, however, the European Commission also highlighted the importance of space applications for European security and defence objectives, adding a clear security dimension to the EU space policy, examined in its own merit. This development, in conjunction with the emphasis attributed to the potential of space programmes for promoting international cooperation and achieving EU external policy objectives, indicates the European Commission's recognition of the space assets' strategic value as instruments of foreign and defence policy objectives. Consequently, it might be argued that it attempted to "normalise" the development of a European space programme from an international relations' theory point of view, by basing it on the traditional concepts of security and foreign policy, as well as economic and social utility.[222]

[221] Ibid.

[222] European Commission. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Towards a Space Strategy for the European Union that Benefits its Citizens. COM (2011) 152 Final of 2 April 2011. Brussels: European Union.

# 5. Space Industry Evolutions

## 5.1 Europe

A financial guarantee from Coface, a French export credit agency, syndicated through French and international banks had permitted Iridium to continue with the biggest commercial space deal ever, a new low-Earth-orbit satellite system. Coface covered 95% of a $1.8-billion facility that had ensured most of the financing for the project. The new constellation, dubbed Iridium Next, replaced Iridium's existing 66-satellite LEO constellation. The costs to build and launch were estimated around $2.9 billion. Paris-based Thales Alenia was selected to supply the $2.1 billion space segment, which includes 66 operational satellites, six in-orbit spares and nine ground spares. In this project two U.S. satellite makers had a role, Ball Aerospace and Boeing's Intelligence and Security Systems Mission Operations group. The first one handled the satellite assembly, integration and testing and the second one delivered the ground system hardware. The first new satellites will be orbit by the first quarter of 2015, and the process will be concluded by 2017[223].

The French space agency, CNES, was expecting to award contracts valued more than $900 million to develop new next-generation rockets, two Earth-observation satellites and satellite-delivered broadband. The funds were allocated to three different project categories. One third of the money was allocated to finance the demonstrators and early designs work on a next-generation launch vehicle, to replace today's heavy-lift Ariane5. A second category funded two environmental satellites. The first satellite to be built in partnership with Germany, dubbed Merlin, is a methane-measuring spacecraft. The second satellite – Surface Water Ocean Topography – SWOT – is a joint French-U.S. mission, in which CNES is going to invest €170 million. The third category was to extend broadband access to regions of France[224].

On June 2010, Iridium Communications awarded Thales Alenia Space of France with a $2.1 billion contract, in order to build Iridium's next- generation constellation of low-orbiting voice and data communications satellite. On June, the financial guarantee by Coface, one of the most active export credit agencies, was just a promise and to immediately start working on the project, Iridium and Thales Alenia signed a $53 million authorization. The Coface's loan covers 95% of a $1,8 billion credit. This new constellation will feature intersatellite links, a feature that will permit Iridium to be less dependent on ground stations to relay signals[225].

In the next five years, SES will be reconfiguring its orbital assets so that by 2015 it will have 30% more capacity spread over a fleet that nonetheless will decline to 38 satellites from the 43 in service today. SES will spend between €430 million and €495 million per year to replace capacity. The plan for 2011 is to spend €790 million on satellites and other projects. This investment should drop to below €390 million by 2014 and stay there for some years. SES has 16 satellites under construction, including its share on the Yahsat satellite for the United Arab Emirates. Of these 16 satellites, 4 are for the new orbital slots and new markets. The remaining 12 are satellites large enough to replace existing spacecraft while still offering expansion capacity[226].

SES sold its ND Satcom subsidiary. With this, SES was expecting to be able to show investors an immediate improvement in gross-profit margins as a result. A broader strategy was to put limits on the satellite fleet operations vertical expansion and turning into services markets to refocus on selling satellite bandwidth. In 2009, ND Satcom accounted for 25% of what SES's calls its "services" revenue, which totalled $443 million[227].

On June 19, Europe's Arianespace Launch Consortium and Russia's Roscosmos signed a

[223] Taverna, Michael A. "French Government Credit Guarantee Assures Iridium Next Go-Ahead." Aviation Week & Space Technology 7 June 2010: 34.
[224] "French Bond Issue To Fund Rocket, Satellite Projects." Space News, 7 June 2010: 3.
[225] De Selding, Peter B. "Iridium Selects Thales Alenia To Build Iridium Next Constellation." Space News, 7 June 2010: 5.
[226] De Selding, Peter B. "SES Expansion Program to Raise Capacity 30 Percent." Space News, 7 June 2010: 6.
[227] De Selding, Peter B. "SES Eyes Improved Gross-Profit Margins Following Sale of ND Satcom Unit." Space News, 7 June 2010: 6.

contract for 10 additional Soyuz Rockets, to be delivered in 2014 and 1015. At this time, Russian and European authorities were reviewing possible dates for the inaugural launch of Russia's Soyuz from Europe's Guiana Space Centre in French Guiana and set a mid-December date for that, but depending in some factors that date could change and push the launch to 2011, Arianespace Chief Executive said. Arianespace continues to accumulate orders for Soyuz missions. Europe's Eumetsat organization ordered 19 launches, including the inaugural flight, which would carry the Hylas-1 and Ka-band consumer broadband spacecraft for Avanti of London[228].

Satellite operators are aware that a difficult period was on the way. But the day of reckoning has been delay successively, in part because satellite programme schedule slip, pushing the spending for the next years and also due to decisions by Intelsat and SES, to order several satellites at a time. The satellite market was buoyed in 2010 by the Intelsat's agreement to purchase for satellites from Boeing and SES's contract. It is expected a severe result from the inevitable market drop. Luxembourg-based SES planned to spend around $1 billion in 2010, for the replacement of midsize satellites with larger ones and expanded its in-orbit fleet in 30% by 2014. Intelsat's capital spending was estimated between $825 and $900 million in 2010. SES will decline its capital spending in the coming years. By 2014, it predicts to spend 50% less per year, as it awaits its next satellite replacement cycle. Intelsat also expects to decrease spending and it has been preparing an initial stock offering to enable its private-equity owners to receive return from their investment. As a demand driver in the coming years, Intelsat plans to focus on the government market[229].

Since July 7, Astrium Space Transportation, leading a consortium of companies, celebrated a €10 million contract for 15 month with ESA to produce designs and cost estimates for a next-generation rocket. This project is financed in €1.5 million by Les Mureaux, France-based Astrium Space Transportation and the remaining by the 18-nation ESA. ESA governments scheduled a decision on the development of a successor to the Ariane 5 rocket to 2012; this will permit European governments to launch civil and military Earth observation satellites on a European vehicle. In the meantime, the design work will be focus on a vehicle that would add or subtract straped boosters to lift satellites into geostationary transfer orbit. This new rocket will be ready around 2025 and the plan is to launch one at each time. The successor should replace both Ariane 5 and the medium-lift Soyuz rocket[230].

Hispasat has contracted with Space Systems/Loral to build Amazonas 3 telecommunications satellite, to replace Amazonas 1. It is schedule to be launched in late 2012, into Hispasat`s 61 degrees west orbital slot for broadcasts in the Americas and Europe and it was designed to deliver 14 Kw of power to its payload. Amazonas 1, launched in 2004 and built by Astrium Satellites of Europe, was projected for a 15-year service life, but it was reduced because of a defect in its on-board fuel system. Madrid-based Hispasat contracted with Palo Alto, Calif. – based Space Systems/Loral for the Hispasat 1E satellite, schedule to 2011. This project is seen as a way to maximize the value of the satellite investment and an open way to new orders from the same customer[231].

Norway has an annual space budget around €100 million per year, its space sector generates revenue of about €650 million but it is not the biggest ESA contributor. Although Norway had a ship-tracking satellite scheduled for July 2010 and was considering a second satellite. Norway's Kongsberg Group has developed an Automatic Identification system – AIS – terminal for space-based maritime traffic monitoring in Norwegian waters, unlike commercial AIS systems that were developed in Canada and USA. Norway's AISSat-1 spacecraft cost €4.4 million and was one of the passengers on the Indian Polar satellite launch vehicle rocket. A possible broadening of the AIS effort was discussed by Norway and ESA, integrated in a European programme[232].

Italy's e-Geos Earth observation satellite services, company that its 20% owned by the Italian Space Agency and 80% by Telespazio of Rome, reported a €90 million revenue in 2009, 13% return on sale and a grown to 300 employees. The company principal product is radar imagery from Italy's Cosmo-SkyMed satellite constellation, placed into orbit in 2007. In addition, e-Geos has struck image-distribution agreements giving it rights to distribute imagery from satellites operated

[228] "Arianespace Places Order for 10 More Soyuz Rockets." Space News, 28 June 2010: 3.
[229] De Selding, Peter B. "Fleet Recapitalization Cycle Likely to End in 2-3Years." Space News, 5 July 2010: 12.
[230] "Astrium to Lead Studies of Successor to Ariane 5". Space News 12 July 2010: 8.
[231] "Hispasat Orders Another Satellite From Loral". Space News 12 July 2010: 9.
[232] "Norway Considers Second Ship-tracking Satellite". Space News 12 July 2010: 12.

by GeoEye and DigitalGlobe, MDA Corp. of Canada and ImageSat of Israel[233].

Hispasat reported a 50.3% increase in net profit for 2009. In 2009 the company reported revenue of €150.8 million, increasing of 9.7% over 2008. EBITDA was 77.4% of revenue, down from 80.1 % a year earlier and net profit was €70.6 million. In 2009 Hispasat distributed a record of €12.2 million in dividends. Hispasat President have seen in this growth proves that the expansion into Americas with the Amazonas satellite was justified. Amazonas 2 was launched in October 2009 and the Amazonas 3 will be launched in 2013. The 30 degrees west orbital position, that serves Europe and North America, accounted 2/3 of the revenue in 2009; the remaining is due to the 61 degrees west position, which serves Americas. Hispasat AG-1 satellite is under construction by OHB Technology of Germany, and scheduled for 2012[234].

Telenor Satellite Broadcasting of Norway reported a 6.1% increase in revenue for the 3 months ending June 30, 2010. Oslo-based Telenor was expecting UPC Direct, one of its major customers, to complete the re-pointing of the rooftop antennas of UPC's more than 300.000 subscribers. Telenor reported revenue of $43.7 million for the same period and EBITDA was 69% of that revenue. To offset the subscribers decline suffered, Telenor moved its aging Thor3 satellite to a new slot; which can work for another 6 to 10 years[235].

OHB Technology of Germany has purchased Thales Alenia Space's Antwerp, Belgium-based satellite ground hardware manufacturing company. Thales Alenia reported, in 2009, revenue of €10 million. The transaction price was not released, but it was inferior to the revenue, however this sale can not be viewed as part of a retrenchment by Thales Alenia Space. The company has no intention to sale its facilities in Belgium – Thales Alenia ETCA. This acquisition was strategic. Belgium is a player of future ESA programmes with increasing importance, because the Belgium government is a strong supporter of space activities. OHB added staff to build 14 Galileo navigation satellites for the European Union[236].

Europe's Astrium space hardware and services provider reported higher pre-tax profit on revenue, as well as the Astrium services division, which has multiyear contracts with NATO, British and German defence forces. Astrium reported revenue of €2.11 billion for the first semester of 2010, dropping 4% from the year earlier. Pre-tax profit was 5% of revenue. Astrium has 3 principal divisions that contribute to revenue: Astrium Space transportation which accounted 45% of the revenue for the first 6 months of 2010; Astrium satellites, 30.8% and the remaining 12% was the contribution of Astrium Services[237].

Telecommunications satellites for Nilesat of Egypt and Rascom of Mauritius were launched successfully by the Arianespace's Ariane 5 ECA rocket. Evry, France-based Ariane-space won contracts to launch two satellites. The Intelsat's IS-20, designed to replace Luxembourg and Washington- based Intelsat's IS-10 and IS-7 satellites. The other satellite is the Gsat-10 built by the Indian Space Research Organisation (ISRO), which will carry 12 Ku-, 12-C- and 12 extended- C-band transponders. On August 4, the Ariane 5 ECA vehicle placed into geostationary transfer orbit the Nilesat 201 and Rascom-QAF 1R satellites, both built by Thales Alenia Space. Nilesat is expected to operate for 15 years and its first and principal mission is the direct-broadcast television, carrying 24 Ku-band transponders for broadband Internet links. Rascom-QAF 1R was filled with fuel to the maximum extent possible, in order to provide 19 years of service life at its 2-9 degrees east orbital slot. Yahsat of the UAE and Arabsat of Saudi Arabia, Mideast satellite operators, also introduced Ka-band to their fleets. During the year of 2010, Arianespace expected to launch 10 satellites in orbit, although just managed to launch 6[238].

RapidEye AG was looking to raise €20 million in equity to expand into new product areas, to expand the market reach of its five-satellite constellations, add capacity to handle new business and to set a solid base to manage the growth of the RapidEye´s second generation system. The company was targeting a €25 million in revenue for 2010[239].

GeoEye contracted with Lockheed Martin Commercial Launch Services of Denver to launch the GeoEye-2 imaging satellite aboard of an Atlas 5 rocket. Another division of Lockheed Martin was contracted in March by Dulles, Va.- based GeoEye to build GeoEye-2, which has an estimated cost in between $750

[233] "Italy's e-Geos Company Turned Profit last Year". Space News 12 July 2010: 12.
[234] "Hispasat: Growth Validates Expansion". Space News 19 July 2010: 3.
[235] "Telenor Revenue Boosted by Nordic HDTV Demand". Space News 26 July 2010: 8.
[236] "OHB Buys Belgian Division from Thales Alenia Space". Space News 26 July 2010: 9.
[237] "Defense, Services Lines Drive Growth at Astrium". Space News 2 Aug. 2010: 3.
[238] "Arianespace Launches Two Sats, Signs Contracts". Space News 9 Aug. 2010: 3.
[239] "RapidEye in Hunt for New Equity Financing". Space News 13 Sept. 2011: 3.

and $800 million and the launch is expected in 2012. GeoEye-2 was the only commercial Atlas 5 launch, the previous satellites – Delta- 4 is used primarily to launch military and intelligence payloads and the last one to be launched, the Intelsat- 14 hosted an experimental U.S. military communications payload. The GeoEye-2 will be financed in $337 million by the U.S. National Geospatial-Intelligence Agency (NGA). The satellite will be placed into sun-synchronous Earth and feature resolution of 33 centimetres[240].

Thales Alenia Space started working on the Turkey's Gokturk high-resolution optical Earth imaging satellite system, the first satellite sold for export with such high resolution. It is schedule for launch in 2013, carrying an optical imager similar to the France's two Pleiades imaging satellites. Furthermore, the contract included the creation of a satellite integration and test centre in Turkey and Gokturk ground infrastructure[241].

Space Exploration Technologies (SpaceX) Falcon 1 rocket has been market by Europe's Astrium space Hardware and Services Company to European governments. Astrium was marketing a European version of Russia's Soyuz rocket, to provide an alternative to the heavy-lift Ariane 5 and Vega rocket, both of which are scheduled to enter service in 2011.This agreement gives the opportunity to Astrium and SpaceX to secure a launch for small government satellites, before the launch of Europe's Soyuz and Vega Rockets. The European governments had expressed the will to launch satellites aboard European rockets, as much as possible. Falcon 1 has a $10.9 million cost per launch and will be able to place into circular orbit satellites weighting up to 1,010kg[242].

Two contracts were signed between European governments and industry to start the production of the first Vega small-satellite launch vehicle and to cover the delivery of the five subsequent Vega rockets. The first contract covers the first Vega Launch in 2011 from Europe's Guiana Space Centre. It was signed between Arianespace launch consortium and ESA. The second contract between Evry France-based Arianespace and Vega prime contractor ELV of Colleferro, Italy, established the delivery terms of the five Vefa vehicles. Under contract to Arianespace, ELV will build Vega and 2/3 of its construction will be held in Italy, with the consequent Italian government contribution[243].

Under an extension of the 2007 agreement, International Launch Services (ILS) will loft a 6 satellite for fleet operator aboard a Russian Proton rocket. ILS launched the SES-1, as part of the MultiLaunch Agreement, and is preparing two missions for 2011 and 2012. In the 2012-2014 timeframe, three ILS missions are planned[244].

Indra – Spanish information and defence technology provider – purchased 49% of IndraEspacio for €39.2 million. This has permitted Indra to strengthen is position in the space market and encouraged the company to look forward for new applications in navigation and Earth observation. IndraEspacio is specialized in satellite ground systems and the deal gave an implied value of €80 million to the company, which reported € 70 million revenue in 2009. However the financial crises can interfere with the space spending for the next years[245].

The government budget woes in 2010 were a reason of concern to Astrium, because it could compromise its leading activities. The EADS space unit saw sales rise 4% last year, around €5 billion and the orders leap 43% to €6 billion. Although, EADS had various disappointments during 2010, for example, those failed attempts to win the first batch of Galileo navigation satellites and the space segment of Europe's Meteosat Third Generation weather satellite system. The company is investing large sums in order to permit the service business to continue drive future growth, however, Astrium's position as the world's top provider of geospatial intelligence system (GIS) products, secure telecommunications satellite capacity are at risk[246].

## 5.2 United States

Space Exploration Technologies (SpaceX) Corp.'s Falcon 9 rocket was launched on June 4, with months of delay, from Cape Canaveral Air Force Station, Fla., at 2:45 pm. EDT. But, on the last second the launch was abort and it is attributed to an "out-of-limit start-up parameter". The SpaceX is a two- stage liquid oxygen-and- kerosene-fuelled rocket and the

[240] "GeoEye Books Atlas 5 For Commercial Launch". Space News 13 Sept. 2011: 8.
[241] "Thales Alenia Begins Work on Turkish Sat". Space News 13 Sept. 2011: 9.
[242] "Astrium to Market Space X Falcon 1 Launches in Europe". Space News 13 Sept. 2011: 14.
[243] "Arianespace Inks Vega Rocket Contracts." Space News 13 Sept. 2011: 15.
[244] "ILS and SES Extend Launch Services Deal". Space News 13 Sept. 2011: 16.
[245] "Indra Buys Remaining 49% of IndraEspacio". Space News 20 Sept. 2011: 9.
[246] Taverna, Michael A. "Waning Support May Undercut Satcom Growth." Aviation Week & Space Technology 17 Jan 2011: 30.

first which lofts a prototype cargo capsule. This new rocket was considered a hopes boost on NASA's controversial commercial spaceflight initiatives. The launch countdown was held at T-minus, while the SpaceX flight team was evaluating a low signal that was read from one of the antennas on the Falcon 9's flight termination system. The launch was seen by thousands of people, through the SpaceX's glitch-prone webcast and wall the preparations could be followed on twitter. Notwithstanding all the criticisms about reaching orbit with the Falcon 9 many were the voices raised to plaudit. NASA Deputy Administrator, Lori Garver, William Pomerantz the senior Director of Space Projects at the Xprize Foundation and Bett Alexander, President of the Commercial Space Flight were pleased with the launch and the day was considered "historic", establishing the historical track record for new vehicles. However the enthusiasm was not universally shared. U.S. Sen. Kay Bailey Hutchison (R.Texas) called the launch "a belated sign that efforts to develop modest commercial capabilities are showing some promising signs".[247]

Iridium faced several challenges that industry officials said to make Iridium just as much of a high-wire act today as it was when it began operating. Three serious challenges were identified was remaining in front of the company, as it was starting to build its second-generation constellation of 72 in-orbit satellites. There were three areas related to the financing of the Iridium Next project outside the Coface-enabled package; the feasibility of the satellite-delivery schedule and whether Iridium has accurately assessed the commercial satellite-launch market. Iridium awarded a $2.1 billion contract to Thales Alenia Space of France, to start delivering spacecrafts in 2015[248].

On June 2, during the visit to NASA's Kennedy Space Centre (KSC) in Florida, Hilda Solis, the U.S. Secretary of Labour announced a $15 million federal grant to Florida's Brevard County for the assistance of 3,200 area workers that were in danger to loose their jobs when NASA retired its space shuttle fleet in the end of 2010. One press article released at that time said that the grant money was intended to help workers from major KSC contractors, including the United Space Alliance, ASRC Aerospace Corp. and Boeing. Up to 20,000 contractor and subcontractor employees were expected to be laid off in the end of the shuttle programme. In order to minimize the gap between the last flight of the shuttle and the first flight of the new commercial taxis NASA is counting on for ferrying astronauts to the ISS, Komas with Rep.Bill Posey introduced new legislation in March. Posey also made some considerations about Obama's Administration. He blamed them with a series of ill-advised decisions that have made the workforce needs all the direr. He affirmed that Obama's planned to cancel NASA's space shuttle replacement effort, the Constellation programme, jeopardizes U.S. human space flight leadership[249].

Joanne Maguire, vice-president of Denver-based Lockheed Martin Space systems said that the company could deliver an Orion-based crew rescue vehicle for the ISS for $4.5 – 5.5 billion if NASA's provided some oversight on manned spaceflights contracts. In February, the White House unveiled a new direction for the U.S. spaceflight programme and marked Orion for termination. Although, in April, President Obama revised the plan, and affirmed that the Orion would be back for the space station crew lifeboat. U.S. lawmakers demanded for documentation to support the decision to terminate Constellation and insisted that the information provided by NASA should include analysis of the executability of the proposed plan through 2025. All the information that NASA choose not to reveal, should also be documented[250].

The U.S. Justice Department announced on June 23 that Northrop Grumman agreed to pay the U.S. $12.5 million to settle allegations that it knowingly submitted false claims to multiple government agencies, when it supplied electronic parts for navigation systems for military transportation. Allegedly Northrop's Woodland Hills based Navigation systems Division failed to test commercial grade electronic components to ensure they would function in the extreme temperatures required for military and space use. This misconduct included U.S. Navy, Army, Air Force, Defence Logistics Agency, Coast Guard, and Forest Service[251].

The industry is developing to offer a significant number of suborbital flights, with a cost between $50.000 and $100.000 per person. The executive vice-president of the Space Studies Institute in Princeton and the chief executive of Masten Space Systems of Mo-

[247] Klamper, Amy. "Falcon 9 Reaches Orbit in Debut." Space News, 7 June 2010: 1.
[248] De Selding, Peter B. "Major Challenges Lie Ahead For Mobile Satellite Services Operator." Space News, 7 June 2010: 5.
[249] "Florida gets $15 M to Retrain Shuttle Work Force" Space News, 7 June 2010: 9.
[250] Klamper, Amy. "Lockheed With Less NASA Oversight, Orion Lifeboat Could Cost $4.5 Billion." Space News, 21 June 2010: 1.
[251] "Northrop to Pay $12.5M In False Claims Case." Space News, 28 June 2010: 8.

jave estimated an offer between 1.000 and 100.000 flights annually. However the president of Spaceworks Commercial consulting firm estimated low end hundreds of flights per year and she also considered that the high price of tickets can be a deter element, as she raised many doubts about the sustainability of suborbital flights service. One idea that was discussed was the possibility for the suborbital market to offer global, high-speed, point-to-point transportation. The manager of the Commercial Reusable Suborbital Research Programme (CRuSR) did not estimate how many people would travel on suborbital flights but said that thousands of payloads could be expected. CRuSR offered in February 2010, microgravity flights for technology development and research[252].

On August 4, Iridium Communications announced that it had secure bank commitments totalling more than $1.8B to finance its second-generation system of 72 in-orbit satellites and 9 ground spares. The constellation is expected to cost about $2.9B to build and launch. The obtained funding was part of a credit facility from Coface, which carried a rate of less than 6%, mostly with fixed-rate terms, to be paid in between 2017-2024. The launch is programmed to 2015 aboard the Falcon 9 rockets, permitting the launch of 9 satellites each time[253].

In order to cover the London-based company's three-satellite contract with Boeing Space and Intelligence Systems, Inmarsat sought for a $500 million financial package on the U.S. Export-Import Bank, however Inmarsat had sufficient capital for the $1.2B Global Xpress project. The negotiation was expected to end in the end of 2010. Each satellite provides 12 kilowatts of power at the end of its 15 year life, has 89 fixed spot beams and weight about 6.000 kg. Inmarsat was negotiating with 4 companies vying to provide Global Xpress ground network, expecting to select 1. Boeing has agreed to purchase 10% of the Global Xpress satellite capacity for the 5 years of the system's operations. Boeing Satellite Systems International president's created a new division to sell Inmarsat Global Xpress capacity. By the end of the fifth year, it is expected to generate $500 million in revenue[254].

On August 12, SpaceX completed its first high-altitude drop test to validate the parachute deployment systems and recovery operations of the Dragon space capsule. The test was held with success, in advance of the launch atop the SpaceX Falcon 9 rocket[255].

In order to account for dollar-euro currency fluctuations and to continue early work on the Iridium Next Constellation, Iridium Communications increased its payments to the satellite prime contractor Thales Alenia Space. McLean, Va. - based paid Thales Alenia Space $164.2 million for six months of work on Iridium Next. Iridium also paid to the Cannes, France-based satellite builder $53 million for three months of work on the 81 satellite Constellation. The Iridium Next constellation had an estimated cost of $3 billion, including the launch of 72 satellites and related ground infrastructure. These satellites are expected to be launched in between 2015 and 2017. Iridium and Boeing concluded an agreement for similar services, once Iridium Next is launched[256].

The U.S. Department of Agriculture's Rural Utilities Services announced, on August 18, 2010, that the U.S. government awarded 4 satellite-broadband providers to provide links to rural areas of the United States. Hughes Network Systems of Germantown received $58.8 million; Carlsbad, Calif. – based ViaSat Inc.'s Wild Blue Communications, $19.5 million; EchoStar XI Operating LLC: $14.2 million and Spacenet of McLean Va. $7.5 million[257].

## 5.3 Russia

The Soyuz TMA-17 Russian spacecraft landed on June 2 at about 9:25 a.m. in Kazakhstan, to return the cosmonaut Oleg Kotov, the USA astronaut Timothy Creamer and the Japanese Soichi Noguchi. Those were half of the space station's full six-person crew and lived in the orbiting laboratory since December. The crew hosted tree visiting NASA space shuttle missions, during their 163 days in orbit. NASA's shuttle, Atlantis, visited in May, delivered a $200 million a Russian Research module called Rassvet. On May 31, Kotov took control of the space station over to its new Expedition 24 Commander, Skvortsov. On June 15, the Soyuz TMA-19 spacecraft launched a 6 month mission, with Fyodor Yurchikhin, Douglas Wheelock and Shanon Walker[258].

[252] "Suborbital Price Drop Foreseen by 2014". Space News 26 July 2010: 3.
[253] "Iridium Secures $1.8B in Loan Commitments." Space News 9 Aug. 2010: 3.
[254] "Inmarsat Seeks U.S. Ex-Im Backing for Satellite Deal." Space News 9 Aug. 2010: 4.
[255] "Space-X Conducts First Drop Test of Dragon". Space News 23 Aug. 2010: 3.
[256] "Iridium Boosts Payments as Dollar Loses Ground to Euro". Space News 23 Aug. 2010: 3.
[257] "Federal Broadband Grants Go to 4 U.S. Satellite Firms". Space News 23 Aug. 2010: 3.
[258] "Three Spaceflyers Return to Earth in Russian Soyuz" Space News, 7 June 2010: 8.

On June 17, at 6:21 pm, the Soyuz TMA-19 linked up with the ISS, carrying two American astronauts and one Russian cosmonaut. This marked the space station crew recurrence to full strength and a milestone for women in space: two female astronauts, Shannon Walker and Tracy Caldwell Dyson, were part of the long-term spaceflight. This space shuttle mission, last five and a half months for this crew and noted NASA's retired from orbit, in the end of 2010. After the termination, NASA would rely on Russian Soyuz to ferry astronauts to the ISS[259].

Inmarsat, the mobile satellite operator, was in negotiations to purchase 3 or 4 large satellites. This $1 billion investment would position the satellite operator in the growing market for mobile broadband. Those satellites would operate in the ka-band portion of the radio spectrum. This deal would permit to the El Segundo, Calif.- based satellite builder to find a second major costumer for its new line of 702 MP satellites. Inmarsat strategy is to keep ahead of a market that increasingly wants a high bandwidth at low prices. The contracts with Boeing gave place to a competitive bidding round that included Astrium Satellites of Europe[260].

A Proton rocket was launched on September 2, at 4:53 a.m. from the Baikonour Cosmodrome in Kazakhstan, carrying 3 Glonass-M Navigation satellites. These were the second trio of Glonass satellites launched in 2010. Roscosmos affirmed that the satellites had reached their intended orbit[261].

Sea Launch Co. was purchased by Energia, a large Russian space hardware manufacturer, after the approval of the U.S. government. This purchased was a way for Energia to enter global commercial launch business. Chicago based Boeing Co. remained a Sea Launch supplier but has ended its management role (it was the general contractor and principal shareholder). Sea Launch was emerging debt-free from Chapter 11 and could survive on three or four launches per year[262].

## 5.4 Japan

Japan's Servis-2 satellite, built by Mitsubishi Electric Corp. for the Tokyo-based Institute for Unmanned Space experiment free flyer. Servis-2 was launched on June 2 by the Russian-German Eurockot Launch Services Company (a joint venture between Astrium of Europe and Moscow-based Khrunichev), from Russia's Plesetsk Cosmodrome. The 736 Kg Servis-2 test commercial off-the-shelf components to use on future space missions and was place into a 1,200 km sun-synchronous orbit. After the Servis-2 launching, Eurockot announced the future launch of the Swarm satellites, being built by ESA, for 2012[263].

## 5.5 China

On June 15, a Chinese Long March 2D rocket launched the Shijian 12 scientific research satellite, from Jinquan Satellite Launch Centre in China's Gansu Province. This satellite was developed by the Shanghai Academy of Spaceflight technology[264].

China Satcom, which was merged in 2009 into China Aerospace Corp. (CASC), reported a 15% increase in revenue in the same year, from its five in-orbit satellites. The revenue totalled 930 million Yuan ($136 million) which placed the company in the 14th place for 2009 in the Space News Top Fixed Satellite Service Operators ranking[265].

On July 31, China launched successfully the fifth spacecraft to join its Beidou-Compass satellite navigation and positioning network. The satellite lifted off at 5:30 a.m. from the Xichuang Satellite Launch Centre, in Sichuan Province. It is expected to provide navigation, timing and short message services in Asia and Pacific region by 2012 and global navigation services by 2020[266].

AsiaSat of Hong Kong reported a 27% increase in revenue on the 6 months ending in June 30, 2010. The whole revenue was 689.8 million Hong Kong dollars. Speedcasts, AsiaSat subsidiary, increased its revenue by 34% during the same period and accounted for 13% of AsiaSat's revenue. The company was encouraged from its joint venture with Echostar of Englewood, Colo. to provide 36 enhanced standard-definition and high-

[259] "New Station Crew Arrives Aboard Soyuz." Space News, 21 June 2010: 3.
[260] De Selding, Peter B. "Inmarsat Poised to Order Ka-band Sats From Boeing in Mobile Broadband Push." Space News, 5 July 2010: 1.
[261] "Russian Proton Launches Trio of Glonass Satellites". Space News 6 Sept. 2011: 8.
[262] "Sea Launch Acquisition Receives U.S. Approval". Space News 13 Sept. 2011:3.
[263] "Japanese Test Satellite Launched Atop Rockot." Space News, 7 June 2010: 3.
[264] "Long March 2D Rocket Lofts Chinese Research Satellite." Space News, 21 June 2010: 9.
[265] "China Satcom '09 Revue Rose by Nearly 16 Percent". Space News 2 Aug. 2010: 8.
[266] "Long March Rocket Lofts Chinese Navigation Satellite". Space News 9 Aug. 2010: 9.

definition television channels in Taiwan. Besides the four satellites operated by AsiaSat, the AsiaSat 7 will be launched during 2011. For the beginning of 2011, AsiaSat had booked 760 million Hong Kong dollars in new orders[267].

The Chinese Sinosat-6, which carries 24 C-band, 8 Ku-band and 1 S-band replaced the Sinosat-w satellite at 125 degrees east, had a leak in its helium-pressurization system that could result in a reduced operational life, from 15 to 10 years. The system is unable to deliver full helium-provided pressure to the satellite's fuel tank. The entire satellite was insured for $200 million and for this problem $60 million was claimed. The Sinosat-6 was the first claim for launch and satellite failures in 2010. The glitch also affected the reputation of the DFH-a platform that Sinosat-6 uses[268].

China launched the Yagon11, the fifth in seven weeks, remote sensing satellite in September 22, 2010, at 10:42 a.m. from Jinquan Satellite Launch Centre. The satellite was placed into orbit atop a Long March 2D rocket and is used to conduct scientific experiments and help with natural disaster response[269].

Great Wall Industry Corp. recovered from its 2009 underperformance during the launch of Indonesia's Palapa-D telecommunications satellites. China is now launching, during 2011, three satellites for non-Chinese customers: W3C satellite for Eutelsat; Paksat 1R for Pakistan and Nigcomsat 1R for Nigeria. The Chief Legal counsel for China Great Wall affirmed that the anomaly in the helium-propulsion on China's Sinosat 6 satellite could delay the launch of the Pakistani and Nigerian spacecraft. The Chinese launcher had proceed with upgrades that have increased the Long March 3B rocket's payload-carrying ability from 5,200 kg to 5,500kg ; they also reduced the amount of time needed for launching to 25 days, permitting the vehicle to launch 10 times per year. China Great Wall has enough business to conduct 20 launches per year in the next 5 years, only counting with domestic launches[270].

Bremen-based OHB Technology signed an agreement with China in order to develop a small constellation to measure atmosphere levels of methane and carbon dioxide. This partnership was seen by the chief executive of OHB Systems as a serious commitment for both parts to the implementation of the post-Kyoto protocol. The constellation could be known as the Disaster Monitoring Constellation, constituted by Earth imaging satellites. The main idea is to provide a globally accepted source of climatic data[271].

## 5.6 India

Private investment is flowing into India's aerospace industry. There are many reasons to explain the growth of the industry in this country. On the one hand, India has a low cost industry and, on the other are the increasing availability of defence work for private companies and the opportunity to gain business from foreign suppliers compelled to offset their sales into India with domestic purchases.

India is still compared with China, unavoidably, but big differences appear between them. India's industry is smaller. The dominant company, Hindustan Aeronautics Ltd., had revenue of $2.6 billion in 2009 and it is encourage by private companies. China's Avic had about 10 times larger revenue and it is dominated by state giants. General Electric is one notable foreign participant in India's industry and their business is growing 10-15% a year..[272]

[267] "AsiaSat Sales and Earnings Post Double-digit Gains". Space News 23 Aug. 2010: 3.
[268] "China's Sinosat-6 hampered by Leak". Space News 13 Sept. 2011: 3.
[269] "China Launches 5th Satellite in 7 Weeks". Space News 27Sept. 2011: 3.
[270] "China Great Wall Shakes Off Satellite's Botched Launch". Space News 27Sept. 2011: 8.
[271] "OHB, China Sign Pact For CarbonSat Mission". Space News 20 Sept. 2011: 8.
[272] Perret, Bradley. "Private Investment Leading The way in Indian Aerospace." Aviation Week & Space Technology 14 June 2010: 51.

# 6. The Defence Perspective

## 6.1 Trends in Military Expenditure

Space-related military spending remained stable in 2010, reaching a total of $34 billion, or 3% more than 2009. As in the previous year, the U.S. military budget represented the bulk of global spending, with $27 billion, or over 80% of the total.273However, this figure only takes into account the U.S. Department of Defence budget. If one considers the total sum of U.S. spending for national security purposes (including intelligence gathering and mapping services) the total U.S. expenditures rise to $46 billion and their global share close to 90%. Furthermore, even this latter figure should be considered conservative, since it does not take into account U.S. government programmes of dual use nature, such as the use of NOAA weather satellites' data by the military.

It is believed that Russia and China followed the U.S. in military space spending in the second and third place respectively, but the exact figures of their budgets are difficult to calculate exactly due to fact that they are entirely classified. According to some sources the Russian budget could be comparable to the country's civil space budget of $2.8 billion and China's could reach as much as $1 billion.[274] Other reports calculate the total figure of worldwide military space expenditures outside the U.S. to less than $3 billion, suggesting much more conservative spending levels for both countries.[275] Furthermore, fluctuating currency exchange rates, as well as different purchasing power levels and employment costs in these countries would make a direct comparison of their budgets to these of developed countries in fixed dollar values a very relative exercise.

Concerning developed regions outside the U.S., European budgets were in 2010 and 2011 the most significant, with a total estimated value of $770 million, excluding dual use systems. This fact would imply that the downward trend in European military space observed in 2009 and 2010 has continued, but it should be considered as a natural result of the European programmes' investment cycles, rather than specific policy decisions to limit them. Indeed, during the period in question a number of programmes has concluded its operational development, while their successors have not yet reached their full development phase yet. For the same reason, this downwards trend is expected to be reversed in the next two years. At the same time, the development of the GMES Earth observation constellation is expected to increase the part that dual use systems play in the European security space architecture, consequently increasing their budget share compared to the purely military spending of member states. Finally, it should also be kept in mind that spending is not always clearly allocable, because some budget positions can be assigned to various categories. Finally, Japan maintained in 2010 and 2011 its position as the country with the fifth largest military space budget, mainly related to the development of its intelligence gathering satellite constellation. Its budget remained stable at approximately $650 million, mainly driven by the Japanese government's continued commitment to improving its intelligence apparatus in the face of the continuously unstable geopolitical environment in the region.

## 6.2 Europe

Military space programmes in Europe continue to belong to the competence of individual member states. They are carried out by all major European space faring nations, with an even wider number of European countries participating at the basis of bilateral or multilateral agreements and arrangements. Although the associated European budgets have dropped significantly in 2010 and 2011, this development can be attributed to a great extend to a curve in the investment cycle in a number of projects, and they are expected to return to their average figures in the medium term. However, the trend of outsourcing services and reducing public budget costs through PPPs has appeared in the field of security space applications too. Together with the increasing number of cooperation agree-

[273] Based on Euroconsult data.
[274] Ibid.
[275] Space Foundation. The Space Report 2011. Colorado Springs 2011.

ments, it demonstrates the willingness of European countries to maintain key operational capabilities through cooperation and innovative funding schemes. The key security space mission areas for European countries that are affected include Earth observation and dedicated military satcom services.

France has the highest investment in national military space programmes, believed to amount to approximately $264 million in 2010. However, the exact amount is difficult to calculate, since almost all of the development work is conducted under the country's civil space agency CNES. This figure is considerably low when compared to 2009, mainly due to the conclusion of key programme's development, such as the Syracuse-3 satcom spacecraft. Earth observation satellite development also remained at historical lows, as the Helios programme has completed its development and the upcoming Pleiades system has not entered its full development phase yet. Nevertheless, related spending is expected to increase in the next two years, as the programme will mature further. In fact, a first sign of this development appeared in 2010 already, since the French defence Earth observation budget more than doubled to reach $86 million, from $30 million in 2009.[276]

Germany reported the third higher spending in military space programmes in 2010, mostly thanks to the deployment of its dedicated SatCom BW military communications satellites, with the two spacecraft constellation completed in 2010. The United Kingdom, which was second with roughly $215, also dedicated the bulk of its budget in compensating the Skynet-5 constellation operator for its use. Although the system performed as expected, increased communications need that were the result of the UK's forces multiple engagements all over the world, and especially in Afghanistan, almost saturated the network. The Italian defence budget also decreased, for the same reasons as in the case of France. Especially as far as Earth observation missions were concerned, with the launch of the fourth and last Cosmo-Skymed satellite in 2010 and its next generation satellites not scheduled for launch before 2016.

## 6.3 The United States

In 2010 and 2011 the U.S. Department of Defence remained the biggest spender by far in the field of military space activities, accounting for at least 80% of expenditures worldwide. This figure increases to almost 90% if one considers the overall security related space programmes and services, which include the related budgets of the National Reconnaissance Office, the national Geospatial Intelligence Agency, or Homeland Security; dual purpose assets, such as NOAA's weather satellites could also be included, as far as they provide service to military as well as civil authorities. However, for the purposes of this report we will examine only DoD programmes, principally for reasons of comparability with the equivalent expenditures of other space faring nations.

In 2010 and 2011 U.S. military programmes continued their trend of annual increase that has continued uninterrupted for over a decade. However, the increase in 2010 was limited to approximately $800 million, or only half of the annual average reported in the previous ten years. This relative stabilisation might be the first sign of a longer period of reduction in military space spending in the U.S. Although this trend will have to be confirmed in the following two years, there are certain factors that may contribute to its development. These would include the Obama administration's decision to cut military budgets in the medium term, the general trend in U.S. military procurement to outsource services to the private sector (especially in the fields of EO and satcom), as well as to reduce operating costs by replacing non critical space assets with hosted payloads in commercial spacecrafts. Furthermore, the fact that a number of DoD programmes that have been under development in recent years will enter their deployment phase is expected to reduce the current level of investments. Finally, one should not underestimate the medium to long term impact of the Obama administration's decision to seek international partners in space projects, which could involve some kind of cooperation in developing space assets and thus further reduce the U.S. share in global military space expenditures.

For the time being however, the U.S. Department of Defence continues the development of a number of dedicated military systems, with special emphasis to the mission areas of navigation, observation, communications and space situational awareness. Regarding satellite navigation programmes, efforts to develop the new generation of GPS satellites continued in 2010 and 2011. Lockheed Martin, which had been contracted in 2008 to build the twelve new spacecraft for a total budget of $3 billion, continued its development work, but concerns continue to be raised on whether the new satellites will start their deployment in 2014 as planned, to re-

[276] Based on Euroconsult data.

place the aging second generation spacecraft. If these concerns where confirmed, a gap in the system's performance could arise during the mid of the decade. On the other hand, the key trend of outsourcing services to the private sector can be observed in the field of Earth observation, where DoD expenditures in 2010 fell further to $432 million. This was primarily the result of the NPOESS cancellation, as well as of the entering into effect of the Enhanced View commercial EO services purchase contract. Military satcom was also an area of activity in 2010 and 2011, with the entire military satcom fleet under upgrading.

## 6.4 Russia

Russia has a long tradition of space military activities, and a great of its launches in 2010 were classified.[277] Rather than investing in new projects, the 2010 expenditures are dedicated to completing previous projects, such as the Glonass GNSS system. Russia has thus invested $925 million[278] in its navigation system overtaking, for the first time the U.S in navigation systems investments. The failure of a rocket carrying three Glonass satellites[279] prevented Russia in 2010 from achieving successfully its constellation by the beginning of 2011 as previously expected. Although in principle a dual use system, Glonass is also funded by the military and provides a standard precision signal to the civil, and a high precision signal for military purposes. It is currently composed of 26 satellites and could become a crucial strategic asset for Russia, if it attracts international customers. Negotiations are under way with countries like Ukraine, Egypt, Brazil and former CIS states.

Another priority of the Russian national security space programme is the need to replace aging military communication satellites. The Russian army operates three types of spacecraft that are due to be modernised: the Raduga and Meridian constellations are likely to be progressively replaced by one launch per year, while the Rodnick system at a rhythm of three per year. The latter is already under modernisation, providing an enhanced service according to officials. In the same way, Russia increases its efforts to renew its earth observation fleet with a dedicated budget of $294 million. Since its content is classified, it is particularly difficult to determine accurately Russian policy in this field. However, it is known that two of four radar satellites are approved to be launched as part of the Kondor series. Russia has also planned to launch several low-cost Kobalt reconnaissance spacecraft of new generation in the next years.

As often with Russia it is really difficult to gauge its military space effort. The country has had significant experience in developing ELINT systems and it is likely that it focuses its effort in systems such as early warning series (Kosmos/Tselina and Prognoz) which is a priority for Russia that owns already three operational early warning satellites. A new generation of such spacecraft have been recently reported, such as Lotos-S launched in 2009, or Oko which will be integrated in the SPRN constellation. The network, which also includes dedicated ground control, is designed to detect and track global ballistic missile launches and the spacecraft in the system uses telescopes to detect infra-red radiation emitted by the exhaust of the rocket engines. Its budget is estimated at $350 million, representing a 3% increase compared to 2009. The country also envisages a programme concerning space debris mitigation which would be focused to sweeping satellite debris, but little information has been known about it.

## 6.5 Japan

The Japanese space programme does not officially have a military component and it is entirely oriented to the peaceful use of space. However, the uncertain geopolitical environment, especially with respect to developments in the Korean peninsula, has raised over the past ten years concerns about the Japanese capacity to conciliate its peaceful space programmes with its own security requirements. The latter has become gradually a key aspect of its national space policy. This trend is mainly reflected by the constant $500-600 million spent each year, essentially related to intelligence gathering capabilities. Although the Japanese budget has slightly decreased compared to 2009, it can be considered stable. However, a further slowdown cannot be excluded due to the particularly harsh impact of the economic crisis to the Japanese economy, as well as because of recent natural catastrophes which will presumably consume a great deal of public spending that under different conditions would be spent elsewhere.

The core of the Japanese space security program is Earth observation. It includes three areas, namely intelligence gathering for national security purposes and for assisting peacekeeping operations; continuous observation and surveillance for rapid response,

[277] FAA Report 2010.
[278] According to Euroconsult data.
[279] See above.

presumably focused on the North Korean missile development programme; and information sharing and communication in favour of Japan's obligations under its alliance with the U.S. Moreover, Earth observation has the advantage to be used for both military and civil purposes. The base of the Japanese security Earth observation effort is constituted by the Information Gathering Satellites (IGS) devoted to providing information to the MoD and the Japanese Defence Agency (JDA). The system is made up of optical satellite whose development started in 1998 and is so far regularly upgraded by newer satellites manufactured by Mitsubishi electric. The overall cost of this programme is around $700 million per year, accounting for the total of Japanese security related expenditures in space. Currently, the IGS system consists of two optical and two radar imaging satellites. The next generation of its satellites will be designed to be more compact, and it is expected that an optical and a radar imaging spacecraft will be launched in 2011 and 2012. Further satellites currently under development are already scheduled to fly between towards the mid of the decade. They are expected to benefit from a greatly improved operational performance that will include higher resolution (0.4 metres in stead of 0.6). The first spacecraft of the series will be IGS-Optic 5 (scheduled for launch in 2014).

Satellite navigation is also an important part of the Japanese effort and like EO its utilisation could serve military and civil policy objectives alike. Jaxa continues the deployment of its navigation constellation named "Quasi-Zenith Satellite System" (QZSS), which will be composed of three satellites and it will be devoted to regional navigation over the Japan and the Asian Pacific area. This system should constitute a strategic asset in the Asian-pacific region for Japan, since both South Korea and Australia, Japan's closest allies in the region, are expected to benefit from the system. Like its European counterpart, there is a sense of uncertainty on how to finance the project, especially since its failure to attract private funds. The system can only be operational with three satellites in orbit, which could cost as much as $2.2 billion to complete.

In spite of the fact that Japanese authorities continue to adhere to the use of dual use systems, the officially announced satellite development programmes bring the country's space applications closer and closer to traditional security and defence mission types. This was mainly noticeable by preliminary work on the development of a new ELINT/SIGINT satellite, as well as by the country's involvement in the U.S. led joint ballistic missile defence system that has instigated the development of an infrared early warning satellite in order to monitor regional missile launches by 2015. Consequently, space surveillance and infrared missile warning sensor technologies were also included in the country's medium term security space research objectives. Although the deployment of such satellites can hardly be described as of dual use nature, Japanese authorities continue to be discrete on the subject, whereas their respective budgets continue to be extremely reserved.

## 6.6 China

Estimating the Chinese effort in space military programmes is a difficult task. Beyond the official dashing statement, it is not always easy to discern the strict reality. China has unquestionably made a great endeavour to catch up its delay in military space capabilities and impose itself as a major actor in it. The perfect illustration of this will is the steady augmentation of its space budget dedicated to military activities, to approximately $1.108 billion in 2010,[280] which demonstrates its commitment to demonstrate independent capabilities in the most visible and crucial space activities that are represented by launcher, space station and manned flight.

The Manned flight budget is estimated to have tripled over the past ten years to reach an amount of $624 million[281] representing about 24% of the total Chinese's budget, and China becomes in 2003 China the third country to acquire manned spaceflight capabilities with the Shenzhou-5 spacecraft, followed by significant success through the Shenzhou programme in 2007 and 2008. It is important to recall at this stage that these programmes and the development of launchers are managed by the People's Liberation Army and must be therefore considered as defence expenditures. Another facet of this phenomenon is the strong commitment for China to establish its own space station by 2022 outside the ISS. However, that does not prevent China from developing cooperation with Nasa and other agencies as far as that does not entail any form of technological or strategic dependence. The perspective for China concerning the future "Tiangong station" are scheduled in this way, firstly improve the technique of "rendezvous" in Space, secondly to launch in orbit by 2012-2013 a small

[280] Based on Euroconsult data.
[281] Ibid.

laboratory where astronaut could live in during short period. The second step is to improve its life support system and logistic by 2013-2014, to have finally by 2016 a station of 13 tons and a capacity up to 5.5 tons enable to dock two manned Shenzhou vessels and one cargo spacecraft. The ultimate objective is to have a station of 30 tons by 2022. It is a necessity to China to develop efficient launchers to cope with its high objectives, this is the reason the launcher programme is the second largest budget in its global space effort with $484 million in 2010. The success of the development of Long March 5 & 6 will be crucial in the nearest future to achieve its ambitions herein explain.

Another crucial areas are constituted by navigation and communication satellite which one more time illustrate the will of China to acquire its own constellation in this critical fields related to the both military and public domain. Concerning navigation system we can easily notice the strong commitment of China which has launched during the years 2010-2011 numerous of satellites destined to its Beidou constellation[282]. Its investment in Satnav project has progressively increased from $100 million in 2005 to $300 million in 2010[283]. The system has the advantage to combine quick positioning, low data rate mobile telecommunication and short messages. The generation Beidou II should count 5 satellites GEO, 5 IGSO and 4 MEO to provide a global coverage of the asia pacific region, and will achieved by 2020 with the third generation comprising 5 GEO, 3 IGSO, 27 MEO be a constellation made up of 35 satellites.

In the same way the Satcom policy aim at reducing dependence on foreign technologies and use the platform developed to penetrate the international market. That has been accomplished so far through the DongFang-Hong-4 (DFH-4) satellite platform. Actually, China knows a certain slow down in this kind of activities, preferring develop low cost satellite destined to emerging countries in a less competitive market already dominated by Europe. It is expected to see a significant augmentation of the governmental Satcom capacity with one launch by year foreseen, in order to improve and introduce new services in S-, L- and Ka-Band. An S-Band geostationary satellite will be also launched around 2015 to provide maritime communication especially for the Chinese Navy in order to protect the commercial fleet against pirate attack on the strategically way near Somalia.

Earth Observation (EO) is also a critical part of military programme and China is not an exception. In this specific area the budget of China is not disclosed but it is estimated to be up to $467 million with a significant increase from 2009 of $63 million. The main strategies envisaged by Chinese authorities aimed at developing independent technologies and foster an industry capable to respond to the civil and military needs. The latest Yaogan satellites (YG-6, YG-7 and YG-8) categorized generically as remote sensing satellites for science, land applications and disaster monitoring purposes, as well as two ZY-2 series, could also be used for reconnaissance purposes. Moreover Fanhui Shi Wixing is a new series of reconnaissance satellites directly controlled by the People's Liberation Army. The Chinese's EO capacity has the specificity to merge civil and military proposes.

Although it was not directly mentioned in its budget, space security applications are nevertheless an important part of the space strategy of China. That has been particularly noticeable in the environmentally speaking catastrophic anti-satellite demonstration in 2007 to testify its operational ASAT and ELINT capabilities. The activities of China in this field are still foggy, but two experimental satellites Shi Jan (SJ-6/2A and SJ-6/2B) in this purpose (ELINT electronic intelligence) would have been launched in 2006[284].

China deploys thus a large effort to catch up it delay in all the space sectors determined to keep its firm independence and take the lead in certain domains. There is a special interaction between the military and civil purposes specific to the Chinese society which has definitely chosen in Space an offensive strategy.

## 6.7 India

India has not officially speaking developed military programmes so far. Indeed, ISRO's activities concern mainly civil preoccupations. This situation could change in the next decade due to the evolution of the geostrategic situation in this area. Pakistan and China provoke growing concern in India especially since the Chinese anti-satellite test in 2007. In 2008 , the Gen. Deepak Kapoor said at a conference in New Delhi on using space for military purposes. India urgently needs to "optimize space applications for military purposes[285] He noted that "the Chinese space program is expanding at an exponentially

[282] FAA report 2010
[283] Based on Euroconsult data.
[284] Ibid.
[285] http://www.msnbc.msn.com/id/25216230/ns/technology_and_science-space/t/indian-army-wants-military-space-program/

rapid pace in both offensive and defensive content." It is now expected that India accords an increasing importance of military purposes and especially concerning the opportunity to develop its own ASAT capability[286] to counterbalance and thwart the Chinese threat and consequently the Pakistan one as well. This evolution is made within a global effort of improving the security of the country especially by developing a working missile defence system by 2012. In this atmosphere it is unlikely that India neglects the considerable asset that represents space in military supremacy, knowing that India has to deal with considerable intern trouble such as Maoist insurrection[287] and space can be a crucial asset in this struggle[288]. This country has besides foreseen to launch its first satellite totally and officially dedicated to military activities in order to support the Indian navy beginning 2011[289].

The direct military investments of India are thus difficult to asses. However, dual use technologies are more discernable and can provide us an insight of the India's strategy. The Indian National Satellite System (INSAT) is the largest domestic satellite communication system in Asia with 11 operational satellites and a total of 186 transponders. The 11th National Space Plan (2007-2012) anticipated the launch of 13 satellites over the same period and expects to reach a total capacity of 500 transponders in 2012. This endeavour has been hampered by the successive failures of the GSLV in 2007 and 2007 but still that India has a very efficient constellation concerning communication. The government is strongly committed to break the isolation of remote areas particularly prone to be influenced by the various local insurgencies.

In the same way the Indian regional navigation satellite system (IRNSS) consisting in of seven satellites with three GEO and four near-GSO satellites is due to be operational in 2012. IRNSS will be a crucial military asses as it will also include positioning, missile targeting. Concerning this programme the Funds reached $57million in 2010, accounting a modest part 5% of the agency's budget, taken over by far by the launcher programme estimated around $531million. The 11$^{th}$ plan is particularly devoted to national security issues and could represent a cornerstone in the way India considers the use of Space. A payload containing GSAT-4 was lost in April 2010 in a launch failure. The replacement spacecraft is to be launched in early 2011. Two additional dual-frequency payloads will be on GSAT-8 and GSAT-10 set to be launched in 2012 to complete the fleet.

Another fundamental dual use segment is represented by earth observation. India has shown a strong desire of independence concerning the EO data developing rather ambitions programs concerning civil objective such as oceanography or to help governmental public policy in territory management. Numerous satellites are due to be launched for civil purposes, such as DMSAR-1 radar mission and GISAT, representing a budget of approximately $77 million in the 2010-2011 national and it is probable that they will use for military intelligence as well. It is also expected that India continues its series of Cartosat satellite in the next few years which as much as appropriate to civil or military purpose.

Thus, India reveals little by little its strategy in relation to the threatening environment in which it moves out. There is a noticeable unbalance between civil and military assets in India, and it is probable that in the future military sector will not be neglected any more given that the challenges the country have to deal with. The first necessity for India is still to develop a reliable rocket in order to not wreck its military effort which includes most of the time costly satellites.

[286] http://www.thespacereview.com/article/1621/1
[287] http://www.bbc.co.uk/news/world-south-asia-12640645
[288] http://www.geospatialworld.net/index.php?option=com_content&view=article&id=7937&catid=66%3Aapplication-miscellaneous&Itemid=1
[289] http://www.defencenews.in/defence-news-internal.asp?get=old&id=239

# List of Acronyms

| Acronym | Explanation |
|---|---|
| 3DTV | 3 Dimensions Television |
| ABAE | Agencia Bolivariana d'Actividades Espaciales |
| ACI | Airports Council International |
| ADF | Australian Defence Force |
| ADM | Atmospheric Dynamics Mission |
| AEB | Agência Espacial Brasileira |
| AEHF | Advanced Extremely High Frequency |
| AFET | Committee on Foreign Affairs |
| AFRL | Air Force Research Laboratory |
| AG | Aktiengesellschaft |
| AGILE | Astrorivelatore Gamma ad Immagini ultra Leggero |
| AIA | Aerospace Industries Association |
| AIS | Automatic Identification System |
| ANGELS | Autonomous Nanosatellite Guardian for Evaluating Local Space |
| AP-MCSTA | Asia Pacific Multilateral Cooperation in Space Technology and Applications |
| APRSAF | Asia-Pacific Regional Space Agency Forum |
| APSCO | Asia-Pacific Space Cooperation Organisation |
| ARMC | African Resource Management and Environmental Constellation |
| ARTES | Advanced Research in Telecommunications Systems |
| ASAT | Anti Satellite |
| ASC | Army Space Council |
| A-SCOPE | Advanced Space Carbon and Climate Observation of Planet Earth |
| ASE | Association of Space Explorers |
| ASI | Agenzia Spaziale Italiana |
| AT&T | American Telephone and Telegraph Corporation |
| Athena-Fidus | Access on theatres for European allied forces nations-French Italian dual-use satellite |
| ATV | Automated Transfer Vehicle |
| AVIC | Aviation Industries of China |
| BAE | British Aerospace |
| BGAN | Broadband Global Area Network |
| BLS | Boeing Launch Services |
| BNSC | British National Space Centre |
| CASA | Construcciones Aeronáuticas Sociedad Anónima |

| Acronym | Explanation |
|---|---|
| CASC | China Aerospace Corporation |
| CASIC | China Aerospace Science and Industry Corporation |
| CASTC | China Aerospace Science and Technology Corporation |
| CBERS | China Brazil Earth Resources Satellites |
| CCD | Charged Coupled Device |
| CD | Conference on Disarmament |
| CEV | Centro Espacial Venezolano |
| CFSP | Common Foreign and Security Policy |
| CGWIC | China Great Wall Industry Corporation |
| CIP | Competitiveness and Innovation Framework Programme |
| CMA | China Meteorological Administration |
| CMSEO | China Manned Space Engineering Office |
| CNES | Centre National d'Etudes Spatiales |
| CNNC | China National Nuclear Corporation |
| CNSA | China National Space Administration |
| COPUOS | Committee on the Peaceful Uses of Outer Space |
| CoReH2O | Cold Regions Hydrology High-resolution Observatory |
| COREPER | Committee of Permanent Representatives |
| COSMO-Skymed | Constellation of small Satellites for the Mediterranean basin Observation |
| COSTIND | Commission for Science, Technology and Industry |
| CSI | Customer Service Improvement |
| CSSC | China State Shipbuilding Corporation |
| DARPA | Defence Advanced Research Projects Agency |
| DARS | Digital Audio Radio Satellite |
| DBS | Direct Broadcast Services |
| DEM | Digital Elevation Model |
| DG | Directorate General |
| DISH | Digital Sky Highway |
| DLR | Deutsches Zentrum für Luft- und Raumfahrt |
| DMO | Defence Material Organisation |
| DMSP | Defence Meteorological Satellite Program |
| DOC | Department of Commerce |
| DoD | Department of Defence |
| DRC | Democratic Republic of Congo |
| DSTO | Defence Science and Technology Organisation |
| DTH | Direct-to-Home |
| EADS | European Aeronautic Defence and Space Company |
| EarthCARE | Earth Clouds, Aerosol and Radiation Explorer |
| EC | European Commission |

| Acronym | Explanation |
|---|---|
| ECA | Evolution Cryotechnique Type A |
| e-CORCE | e-Constellation of Observation by Recurrent Cellular Environment |
| EDA | European Defence Agency |
| EDEM | European Defence Equipment Market |
| EDRS | European Data Relay Satellite |
| EEA | European Environment Agency |
| EELV | Evolved Expandable Launch Vehicle |
| ELV | Expandable Launch Vehicle |
| EGNOS | European Geostationary Navigation Overlay Service |
| EIP | Entrepreneurship and Innovation Programme |
| EISC | European Interparliamentary Space Conference |
| ELINT | Electronic signals Intelligence |
| EMS | Electromagnetic Sciences |
| EMSA | European Maritime Safety Agency |
| EnMAP | Environmental Mapping and Analysis Programme |
| EOS | Earth Observation System |
| EPS | EUMETSAT Polar System |
| ESA | European Space Agency |
| ESDP | European Security and Defence Policy |
| ESOA | European Satellite Operators Association |
| ESP | European Space Policy |
| ESPI | European Space Policy Institute |
| EU | European Union |
| EUFOR | European Union Force |
| EUMETSAT | European Organisation for the Exploitation of Meteorological Satellites |
| EUSC | European Union Satellite Centre |
| Eutelsat | European Telecommunications Satellite Organisation |
| EVA | Extravehicular Activity |
| FAA | Federal Aviation Administration |
| FAO | Food and Agricultural Organisation |
| FBI | Federal Bureau of Investigations |
| FCC | Federal Communications Commission |
| FED | Federal Reserve System |
| FLEX | Fluorescence Explorer |
| FP7 | Framework Programme for research and technological development 7 |
| FRONTEX | European Agency for the Management of Operational Cooperation at the External Borders |
| FSS | Fixed Satellite Services |
| FY | Fiscal Year |
| FY | Feng Yung |

| Acronym | Explanation |
|---|---|
| GAD | General Armaments Department |
| GCOM-W | Global Change Observation Mission-Water |
| GDP | Gross Domestic Product |
| GEO | Geostationary Orbit |
| GEOSS | Global Earth Observation System of Systems |
| GIS | Geographic Information System |
| GMES | Global Monitoring for Environment and Security |
| GNI | Gross National Income |
| GOCE | Gravity field and steady-state Ocean Circulation Explorer |
| GOES | Geostationary Operational Environmental Satellite |
| GOSAT | Greenhouse Gases Observing Satellite |
| GPS | Global Positioning System |
| GSA | GNSS Supervisory Authority |
| GSC | Guyana Space Centre |
| GSI | Global Security Institute |
| GSLV | Geosynchronous Satellite Launch Vehicle |
| GTO | Geostationary Transfer Orbit |
| HDTV | High Definition Television |
| HQ | Headquarters |
| HSPG | High-Level Space Policy Group |
| HTV | H2A Transfer Vehicle |
| HYLAS | Highly Adaptable Satellite |
| IAA | International Academy of Astronautics |
| IAEA | International Atomic Energy Agency |
| IAF | International Astronautical Federation |
| IATA | International Air Transport Association |
| IAU | International Astronomical Union |
| IBEX | Interstellar Boundary Explorer |
| IBMP | Institute for Biomedical Problems |
| ICBM | Intercontinental Ballistic Missile |
| ICG | International Committee on Global Navigation Satellite Systems |
| ICU | Islamic Courts Union |
| IEA | International Energy Agency |
| IGN | Institut Géographique National |
| IGS | Integrated Geo Systems |
| IIASA | International Institute for Applied System Analysis |
| ILS | International Launch Services |
| IMF | International Monetary Fund |
| IMO | International Maritime Organisation |

| Acronym | Explanation |
|---|---|
| IMS | Indian Mini Satellite |
| INKSNA | Iran – North Korea – Syria Nonproliferation Act |
| INPE | Instituto Nacional de Pesquisas Espaciais |
| IPCC | Intergovernmental Panel on Climate Change |
| IPO | Integrated Program Office |
| IRNSS | Indian Regional Navigational Satellite System |
| ISAF | International Security Assistance Force |
| ISB | Industry State Bank |
| ISC | International Space Company |
| ISPRS | International Society for Photogrammetry and Remote Sensing |
| ISRO | Indian Space Research Organisation |
| ISS | International Space Station |
| ITAR | International Traffic in Arms Regulations |
| ITU | International Telecommunication Union |
| JAPCC | Joint Air Power Competence Centre |
| JAXA | Japan Aerospace Exploration Agency |
| KARI | Korea Aerospace Research Institute |
| KHTT | Know-How-Technology Training |
| KSLV | Korea Space Launch Vehicle |
| LAMOST | Large Sky Area Multi-Object Fibre Spectroscopic Telescope |
| LCROSS | Lunar Crater Observing and Sensing Satellite |
| LEO | Low Earth Orbit |
| LISA | Laser Interferometer Space Antenna |
| LM | Long March |
| LMCLS | Lockheed Martin Commercial Launch Services |
| LRF | Lloyd's Register-Fairplay |
| LRG | Launch Risk Guarantee |
| LRO | Lunar Reconnaissance Orbiter |
| MAI | Moscow Aviation Institute |
| MASTIS | Maritime Advanced SATCOM Terrestrial Infrastructure System |
| MAVEN | Mars Atmosphere and Volatile Evolution |
| MDA | MacDonald Dettwiler and Associates |
| MDA | Missile Defence Agency |
| MEO | Medium Earth Orbit |
| METI | Ministry of Economy, Industry and Trade |
| MEXT | Ministry of Education, Science and Technology |
| MHI | Mitsubishi Heavy Industries |
| MHS | Microwave Humidity Sounder |
| MIC | Ministry of Internal Affairs and Communication |

| Acronym | Explanation |
|---|---|
| MLM | Multipurpose Laboratory Module |
| MoD | Ministry of Defence |
| MONUC | Mission de l'Organisation des Nations Unies en République démocratique du Congo |
| MoonLITE | Moon Lightweight Interior and Telecom Experiment |
| MoU | Memorandum of Understanding |
| MR | Medium Resolution |
| MRM | Mini Research Module |
| MSC | Missile Systems Centre |
| MSG | Meteosat Second Generation |
| MSS | Mobile Satellite Services |
| MSV | Mobile Satellite Ventures |
| MTG | Meteosat Third Generation |
| MUOS | Mobile User Objective System |
| MUSIS | Multinational Satellite-based Imagery System |
| NASA | National Aeronautics and Space Administration |
| NASDA | National Development Space Agency of Japan |
| NATO | North Atlantic Treaty Organisation |
| NDPG | National Defence Program Guidelines |
| NERC | Natural Environment Research Council |
| NEREUS | Network of European Regions Using Space Technologies |
| NFIRE | Near Field Infrared Experiment |
| NGA | National Geospatial-Intelligence Agency |
| NGDI | National Geospatial Data Infrastructure |
| NGO | Non-governmental Organisation |
| NOAA | National Oceanic and Atmospheric Administration |
| NPOSS | National Polar-orbiting Operational Satellite System |
| NPP | NPOESS Preparatory Project |
| NRO | National Reconnaissance Office |
| NSR | Northern Sky Research |
| NSSA | National Security Space Authority |
| OGDR | Operational and Geophysical Data Record |
| OHB | Orbitale Hochtechnologie Bremen |
| OOSA | Office of Outer Space Affairs |
| OPEC | Organisation of Petroleum Exporting Countries |
| ORFEO | Optical and Radar Federated Earth Observation |
| ORS | Operationally Responsive Space |
| OSTM | Ocean Surface Topography Mission |
| PFI | Public Financing Initiative |
| PICC | People's Insurance Company of China |

| Acronym | Explanation |
|---|---|
| PLA | People's Liberation Army |
| PNAE | Plano Nacional de Atividades Espaciais |
| PND | Portable Navigation Device |
| POES | Polar Operational Environment Satellites |
| PPP | Public Private Partnership |
| PREMIER | Process Exploration through Measurement of Infrared Emitted Radiation |
| PRISMA | Precursore Iperspettrale della Missione Applicativa |
| PSIPW | Prince Sultan Bin Abdulaziz International Prize for Water |
| PSLV | Polar Satellite Launch Vehicle |
| R&D | Research & Development |
| RCA | République Centrafricaine |
| ROSA | Radio Occultation Sounding for Atmosphere |
| RSC | Rocket and Space Corporation |
| S&T | Science and Technology |
| SA | Sociedad Anónima |
| SAP | Programme on Space Applications |
| SAR | Synthetic Aperture Radar |
| SARA | Sub-kev Atom Reflecting Analyser |
| SBIRS | Space Based Infrared System |
| SBSS | Space Based Surveillance System |
| SC | Security Council |
| SDSTB | State Defence Science and Technology Bureau |
| SEDE | Subcommittee on Security and Defence |
| SES | Société Européenne des Satellites |
| SGAC | Space Generation Advisory Council |
| SHF | Super High Frequency |
| SHSP | Strategic Headquarters for Space Policy |
| SICRAL | Sistema Italiano per Comunicazioni Riservate ed Allarmi |
| SIGINT | Signals Intelligence |
| SIR-2 | Spectrometer Infrared 2 |
| SIRAL | SAR/Interferometric Radar Altimeter |
| SLA | Service Level Agreement |
| SMDC | Space and Missile Defence Command |
| SME | Small and Medium Entreprises |
| SMOS | Soil Moisture and Ocean Salinity |
| SMP | Systèmes Midi-Pyrénées |
| SNC | Sierra Nevada Corporation |
| SPIDER | Space-based Information for Disaster Management and Emergency Response |
| SS2 | Space Ship 2 |

| Acronym | Explanation |
|---|---|
| SSA | Space Situational Awareness |
| SSC | Swedish Space Corporation |
| SSL | Space Systems/Loral |
| SSOT | Sistema Satelital para Observacion de la Tierra |
| SSTL | Surrey Satellite Technology Ltd. |
| STFC | Science and Technology Facilities Council |
| STSS | Space Tracking Surveillance System |
| SWF | Secure World Foundation |
| TCBM | Transparency and Confidence Building Measures |
| TEN | Trans-European Networks |
| TEN-T | Trans-European Transport Networks |
| TFG | Transitional Federal Government |
| THEO | Thai Earth Observation System |
| TRAQ | Tropospheric composition and Air Quality |
| TSAT | Transformation Communications Satellite |
| TSB | Technology Strategy Board |
| TV | Television |
| UAE | United Arab Emirates |
| UHF | Ultra High Frequency |
| UK | United Kingdom |
| ULA | United Launch Alliances |
| UN | United Nations |
| UNCCC | United Nations Climate Change Conference |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNGA | United Nations General Assembly |
| UNGIWG | United Nations Geographic Information Working Group |
| UNIDIR | United Nations Institute for Disarmament Research |
| UNISPACE | United Nations Conference on the Exploration and Peaceful Uses of Outer Space |
| UNSC | United Nations Security Council |
| UNSDI | United Nations Spatial Data Infrastructure |
| U.S. | United States |
| USAF | United States Air Force |
| USAT | Ultra Small Aperture Terminals |
| USN | Universal Space Network |

| Acronym | Explanation |
|---|---|
| VERTA | Vega Research and Technology Accompaniment |
| VHR | Very High Resolution |
| VSAT | Very Small Aperture Terminals |
| WEU | Western European Union |
| WFP | World Food Programme |
| WGS | Wideband Global Satcom |
| WHO | World Health Organisation |
| WK2 | White Knight 2 |
| WRC | World Radiocommunication Conference |
| WRS | World Radiocommunication Seminar |
| WSSD | World Summit on Sustainable Development |
| WSWA | World Space Week Association |
| XSS | Experimental Spacecraft System |

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# About the Author

Spyros Pagkratis joined the European Space Policy Institute in Vienna in 2010. Prior to that, he briefly worked as a space policy analyst with the Western European Union Assembly and EADS Astrium Space Transportation in Paris. He holds a degree in history from Athens University and Master's degrees in international relations' history from Sorbonne, as well as in defence policy and armament procurement planning from Panthéon/Assas Universities in Paris.

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