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Introduction

When reading this issue of Space Policy, Issues and Trends it should be kept in mind that there is a remarkable lack of consistency in the publicly available figures on space activity. This is attributable to varying methodologies used by the data providers, currency conversion issues, and periodicity variances. The lack of consistency starts at the very top, with the estimates of the overall size of the global space economy, where there can be differences between sources of tens of billions of Euros; and it continues down to company to company comparisons, where different accountancy rules might bring considerable contortion. But it is, of course, also a commonplace that differences in purchasing power in different economies, and differences in wage and infrastructure cost make one-to-one comparisons very difficult. Some countries are very restrictive on providing institutional data, for instance on defence spending.

Still, this issue of Space Policy, Issues and Trends will provide many insights, since all the data uncertainties do not mask many important trends and developments. As Winston Churchill taught us, statistics must be taken with a grain of salt, yet purely by looking at relativities much can learned.

This is not a reason to be complacent about the precision of figures. Space has a great societal importance and the space community owes it to political decision makers to be able to provide normalised, accurate figures. In this domain, the United States is clearly ahead of the game, and Europe must perhaps consider whether institutions such as Eurostat should not become more involved in the data collection and processing for the space field.

1. Global Political and Economic Trends

1.1 Global Economic Outlook

According to the United Nations' Annual Report "World Economic Situation and Prospects", the thread of this reporting period, covering mid-2012 into mid-2014, was the underperformance of the world economy, which was observed across almost all regions and major economic groups.[1]

The year 2012 was characterized by a considerable weakening of the world economy. Several developed nations, especially those in the Euro zone, experienced a double-dip recession, aggravated by sovereign debt crises and cumulating high unemployment, weak aggregate demand compounded by fiscal austerity, high public debt burdens, and financial fragility. These negative effects in turn spilled over to the developing nations and economies in transition through weaker demand for their exports and heightened volatility in capital flows and commodity prices. Some of the larger of these economies, including China, were not only affected externally, but also faced internal issues relating to weakened investment because of financing constraints in some sectors of their economies and excess production capacity elsewhere. The lower-end income countries had been shielded from these developments, but towards the end of 2012 they also started to be affected by the effects of the slowdown in both the developed and major middle-income countries.[2]

In 2013, World Gross Product (WGP) is estimated to have grown by a subdued 2.1%, lower than the 2.4% that had been previously forecasted. This was mainly because most developed economies experienced the lingering effects of the financial crisis, grappling in particular with the challenges of taking appropriate fiscal and monetary policy actions.[3]

There were however signs of improvement, partly due to the Euro zone finally rising out of the recession. Western Europe showed a positive growth inclination from the second quarter of 2013 on, owing to stronger growth of two of Europe's economic motors, Germany and the United Kingdom. The return of growth in these countries in turn led to an improvement of the situation in Eastern Europe. Moreover, the crisis in Europe's southern periphery also seems to have toned down due to increased output. Ireland, Portugal and Spain, three of the five high-spread economies ended their recession in 2013, aided by strong export growth, with Italy and Greece easing their recession periods. Even though this seems to be the coming of a new dawn for the Euro zone, output has not yet caught up with pre-crisis levels, and is still up to 10% or more below pre-crisis levels in those economies that were struck the hardest in the European economic area. Another significant challenge that will be high up on the agenda of the decision makers is the youth and long-term unemployment which remain endemic.[4]

The economy of the United States of America continued to recover, although 2013 growth was significantly lower than in 2012, as a result of fiscal tightening and a series of political gridlocks over budgetary issues, culminating in the government shutdown of October 2013. Nevertheless, US GDP is expected to grow by 2.5% and 3.2% for 2014 and 2015 respectively. Although unemployment levels are at their lowest since 2008, employment rates have not yet reached pre-crisis levels – due to withdrawal from the labour force of retirees, but also because of large numbers of part-time workers. Even Japan, the third member of the major high-income economies, managed to end its decade-long deflation through a set of expansionary policy packages. A key driver of growth there was investment in physical assets, with several construction projects fi-

[1] "World Economic Situation and Prospects 2014." 2014. United Nations 20 May 2014 <http://www.un.org/en/development/desa/policy/wesp/wesp_current/wesp2014.pdf>.
[2] "World Economic Situation and Prospects 2013." 2013. United Nations 20 May 2014 <http://www.un.org/en/development/desa/policy/wesp/wesp_archive/2013wesp.pdf>.
[3] "World Economic Situation and Prospects 2014." 2014. United Nations 20 May 2014 <http://www.un.org/en/development/desa/policy/wesp/wesp_current/wesp2014.pdf>.
[4] Ibid.

nanced by the government. GDP is forecast to moderate to 1.5% in 2014.[5]

Despite tensions on financial markets and weaker momentum in the developed world, growth in the developing countries strengthened in the second half of 2013, after a period of feeble growth at the end of 2012 and a weak start to 2013. This recovery, however, has been uneven, with growth accelerations in China, India, Malaysia, Thailand and Mexico, offsetting the less well-off countries of South Africa, Turkey, Indonesia and the contracting Brazil.[6] Growth in the developing economies has been estimated to average 5.1% in 2014 and 5.3% in 2015.[7]

Overall, WGP is forecast to grow at a pace of 3.0% and 3.3% in 2014 and 2015, respectively. Even though 2013 was characterized by a subdued performance, some signs of improvement have emerged. Inflation remains tame worldwide, partly reflecting output gaps, high unemployment and a continued financial deleveraging in major developed economies. The global employment situation remains troublesome however, as a long-lasting problem that continues to weigh on the labour markets of many countries and regions, especially in the Euro zone.[8]

1.2 Political Developments

1.2.1 Geopolitics

The Arab Spring that saw its origins in Tunisia in December 2010, continued in 2012 while previously marginalized Islamist political forces were making dramatic gains. Parties that were once banned or fringed increasingly expanded their grip in Tunisia, Libya, and Egypt. In the case of Egypt, the Muslim Brotherhood saw its candidate Mohamed Morsi democratically elected as President, nevertheless triggering new protests by millions of Egyptians.[9] Morsi was accused of exploiting his position to consolidate the power of the Brotherhood and was removed from office by army chief Abdul Fatah el-Sisi. This move was again followed by another series of mass protests, polarizing Egyptian society between backers of Morsi and of Sisi. The outcome was a crackdown on the Muslim Brotherhood leaders and their supporters by the military-backed interim government, resulting in the solidification of power by Sisi and the new technocratic regime. Elections are planned for 2014 with Sisi running as candidate.[10]

In 2013, the African continent witnessed the rise of Islamist extremist-fuelled terrorism, leading to a hostage crisis at an Algerian oil field, repeated attacks by Boko Haram in Nigeria, and the assault by Al-Shabab on a mall in Nairobi. France also intervened and took up weapons by intervening in Mali, successfully pushing back Islamist forces.[11]

In the Middle East, Syria's Civil War has shown no signs of abating. The war that has cost the lives of 100,000 people so far created the largest refugee crisis in years.[12] After a sarin gas attack on a Damascus suburb in August 2013, it was established that Syrian President Bashar Assad was behind the attack, killing at least 1,429 people. In a response to these worrying escalations, US President Barack Obama sought authorization to strike Syria's installations of chemical weapons, which was hailed as a major development by the rebels seeking to overthrow the regime since February 2011. However, with US public opinion dead set against another US military intervention in the Middle East, it never got to this point. Even though the Assad regime has reportedly been cooperating with UN inspectors aiming to eradicate the stockpile of chemical weapons, the civil war still rages on and few are optimistic that this horrifying chapter of Syria's history will soon come to an end.[13]

In Iran, new President Hassan Rouhani had a phone call with President Obama; historically noteworthy as it was the first official direct dialogue between the two states for three decades. This new rapprochement of the Islamic Republic with the Western world led to the signing of an agreement in November 2013 whereby Iran committed itself to cur-

[5] Ibid.
[6] "Global Economic Prospects | Coping with Policy Normalization in High-Income Countries." Jan. 2014. The World Bank 20 May 2014 <http://www.worldbank.org/content/dam/Worldbank/GEP/GEP2014a/GEP2014a.pdf>.
[7] "World Economic Situation and Prospects 2014." 2014. United Nations 20 May 2014 <http://www.un.org/en/development/desa/policy/wesp/wesp_current/wesp2014.pdf>.
[8] Ibid.
[9] Tharoor, Ishaan. "Top 10 Everything of 2012 | International News." 4 Dec. 2012. Time 19 May 2014 <http://world.time.com/2012/12/04/top-10-international-news-lists/>.
[10] Rayman, Noah. "Top 10 International News Stories." 4 Dec. 2013. Time 19 May 2014 <http://world.time.com/2013/12/04/world/slide/top-10-international-news-stories/>.
[11] Ibid.
[12] Tharoor, Ishaan. "Top 10 Everything of 2012 | International News." 4 Dec. 2012. Time 19 May 2014 <http://world.time.com/2012/12/04/top-10-international-news-lists/>.
[13] Rayman, Noah. "Top 10 International News Stories." 4 Dec. 2013. Time 19 May 2014 <http://world.time.com/2013/12/04/world/slide/top-10-international-news-stories/>.

tailing its infamous nuclear activities in exchange for the waiving of sanctions costing billions of dollars.[14]

In the beginning of 2013, the world was gripped by the story evolving around NSA whistle-blower Edward Snowden, with repercussions far outside the intelligence community. The cache of documents that Snowden exposed revealed the extent of US espionage operations in various parts of the world, thereby threatening to damage the relations between the US and some key international players. After fleeing to Hong Kong, the now-outcast Snowden was granted asylum by the Russian government which did little good for the ever-delicate relationship between Washington and Moscow.[15]

The United States also found itself in the first government shutdown since the mid-1990s which lasted more than two weeks in October 2013. Due to the inability to reach an agreement on federal spending levels, the federal bureaucracy ground to a halt, slowing economic growth at an estimated cost of around $24 billion according to Standard and Poor's credit agency.[16]

Across the Atlantic, mass protests and strikes in 2012 became a common sight in Spain, Italy, Portugal, and elsewhere, as infuriated crowds voiced public discontent with the austerity measures resulting from bailouts that kept their countries away from bankruptcy.[17] The year 2013 showcased the resiliency of the euro, partially eliminating concerns over the survival of the European currency bloc. The economy of the Euro zone got itself on the right track towards recovery, even though government debts are precariously high and unemployment has only come down slowly, remaining painfully high in much of Southern Europe.[18] In this regard, long-term prospects look bleak with double digit unemployment among youth, reaching more than 50% in Greece and Spain.[19]

In this reporting period, China found itself in ongoing disputes with Vietnam and the Philippines over maritime territory and the likely lucrative gas reserves that come with it. Even more intense was the situation with rival Japan, both nations contesting a string of islands that led to massive anti-Japan protests in China.[20] And in India, public anger was fuelled by waves of corruption scandals in which top politicians were accused of exploiting their positions for financial gain.

1.2.2 Environment

Space applications have an important role in the monitoring and protection of the environment. Space assets are uniquely positioned to offer a global perspective on climate change. They help to better manage disaster situations around the world, and are often a common multinational platform for collecting relevant meteorological and environmental data. These characteristics make them ideal promoters of international understanding and cooperation in this field. Satellite based systems are being used to gather information on climate change indicators e.g. the melting of the ice-caps, changes in the global sea level, and gathering data on regions most-affected by global warming. Remote sensing technologies can also be used to monitor deforestation and land use, and are important for better utilization of fresh water sources. There is no doubt that space technologies will play an important role in human and environmental security in the future, hence technical development of their capabilities is necessary.

Despite the financial crisis, climate change remains one of the commonly recognized agenda topics within the global political debate. Following the complicated acceptance and application of the 1997 Kyoto Protocol, which was set to expire in 2012, and the "Copenhagen Accord" of 2009 establishing voluntary emissions cuts,[21] new rounds of negotiations over the follow-up international agreement continued both in 2012 and 2013. The 18th Conference of Parties to the UN Framework Convention on Climate Change (UN FCCC/COP) took place in Doha, Qatar, from 26 November and 8 December 2012; it was followed by the 19th UN FCCC/COP in the next year, which was held in Warsaw, Poland, from 11 and 23 November 2013. In the 18th conference, a historic shift from previous

[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Tharoor, Ishaan. "Top 10 Everything of 2012 | International News." 4 Dec. 2012. Time 19 May 2014 <http://world.time.com/2012/12/04/top-10-international-news-lists/>.
[18] Rayman, Noah. "Top 10 International News Stories." 4 Dec. 2013. Time 19 May 2014 <http://world.time.com/2013/12/04/world/slide/top-10-international-news-stories/>.
[19] Stewart, Heather. "Youth Unemployment Could Prolong Eurozone Crisis, Christine Lagarde Says." 10 Dec. 2013. The Guardian 19 May 2014 <http://www.theguardian.com/business/2013/dec/10/youth-unemployment-eurozone-crisis-christine-lagarde-imf>.
[20] Rayman, Noah. "Top 10 International News Stories." 4 Dec. 2013. Time 19 May 2014 <http://world.time.com/2013/12/04/world/slide/top-10-international-news-stories/>.
[21] "United Nations Climate Change Conference kicks off in Copenhagen." 7 Dec. 2009. United Nations Development Programme 20 Feb. 2012 <http://content.undp.org/go/newsroom/2009/december/historic-united-nations-climate-change-conference-kicks-off-in-copenhagen.en>.

meetings occurred, when the summit established for the first time that rich nations should consider compensating poor nations for losses and damages due to climate change.[22] Moreover, an agreement was reached to extend the life of the Kyoto Protocol to 2020; and the conference built on the previous Durban platform to develop a successor to the Kyoto Protocol by 2015 and enter it into force by 2020. While the Kyoto Protocol is the sole legally binding climate plan, obliging about 35 industrial nations to cut their emissions significantly, with the earlier withdrawal of Russia, Japan and Canada; the remaining backers, led by the European Union and Australia, now account for only 15% of world greenhouse gas emissions.[23] The international community showed willingness to move away from the long lasting deadlock and towards real political solutions, despite varying degrees of reservation by the big players, the US, EU, and China, on levels of emission cuts and the wording of the 'Loss and Damage mechanism'. And traditional differences between the positions of developed and developing countries were significant and were stressed again during the conference, e.g. Russia, Ukraine and Belarus had hoped to be granted extra credit for the emissions cuts they had made when their industries collapsed, but that was ignored as an attempt to increase their emissions as other nations were obliged to cut theirs.

At the 19th conference, delegates continued negotiations towards a new global agreement on climate change. A potential deadlock emerged between industrialized and emerging nations on the limit of the level of emissions, with China giving deference to emerging nations for growth, while the US pushed for more accountability from the same in reducing emissions. The talks also led to the proposed 'Warsaw International Mechanism for Loss and Damage' that would provide expertise and some funds to help developing nations mitigate losses and damage from extreme environmental events (e.g. heat waves, droughts and floods), and imminent threats (e.g. rising sea levels, and land desertification).[24] Moreover, the Warsaw conference saw progress in the development of the Green Climate Fund, with the initial resource mobilization process expected to begin in the second half of 2014.[25] This fund, planned to be a major channel of financing for developing world action, will gather and distribute $100 billion (about €75.5 billion) by 2020 to help developing countries handle the side effects of global warming and climate change. The other important outcome was the progress on the UN Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN REDD), where governments agreed on a set of measures to reduce emissions from deforestation and forest degradation, establishing the means for results-based payments if developing countries can demonstrate the protection of forests (backed by initial pledges of $280 million). Deforestation and soil degradation are well known, not only as the negative effect of global climate change, but also as a significant contributor to it. In sum, recent progress on global climate issues has shown that the gap between leading industrialised and emerging countries is slowly narrowing, with the upcoming 2015 replacement protocol expected to be applicable to all nations involved in the climate change discussion process.

Environmental and sustainable development issues continued to be important for both internal and external EU policies. For instance, just weeks before the 19th UN FCCC/COP Poland's insistence on its use of coal to generate 88% of the country's electricity was seen to hold the EU back in its clean-energy goals intended to reduce the greenhouse gases linked to global warming.[26] Nevertheless, over the course of 2012 and 2013 several important initiatives regarding environmental issues were undertaken at the EU level.[27] Prior to the 18th UN FCCC/COP, the EU Council set out the EU position on climate change, in which in addition to stressing the urgency of establishing an ambitious international regime to solve global climate changes, it implemented its unilateral commitment to cut its emissions by at least 20% of 1990 levels by 2020.[28] At the 19th UN FCCC/COP, the EU's stance focused on the

[22] Harrabin, Roger. "UN climate talks extend Kyoto Protocol, promise compensation." 8 Dec. 2012. BBC 15 May 2014 <http://www.bbc.com/news/science-environment-20653018>.

[23] Doherty, Regan and Barbara Lewis. "Doha climate talks throw lifeline to Kyoto Protocol." 8 Dec. 2012. Reuters 15 May 2014 <http://www.reuters.com/article/2012/12/08/us-climate-talks-idUSBRE8B60QU20121208>.

[24] "Deadlock broken at UN climate talks." 24 Nov. 2013. Aljazeera 15 May 2014 <http://www.aljazeera.com/news/europe/2013/11/deadlock-broken-at-un-climate-talks-20131123163641928770.html>

[25] "Warsaw Outcomes." United Nations Framework Convention on Climate Change 15 May 2014 <http://unfccc.int/key_steps/warsaw_outcomes/items/8006.php>.

[26] Hakim, Danny. "Poland, Wedded to Coal, Spurns Europe on Clean Energy Targets."

[27] Council of the European Union. The 318th Council Meeting: Environment. Press Release 15321/11 final of 10 Oct. 2011. Brussels: European Union.

[28] "Environment ministers set out EU position ahead of Doha Climate Conference." 25 Oct. 2012. Council of the European Union 16 May 2014 <http://www.consilium.europa.eu/homepage/highlights/environment-ministers-set-out-eu-position-ahead-of-doha-climate-conference?lang=en>.

proper implementation of existing decisions and advancing work under the Durban Platform for Enhanced Action by quickly closing the gap in the pre-2020 level of mitigation ambition, and preparing the ground for adopting a new legally-binding global post-2020 climate agreement by 2015.[29]

During the Polish presidency, the EU Council adopted conclusions on the assessment of the EU's 6th Environmental Action Programme (EAP) 2002-2012. The conclusions proposed by the European Commission were seen as comprehensive and forward-looking, and took into account existing initiatives such as the Europe 2020 Strategy; the EU positions on the UN Conference on Sustainable Development (Rio +20); the post-2010 Biodiversity Strategy; and more. Regarding the 2012 Rio +20 UN Conference, the Polish Presidency significantly assisted in establishing the EU's general positions, mostly stressing the use of green energy in the context of sustainable development and poverty eradication, and the establishment of an institutional framework for sustainable development.[30]

Furthermore, on 20 November 2013 the European Parliament and European Council adopted a decision to establish the EU's 7th Environmental Action Programme (EAP) to 2020 "living well, within the limits of our planet", which entered into force in January 2014. It identifies three key objectives: e.g. protection, conservation and enhancement of the EU's natural capital; turning the EU into a resource-efficient, green, and competitive low-carbon economy; and safeguarding the Union's citizens from environment-related pressures and risks to health and wellbeing. It also lists four 'enablers' that will facilitate these goals: better implementation of legislation; better information by improving the knowledge base; increased and wiser investment for environment and climate policy; and full integration of environmental requirements and considerations into other policies. Its two overarching horizontal priority objectives are to make the Union's cities more sustainable, and to help the Union address international environmental and climate challenges more effectively.[31]

1.2.3 Energy

While economic recovery was on the uptick in 2012 and 2013, the global energy map was undergoing revision with the increase in oil and gas production in the United States, along with a retreat from nuclear power in some countries, growth in the use of wind and solar technologies, and the spread of unconventional gas production. Roles are beginning to shift among major energy importers and exporters, as decision makers attempt to reconcile their state economic, energy and environmental objectives. The next stage in global energy development will require an awareness of the dynamics underpinning energy markets to anticipate how growth may be achieved and, with the rise of unconventional oil and gas and of renewables, map where the distribution of the world's energy resources will take root.

Another recurring trend during the review period was the increasingly strong role of emerging countries in determining energy market behaviour. The tide of energy demand is beginning to flow toward emerging economies, particularly China, India, and the Middle East, which have increased global energy use by one-third. While the US is projected to become the largest oil producer by 2020, moving toward meeting all its energy needs from domestic resources by 2035, North America is expected to shift toward becoming a net oil exporter by 2030.[32] On the other hand, China is poised to become the largest oil-importing country and India will be the largest importer of coal by the early 2020s, which should shift the majority of energy trade from the Atlantic region to the Asian-Pacific.[33] By 2030, China's oil consumption is expected to overtake the US, while the Middle East will do likewise with the EU, as the decline in oil use in OECD countries accelerates.[34] An important side effect of this trend is that significant investments in energy production and distribution will have to be made to respond to growing demand. By some estimates, as much as $38 trillion will have to be invested in related infrastructure by 2035, of which $20 trillion is to be for fossil fuel exploitation.[35] Yet energy price variations among regions are likely to affect

[29] "EU adopts its position for the UN climate change conference." 15 Oct. 2013. Council of the European Union 16 May 2014 <http://www.consilium.europa.eu/homepage/highlights/eu-adopts-its-position-for-the-un-climate-change-conference?lang=en>.
[30] Council of the European Union. Rio+20: Towards Achieving Sustainable Development by Greening the Economy and Improving Governance. Council Conclusion 15388/11.
[31] European Union. Decision of the European Parliament and of the Council on a General Union Environment Action Programmes to 2020 "Living Well, Within The Limits Of Our Planet". 20 Nov. 2013, European Parliament and Council Decision PE-CONS 64/1/13 REV 1 of 20 November 2013. Strasbourg: European Union <http://ec.europa.eu/environment/newprg/pdf/PE00064_en.pdf>.
[32] International Energy Agency. World Energy Outlook 2012. IAE: Paris, 2012.
[33] International Energy Agency. World Energy Outlook 2013. IAE: Paris, 2013.
[34] Ibid. at 4.
[35] International Energy Agency. World Energy Outlook 2011. IAE: Paris, 2011.

industrial competitiveness, influencing investment decisions and company strategies. While the price of crude oil has remained high since 2011, the prices of other fuels have been subject to significant regional variations. It should be noted that energy-intensive sectors worldwide account for around one-fifth of industrial value addition, one-quarter of industrial employment and 70% of industrial energy use.[36]

Despite the growth in renewable low carbon sources of energy, fossil fuels remain dominant in the global energy mix, supported by six times more subsidies than subsidies to renewables in 2011. In the long run, the share of fossil fuels in the global primary energy consumption mix is projected to fall slightly from 81% in 2010 to approximately 75% in 2035, though natural gas is expected to increase its relative share within the fossil fuel mix. At the same time, the problem of decreasing the environmental footprint of fossil fuel energy consumption remains unsolved. With the energy sector responsible for two-thirds of global greenhouse-gas emissions, it will be pivotal in determining whether or not climate change goals are achieved. In the current scenario, even with carbon abatement schemes announced by the EU, the US, China, and Japan to improve energy efficiency, support renewables, reduce fossil-fuel subsidies and, in some cases, to put a price on carbon, energy-related CO2 emissions are expected to still rise by 20% by 2035.[37]

1.2.4 Resources

Space applications and Earth monitoring technologies play an important role in the area of resource management, as they can provide better control of and support for the utilisation of scarce natural resources. Likewise, satellite based technologies can perform indispensable tasks for international trade, e.g. by streamlining global business transactions and payments. Global navigation satellite systems (GNSS) are already relied on as an integral part of transportation and utilisation of natural, agricultural and industrial resources. And the use of meteorological and imaging satellites is making agricultural output bigger and more reliable, along with greater precision. For many developing countries the rationale for investment in space is improvement of the management of their agricultural and natural resources.

Between 2011 and the end of 2013, commodity prices continued to recede, though their effect on consumer price inflation varied between high-income and developing economies due to country-specific conditions. This tendency can be attributed to weaker global demand as a result of the economic crisis. Nevertheless, by the end of 2013, there were signs of a turning point in the global economy, as stronger growth was expected in high-income economies, which were beginning to match the growth of emerging economies that had been less scathed by the crisis. In this period, favourable weather conditions in several agriculture markets, as well as strong coal and metals production, led to price declines in these respective commodities. Oil prices eased by the end of 2013, due to the growing supply in the US and the easing of tensions surrounding Iran. Yet, there remains some uncertainty with regard to oil commodities, as potential political turmoil in the Middle East could result in substantial price increases, whereas the increase of crude-oil substitutions for other types of energy could result in the opposite outcome. Furthermore, currency fluctuations have affected domestic prices of commodities, sometimes increasing demand.[38]

While the rate of growth of international trade was expected to return to 7-8% in 2011, it fell below that mark, reaching 5.3% for that year; it decelerated even further to 1.7% in 2012. However, the return of trade to pre-crisis levels has been uneven among economies, with developed, developing and transitioning economies all experiencing a slower rate of expansion in 2012 than experienced in the previous year. For instance, trade in Europe has been sluggish, due partly to the nominal growth of imports in addition to its extremely weak intra-EU trade that was responsible for nearly 90% of the slowdown in Europe's exports. Japan has not fared much better in its exports following its 2011 earthquake, though it is beginning to increase its imports. However, the US is beginning to show signs of growth, with some increase in both its import and export volumes, despite signs of deceleration of the latter in 2013. Another example is the situation in the economies in transition. While figures remained positive for most transition economies, they have decelerated considerably with export volumes increasing by 1% in 2012 from 4.2% in 2011, and imports dropping to 3.9% in 2012 from 15.7% in 2011. Developing economies also experienced diminishing growth in 2012, though the change

[36] International Energy Agency. World Energy Outlook 2013. IAE: Paris, 2013.
[37] Ibid.

[38] The World Bank. Global Economic Prospects – Coping with policy normalization in high-income countries. Volume 8 / January 2014. Washington DC: World Bank, 2014.

was not quite as severe, with import growth falling to 4.5% in 2012 from 7.4% in 2011, and exports displaying similar results at 3.6% in 2012 from 6% in 2011. It would appear that the previous crisis has altered trade patterns, with the volumes of trade of most developed regions remaining below their pre-crisis levels, while imports and exports in emerging economies have exceeded their pre-crisis peaks, though even that growth appears to be slowing down recently due to decreases in demand, hinting at a less favourable trade environment in the near future.[39]

Oil and mineral exporters experienced significant gains during the period. Oil prices remained high and relatively stable between 2012 and 2013, primarily because of decreases in production by members of the Organization of the Petroleum Exporting Countries (OPEC) in the last quarter of 2012, and geo-political tensions in Western Asia affecting oil supplies. Increased oil production in North America, and decelerating global demand growth in OPEC countries brought downward pressure on oil prices in 2013, though prices still increased at the start of the year based on expected improvement in economic conditions. To compare the situation with previous years, according to the figures of the United Nations Conference on Trade and Development (UNCTAD) crude oil market prices fluctuated in a $99-$111 band during the second half of 2012 and first half of 2013, with an average price of $105.5 per barrel for the 12-month period. While in 2011 growth in the oil trade expanded by roughly 1%, demand for crude oil marginally increased again by 1.5% in 2012. For 2013, growth in the demand for oil was expected to come from non-OECD countries, while it was expected to fall for OECD countries.[40]

Additionally, non-oil commodity prices continued to exhibit some negative growth, due in part to improved supply conditions and a steep decline in global demand. However, there are signs of an uptick in the near future resulting in a minimal price growth in these commodities, with increasing demand coming from rapidly growing developing countries such as China. Nevertheless, whereas non-oil commodity prices posted a 17.9% increase in 2011, those prices decreased by 8.4% in 2012, and showed a further reduction of 3.3% in 2013.[41] Non-oil commodities prices are forecast to begin increasing by 2016.[42] As in previous years, uncertainty and instability have been the major distinguishing features of commodity markets, which is also reflected in the greater volatility of commodity prices. Looking at UNCTAD commodity price statistics, between the two periods 2003-2007 and 2008-2012, the simple measure of commodity groups showed medium levels of volatility in food commodity prices, with prices increases diminishing somewhat in the second period. On the other hand, vegetable oil seeds and oils, agricultural raw materials, minerals and metals and crude petroleum all showed higher levels of volatility.[43] Whereas metals and minerals prices rose steeply in the second half of 2010, and peaked during the first months of 2011 with relative stability in the following 18 months, prices in this market group declined sharply by mid-2013, with the index expected to decline almost 11% in 2013. While gold, along with platinum and silver, have benefited from uncertainties about the global economy, the decline has marked a reversal from the previous eleven years of increasing precious metals prices. While still considered as safe havens, the indexes for gold, silver, and platinum declined by 15.5%, 23.5%, and 9.8% respectively in 2013.[44] This is partially due to production and supply improvements, along with global recovery picking up pace, and the easing of financial tensions in Europe.[45]

1.2.5 Knowledge

There is no doubt that sustained education and knowledge improvement is one of the necessary conditions for successful space activities, as well as for the full exploitation of their societal benefits. In general, space technology and development, drawing on multiple scientific disciplines, is one of the most difficult and challenging fields in scientific and technical research. Therefore, coherent and sustainable strategies aimed at improving higher education and supporting technical and scientific activities are particularly relevant and necessary for space sector activities.

[39] United Nations Conference on Trade and Development. Trade and Development Report, 2013. Geneva: UNCTAD, 2013. 1-10.
[40] Ibid. at 7-10.
[41] Ibid. at 9.
[42] The World Bank. Global Economic Prospects – Coping with policy normalization in high-income countries. Volume 8 / January 2014. Washington DC: World Bank, 2014.
[43] Instability indices and trends of free-market commodity prices for selected periods, annual, 1983-2012. UNCTADstat 13 Apr. 2014 <http://unctadstat.unctad.org/ReportFolders/reportFolders.aspx>.
[44] World Bank Group. Global Economic Prospects – Commodity Markets Outlook. 2014 / April. Washington DC: World Bank, 2014: 19.
[45] The World Bank. Global Economic Prospects – Less volatile, but slower growth. Volume 7 / June 2013. Washington DC: World Bank, 2013: 104.

For Europe, the expansion of its pool of highly skilled and specialised scientists and professionals should be a constant priority if it is to remain a leading actor in the field of space-related scientific and technological R&D. With other developed and emerging economies increasing investment in R&D in response to the financial crisis, for Europe to remain a leader in the global race for knowledge and excellence in space R&D current levels of financial spending and political commitment in this area will have to be increased, and not only simply maintained. For example, in 2013, 29% of the European working age population (including all EU Member States except Bulgaria, Cyprus, Malta, Latvia, Lithuania, Romania, and Croatia) held a higher education degree compared to 42% in the US, 46% in Japan and 51% in Canada.[46] While OECD figures tend to show that many European states can expect in the future a significant increase in the proportion of their population that attains a higher education degree, countries including Germany and Austria, and to a lesser extent Italy, Slovakia, Hungary, Czech Republic, and Greece are at risk of falling further behind the OECD average of 32% of the working age population (between 25-to-64 years of age) with a higher education degree.[47]

Yet the crisis has reinforced the importance of a good education. Employment rates were the highest among people with a tertiary education with higher or specific skills, while low-skilled workers were more likely to find that their jobs had been automated.[48] According to a 2012 report of the European Centre for the Development of Vocational Training, the European skills forecast indicates that by 2020 around 38.2% of jobs in the EU will require higher education qualifications, while medium qualification jobs would remain at about 46.5%, and low qualification jobs would diminish to 15.3% from 21.9% in 2010.[49] By 2011, the share of the European population aged 30-34 having completed tertiary or equivalent education reached 37%. When looking at graduation rates in tertiary education, it is likely that most European countries will achieve the EU's goal of 40% of 30-34 year-olds completing higher education by 2020.[50] However, only 26% of the overall working age population are qualified to this level today.[51] While the EU is several points short of its 40% goal, it can identify three main challenges that are common to many Member States and have a direct impact on the ability of higher education systems to provide the number of highly qualified graduates a modern knowledge-based economy needs. These include the need to broaden access to higher education especially for states such as Bulgaria, Romania, the Czech Republic, Greece, and Hungary; to reduce drop-out rates and the time it takes to complete a degree, experienced mainly in Austria, Belgium, France, Greece, Hungary, Italy, the Netherlands, Poland Romania, Sweden, and Slovenia, and to improve the quality of higher education and make it more relevant.[52]

Encouragingly, the population of university and higher education students in Europe has been constantly increasing in recent years. Today, there are approximately 4,000 universities and other kinds of higher education institutions in Europe, with more than 19 million students. Nevertheless, this quantitative increase has not been accompanied by qualitative improvements in governance structures and proposed academic curricula, or by increases in funding. Although increasing in size, Europe's higher education system has not yet achieved an academic curricula distribution that will train scientists and professionals with the right kinds of skills to support economic growth and scientific excellence in new technologies. This is especially true for the space sector, which has a relatively limited human resources supply and demand chain.[53]

According to a European Commission report, the potential of European higher education institutions to fulfil their role in society and contribute to Europe's prosperity is not fully exploited. EU officials have pointed out that greater capacity for research and development could fuel innovation across all sectors of the economy, improving competitiveness and fostering job creation. The same report highlights the potential technological spin offs of innovation and their capacity to revitalise more traditional economic sectors and rural areas, multiplying their broader societal impact.[54] In this context, the role of space ap-

[46] OECD. Education at a Glance 2013: OECD Indicators, OECD Publishing, 2013: 37 <http://dx.doi.org/10.1787/eag-2013-en>.
[47] Ibid. at 31.
[48] Ibid. at 74.
[49] European Centre for the Development of Vocational Training. Future skills supply and demand in Europe: Forecast 2012. CEDEFOP, 2012: 34.
[50] OECD. Education at a Glance 2013: European Union – Country Note. OECD Publishing, 2013: 8.
[51] National Priorities: Recent Trends & Future Developments – European Union. 1 May 2012. International Institute of Education 5 May 2014.
[52] Europe 2020 Target: Tertiary Education Attainment. Europa.eu 11 May 2014 <http://ec.europa.eu/europe2020/pdf/themes/28_tertiary_education.pdf>.
[53] Id.
[54] European Commission. Communication from the Commission. Europe 2020: A Strategy for Smart, Sustainable

plications should be highlighted, as for example in the case of using communications satellites to improve broadband Internet connectivity in remote areas. Finally, the new strategy proposed by the European Commission identifies priority areas where EU countries need to do more to achieve shared education objectives and describes how the EU can support the modernisation of national higher education policies. According to the EC proposal, EU-level initiatives will include a multi-dimensional university ranking which will better inform students about university courses and support competition between universities.

The EU budget dedicated to funding programmes for education, training and youth was about €8.8 billion for the period 2007-2013. In addition to this, the EU spent an additional €4.7 billion on training, mobility and career development for researchers. For the 2014-2020 budget period the European Commission emphasises the priority of "smart growth" through knowledge creation, consequently allocating substantial funds to skills and knowledge creation. According to the budget proposal, a single funding programme for education, training and youth will receive €15.2 billion in the 2014-2020 period, which means an increase of 73% compared to the 2007-2013 period. The Commission has also proposed a 46% rise in research funding under the planned Horizon 2020 strategy that will bring funding up to €80 billion.[55]

Considering the shortcomings, it was not a surprise that initiatives in the scientific research and education fields were among the top priorities of the EU Council. For example, increasing continuous learning, as well as educational and professional mobility, and modernising higher education infrastructure and curricula were some of the key initiatives in this respect. The implementation of these priorities followed the broad lines of the Europe 2020 Strategy and its flagship initiative "Youth on the Move", for the creation of new skills and new jobs. In this context, the Council launched a comprehensive debate on learning and mobility issues in the framework of EU educational programmes, taking into account its international dimension and also including EU neighbours. These actions were further supported by the European Commission, which set the goal of doubling the number of EU grant recipients for studying and training abroad at 800,000 students by 2020. In addition to this, around €72.5 billion was to be spent on education and training across Europe's regions until 2013, and this pace is expected to be maintained in the future.[56]

1.2.6 Mobility

Maritime commerce accounts for the bulk of global trade, whereas air traffic carries most of the world's passenger traffic. Space assets are indispensable to both, as they provide meteorological, navigation and communication services that make sea and air transport safer and cheaper. Maritime navigation and mobile communications are two of the upcoming sectors with significant financial interests in the development of new generations of satellite-based applications.

In the two years ending in December 2013, the transport sector, particularly in Europe, continued to suffer from the effects of the global financial crisis. As the principal facilitator of global commodity flows, the transport sector continued its steep decline in demand due to the crisis, and the subsequent slowdown in the demand for raw materials. Recovery has been uneven across regions, with the loss of momentum of trade growth affecting the rate of economic recovery among states at different speeds. In addition to a weaker world economy in 2011, trade was also affected by natural and political disasters that had the effect of disrupting supply chains and production processes in parts of Asia and North Africa. On top of those economic uncertainties, the financial crisis brought with it a lack of trade finance, and an influx of protectionist measures that were additional factors that clouded the outlook for trade. Moreover, the tightening of lending by the banking sector also adversely affected transport, restraining necessary credit flows that facilitate international commerce transactions. Indeed, the collapse of confidence that accompanied the sovereign debt crisis in Europe had significant repercussions in the transport sector, with several banks refusing to issue letters of credit or accepting certain forms of collateral for loans. These effects continued into 2013, albeit with signs of marginal growth in all regions but the EU. The European Union has been slower to recover in global trade growth due in-part to constraints from austerity

and Inclusive Growth. COM (2010) 2020 final of 3 Mar. 2010. Brussels: European Union.

[55] "An EU Strategy for Modernising Higher Education – Questions and Answers." 20 Sept. 2011. European Commission – Press Release. 1 Mar. 2012 <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/11/615&format=HTML&aged=0&language=EN&guiLanguage=fr>.

[56] "Extra Funds for Education, Youth and Creativity Will Boost Jobs, says Commission." 11 June 2011. European Commission – Press Release. 29 Feb. 2012 <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/857&format=HTML&aged=0&language=EN&guiLanguage=fr>.

measures and rising unemployment, which resulted in a reduction of import demand.

Maritime transport is the most commonly used form of transport for international trade, representing the bulk of global trade transport (90%). Consequently, it suffered the greatest blow from the continued crisis beginning in 2008. Indeed, the impact of the financial crisis terminated one of the longest uninterrupted growth periods in recorded maritime history, with vessel orders reaching 10,053 ships by the beginning of 2008, making the timing of the crisis particularly adverse. In the following two years, a great number of orders were cancelled, due to decreased maritime activity that led to an unprecedented level of distress demolitions (projected to have reached 15-18% of world fleet capacity in 2010). In 2011, the total quantity of tonnage sold for demolition increased by 31%, with a 356% surge in the scrapping of many still sea-worthy dry-bulk ships that were sold rather than allowed to continue to generate financial losses due to energy inefficiencies.[57] The total tonnage sold for demolition increased by another 36.7% in 2012, with similar results as the previous year.[58] However, orders for new vessel types are at a historical low, bringing a need for investors to place new orders or risk that all sectors of the maritime industry will reduce employment levels. Another medium-term consequence of the financial crisis with effects on sea trade could be the appearance of protectionist measures that would further hinder world trade.

Another challenge for the maritime industry was the increased number of piracy incidents, especially off the Somalia coast, the Gulf of Aden and the West Indian Ocean between 2005 and 2012. Although an increased international military presence in these regions improved security somewhat, piracy incidents persisted. Nevertheless, while the number of reported piracy incidents in 2011 increased by 11.3% to 544, that number decreased by 37.3% to 341 reported incidents in 2012. That number again decreased by 12.6% to 298 reported piracy incidents in 2013, with the number of Somalia-based piracy incidents falling to 20, from the 78 incidents reported in 2012. Still, there remain a high number of captives held ashore.[59] In its heyday, the surge in piracy in the Gulf of Aden generated considerable costs especially for Europe as 80% of shipments that pass through the area come from or are going to this continent. Rerouting shipments around the Cape of Good Hope alone is estimated to have created over $7.5 billion of additional shipping costs annually with associated increased energy consumption. Coordinated measures were undertaken by the International Maritime Organisation (IMO) to face the deteriorating security environment in the area and provide security for ships navigating in these waters. In this context, it approved of ship owners voluntarily arming their vessels at their own expense, notably by hiring armed guards when passing through the region, and later drafted guidelines on the use of such personnel on board ships in the high risk area.[60]

[57] United Nations Conference on Trade and Development. Review of Maritime Transport 2012. Geneva: UNCTD, 2012. 49.

[58] United Nations Conference on Trade and Development. Review of Maritime Transport 2013. Geneva: UNCTD, 2013. 60.

[59] C.f. International Maritime Organization. Reports On Acts Of Piracy And Armed Robbery Against Ships: Annual Report 2012. MSC.4/Circ.193 of 2 Apr. 2013. London: IMO <http://www.imo.org/OurWork/Security/PiracyArmedRobbery/Reports/Documents/193_Annual2012.pdf>; International Maritime Organization. Reports On Acts Of Piracy And Armed Robbery Against Ships: Annual Report 2013. MSC.4/Circ.208 of 1 Mar. 2013. London: IMO <http://www.imo.org/OurWork/Security/PiracyArmedRobbery/Reports/Documents/208_Annual_2013.pdf>.

[60] International Maritime Organization. Revised Interim Guidance To Shipowners, Ship Operators And Shipmasters On The Use Of Privately Contracted Armed Security Personnel On Board Ships In The High Risk Area. Maritime Safety Committee. MSC.1/Circ.1405/Rev.2 of 25 May 2012. London: IMO <http://www.imo.org/OurWork/Security/PiracyArmedRobbery/Guidance/Documents/MSC.1-Circ.1405-Rev2.pdf>; International Maritime Organization. Revised Interim Recommendations For Flag States Regarding The Use Of Privately Contracted Armed Security Personnel On Board Ships In The High Risk Area. Maritime Safety Committee. MSC.1/Circ.1406/Rev.1 of 16 September 2011. London: IMO <http://www.imo.org/MediaCentre/HotTopics/piracy/Documents/1406-Rev-1.pdf>.

2. Global Space Economy

This chapter covers the 2012 and 2013 public budgets and commercial revenue that are related to space activity. There will be a brief discussion of space related public budgets and commercial revenue with a quantitative assessment of the overall market value and financial performance of space activities in the last 24 months. It should be noted that in the absence of internationally uniform standards, developing an accurate estimate of financial and market figures of global space activities is a complicated task, especially when considering that most countries and space research institutions adopt their own distinct methods of categorising and distributing funding for space activity. Likewise, the lack of transparency in certain government space programmes, e.g. military space projects, further complicates calculations. Moreover, commercial companies 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 Revenue

Worldwide national space budgets continued to increase in 2012, although funding decreased in 2013. In 2012, total world governmental expenditure on space programmes amounted to $78.44 billion from $72.77 billion in 2011, with much of the increase going toward military programmes.[61] Total government expenditures for civil space programs decreased from $44.92 billion in 2011 to $42.24 billion in 2012.[62] In 2013, total world governmental expenditure on space programmes amounted to $74.10 billion, a 1.7% decrease in the respective funding prior to conversion into US currency for comparison, with the US government decreasing its funding by 9.4%, while non-US government investment increased by 10.1%.[63] Total government expenditure for civil space programs decreased slightly to $42.17 billion in 2013.[64] It should be mentioned that the rate of overall growth of these space budgets has decreased in intervals since 2010. In the entire space industry, including commercial revenues and government expenditure, the compound annual growth rate (CAGR) peaked in 2010 at 6.3%; thereafter in 2011 it reduced to 5.7%, dropping lower to 4.1% in 2012, and settling at 4.0% in 2013.[65] A more detailed analysis of institutional budgets is set out in the following section.

The Space Reports of 2013 and 2014 were used as guides for the commercial revenue of space activities, listing the 2012 total revenue of commercial satellite services at about $115.97 billion. These revenues were compiled from various activities including telecommunications, Earth observation and positioning services. This amount is a 4.9% increase from the $110.53 billion in 2011. The revenue of space-related commercial infrastructure including manufacturing of spacecraft and in-space platforms, launch services as well as ground equipment is estimated to have reached around $109.90 billion (this diminished amount corresponds to the 7% decrease in launch attempts numbering 78 in 2012, down from 84 in 2011). Overall, total commercial space revenue in 2012 reached $225.87 billion.[66] In 2013, total revenue of commercial satellite services grew by 5.7% reaching $122.58 billion, while space-related commercial infrastructure grew by 6.9% reaching $117.49 billion; i.e. total commercial space revenue reached $240.07 billion in 2013.[67]

2.2 Overview of Institutional Space Budgets

From the Space Report, total institutional spending on space programs in 2012, including that of intergovernmental organisations, can be estimated to have increased by 1.3% (prior to conversion into US currency for

[61] The Space Report 2013. Colorado Springs: The Space Foundation, 2013: 26.
[62] Ibid. at 40. The amount was calculated by subtracting the total military expenditure on space from the total world governmental expenditure on space (see supra footnote).
[63] The Space Report 2014. Colorado Springs: The Space Foundation, 2014: 24.
[64] Ibid. at 40.
[65] Ibid. at 24.
[66] The Space Report 2013, 26.
[67] The Space Report 2014, 24.

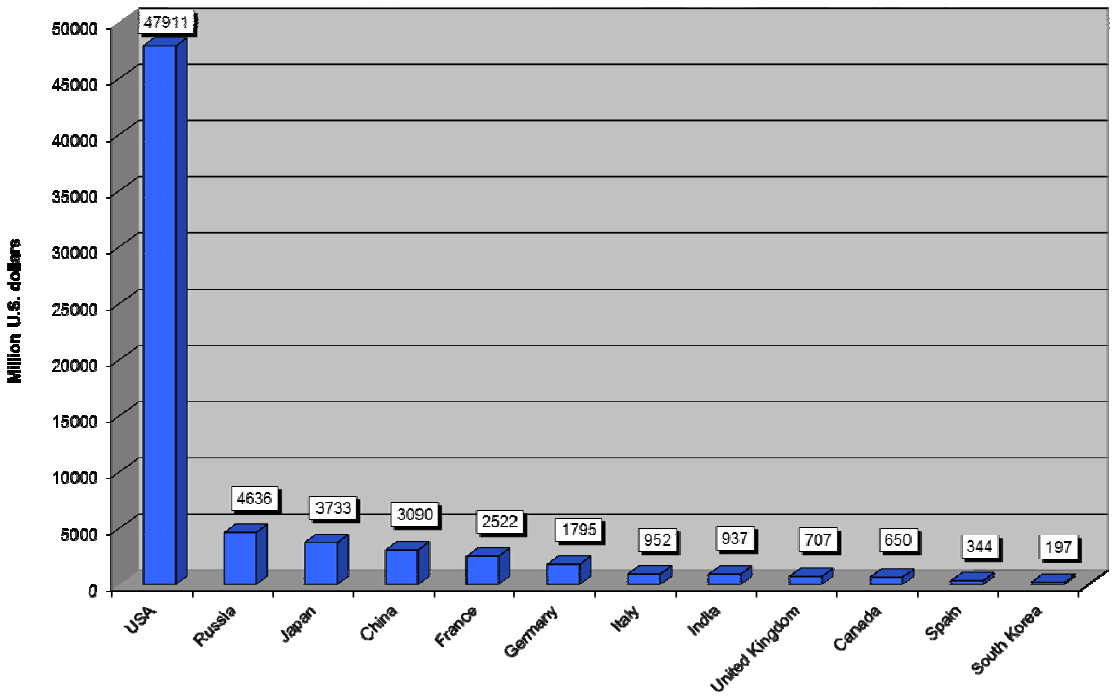

Figure 2.1: Public space budgets of major space powers in 2012 (Based on Euroconsult and the Space Report 2013 data)

comparison) to $78.44 billion in 2012 from $72.77 billion in 2011; these estimates do not fully depict the changes in budgetary spending cycles in all states that are considered, though.[68] This space spending was comprised of a reduced 53.9% share in civil expenditure ($42.24 billion of the total) and an increased 46.1% share in defence expenditure ($36.2 billion); this ratio changed by a factor of 7.8 percentage points from 2011. Total institutional spending on space programs in 2013 decreased by 1.7% to $74.10 billion, with civil expenditure ($42.17 billion of the total) increasing its share to 56.9%, while global defence expenditure ($31.93 billion) held a reduced share of 43.1%.[69]

On the other hand, estimates by Euroconsult listed 2012 civil space expenditure to be $41.30 billion, while its estimates for government expenditure for defence space programmes reached $31.69 billion.[70] Here, the 2012 ratio of defence expenditure relative to civil expenditure experienced moderate change compared to 2011, with a 56.6% share for civil expenditure and a 43.4% share in defence expenditure compared to 52% and 48% respectively in 2011. In 2013, civil space expenditure reached $43.72 billion, while defence space programmes amounted to $28.43 billion; changing the civil-to-defence ratio to 60.6% toward civil expenditure, while 39.6% of funding went to defence purposes.[71]

The Space Report 2012 estimated worldwide defence related space expenditure to be $27.85 billion in 2011, with 95% of this funding going toward US national defence purposes, the 2013 edition of this report showed the US share of defence related space expenditure to have diminished substantially. In 2012, while worldwide defence related space expenditure increased to $36.2 billion, US spending in defence increased to $27.47 billion, reaching a 75.9% share of the total amount; in the following year, worldwide defence related space expenditure declined to $31.93 billion, the US share of that amount ($21.72 billion) amounted to 68.0%. The funds in the US came from, *inter alia*, the Department of Defence (DoD), the National Reconnaissance Office (NRO), and the National Geospatial-Intelligence Agency (NGA). It should be noted that a degree of uncertainty exists regarding expenditures on defence space activities as not all relevant fund

[68] Cf. The Space Report 2013, 37 and The Space Report 2012. Colorado Springs: The Space Foundation, 2012: 43; note: Figures in this section are based on the Space Report data (USA, Russia, Japan, China, and France), while all other values in figures 2.1 & 2.2 come from the Euroconsult Report 2013 - Profiles of Government Space Programs. Paris: Euroconsult, 2014.

[69] Cf. The Space Report 2014, 40 and The Space Report 2013, 37; note: Figures in this section are based on the Space Report data (USA, Russia, Japan, China, and France), while all other values in figures 2.1 & 2.2 come from the Euroconsult Report 2013 - Profiles of Government Space Programs. Paris: Euroconsult, 2014.

[70] Profiles of Government Space Programs. Paris: Euroconsult, 2014: 9-12.

[71] Ibid.

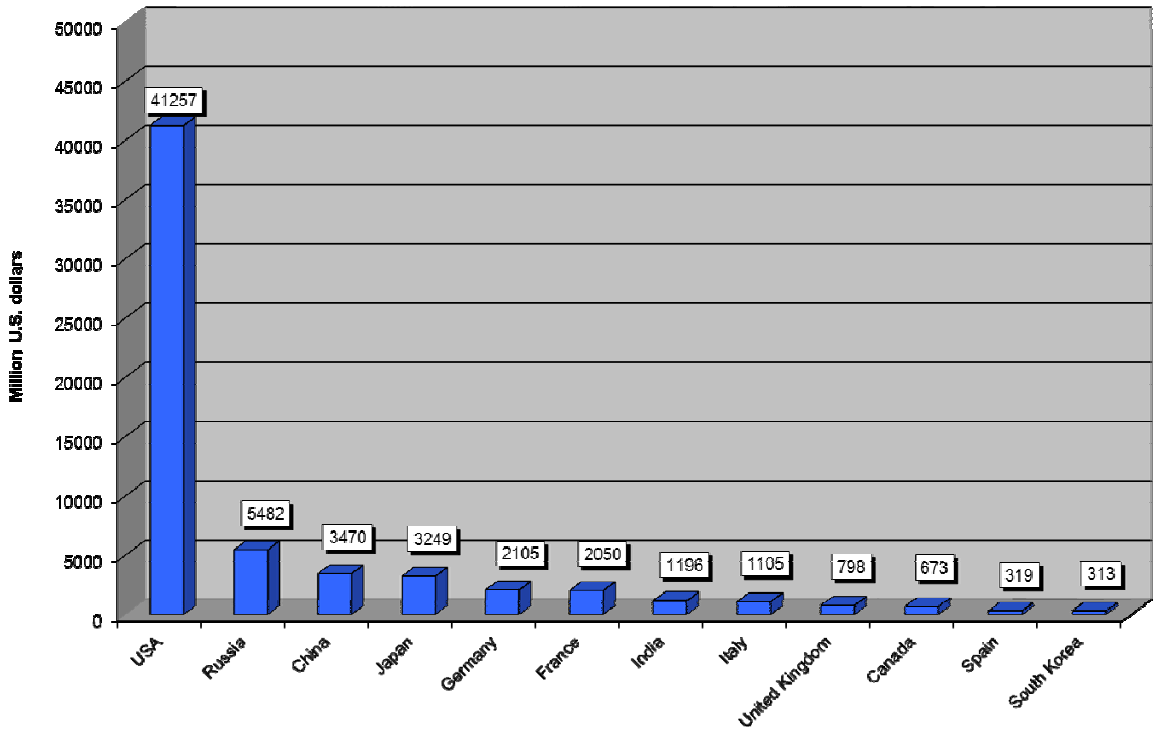

Figure 2.2: Public space budgets of major space powers in 2013 (Based on Euroconsult and the Space Report 2014 data).

ing is made public. While the United States is still clearly a driving force in worldwide space activity, particularly in the defence area, its lead has begun to diminish while other states have continued to gain ground.

The expenditure hierarchy among states remained unchanged in 2012, but saw significant reordering in 2013. The United States holds a strong lead position, with the largest space budget placing $20.44 billion toward civil purposes, and $27.47 billion toward defence; in 2013, $19.54 billion went toward civil purposes and $21.72 billion toward defence.[72] Russia's budget, though increasing by 12.5% in 2012 and 18.2% in 2013, is still considered as underestimated due to sparse information on its classified military launches, and its scientific programmes. In 2013, China took third position in funding, previously held by Japan. While France increased its spending in 2012 by 11.1%, it was overtaken by Germany in 2013.[73] India and Italy reduced the gap for the 7th position, with India increasing its budget by 27.5% in 2013, while Italy saw a 16.1% increase in its space spending for civil and military purposes.

The European Space Agency maintained a relatively unchanged budget for 2012 of €4.02 billion ($5.17 billion), nominally increasing the amount from €3.994 billion ($5.33 billion) in 2011.[74] In 2012 the five biggest contributors were Germany 18.7%, France 17.9%, Italy 8.7%, the UK 6.0%, and Spain 4.6%. The biggest ESA contributors in 2013 were Germany 18.0%, France 17.5%, Italy 9.3%, the UK 7.0%, and Spain 3.5%.[75]

And while Japan's budget listed another reduction of 3.7% in 2012, moving from ¥309.4 billion to ¥298.0 billion; its space budget increased by 8.1% to ¥322.2, marking a shift from Japan's reduced spending immediately following its regional crisis and a change in its priorities.[76] The increasing civilian budgets of the Asian space powers, Japan, China, and India have helped to balance the world concentration of space expenditure, accounting for about 11.8% of the whole, whereas the US, Europe (including ESA contributions), and Russia, generated around 82.9% of that expenditure in 2013.[77]

When measuring the concrete effort of countries in the space sector it is necessary to put the figures into perspective in regard to GDP[78] (Figures 2.3 and 2.4). Yet considering

[72] The Space Report 2014, 38.
[73] Ibid. at 47.

[74] "ESA Budget for 2012." Jan. 2012. ESA 30 May 2014 http://download.esa.int/docs/corporate/pies_final_final.ppt.
[75] "ESA Budget 2013." 24 Jan. 2013. ESA 2 Feb. 2014 <http://www.esa.int/About_Us/Welcome_to_ESA/Budget_as_presented_during_DG_press_conference_24_January_2013>.
[76] The Space Report 2014, 52.
[77] Euroconsult 2014: 8.
[78] The data used is the nominal GDP converted to current US dollars using the official exchange rates as indicated by the International Monetary Fund.

the absolute numbers alone will paint only a partial picture since comparisons between countries with different economic conditions (e.g. purchase power parities or wage levels) can be misleading.

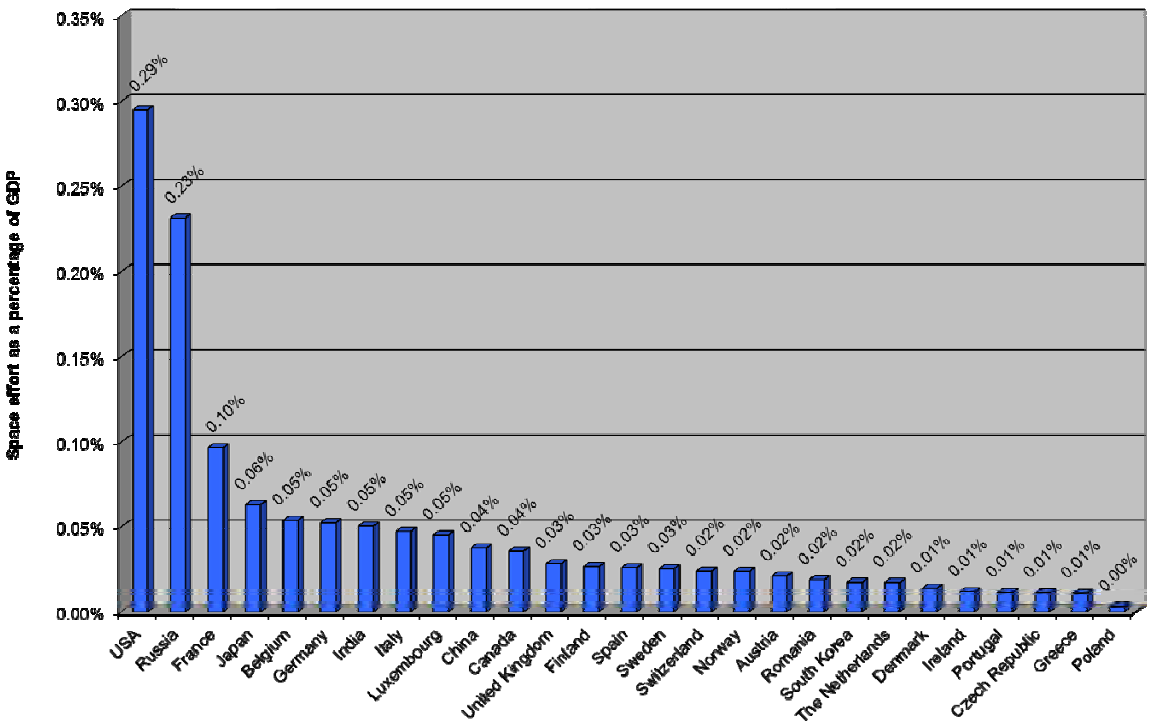

Figure 2.3: Public space budgets (selection) as a share of nom. GDP in 2012 (source: Euroconsult/IMF)

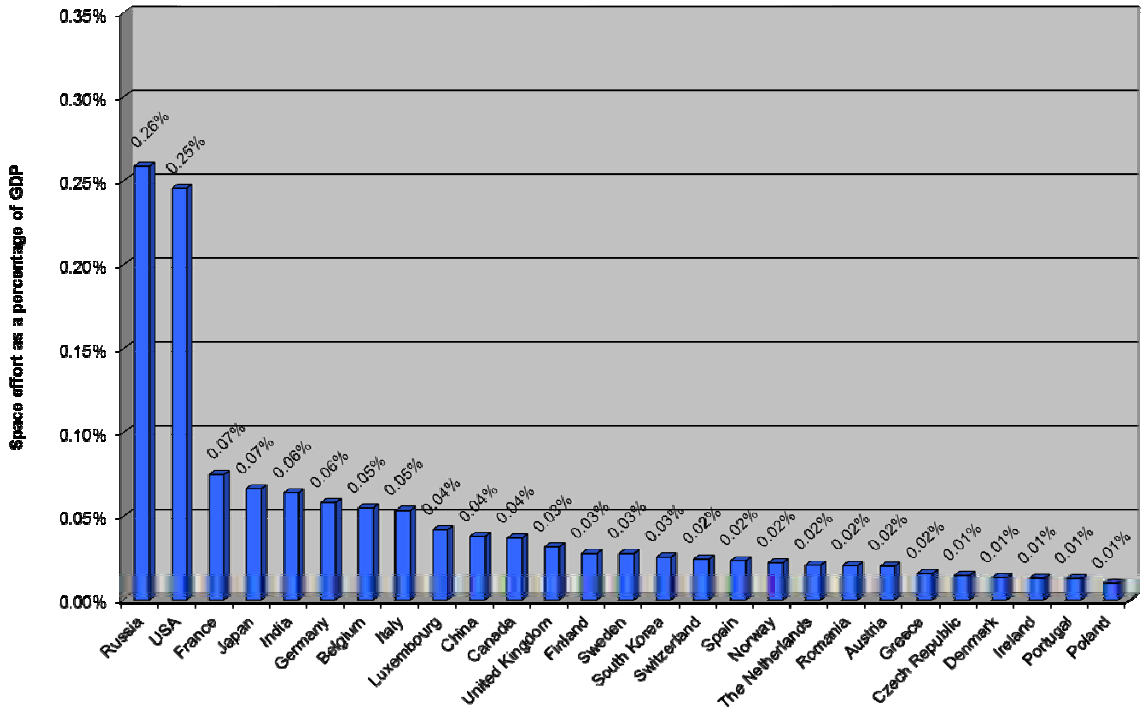

Figure 2.4: Public space budgets (selection) as a share of nom. GDP in 2013 (source: Euroconsult/IMF)

In 2012 and 2013, US space budget figures continued to diminish, falling to 0.29% in 2012 from 0.31% in the previous year; they dropped even further to 0.25% in 2013. What is most revealing in this comparison is that while the US amount still evidences its strong engagement in the space field, in 2013 the US dropped to second position in terms of space budgets as a percentage of GDP. While the US seems to be tapering off its level of investment, Russia's space effort has continued to increase, moving up by 0.01 to 0.23% in 2012, followed by an increase to 0.26% in 2013, which surpassed the US for first position. France reclaimed its 3rd position spot relating to space efforts as a percentage of GDP for both 2012 and 2013 with 0.10% and 0.07% respectively, while Japan and India maintained their spending ratios at 0.07% and 0.06% respectively in 2013. In both 2012 and 2013, Germany, Belgium, and Italy invested 0.05% of their GDP on space activities, while the other leading space countries in Europe continued to invest 0.05% or less.

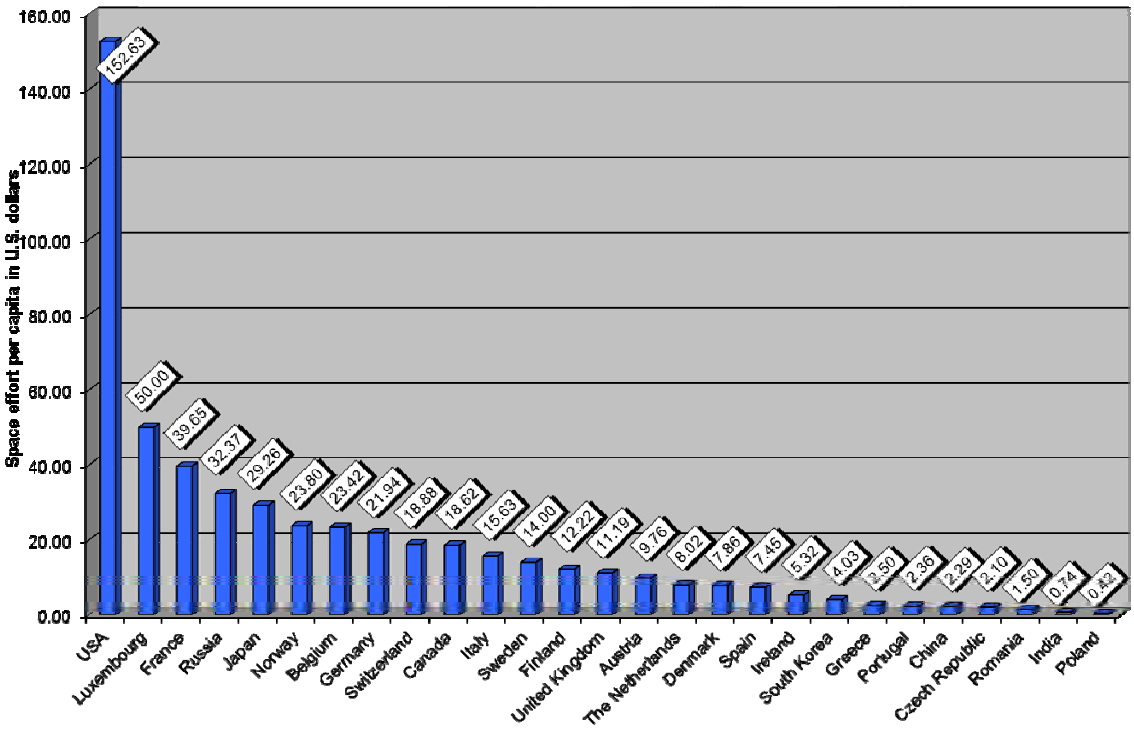

Figure 2.5: Public space budgets per capita (selection) in 2012 (source: Space Report 2013/Euroconsult/Population Reference Bureau)

While the US dominated per capita space expenditure in 2012 at $152.63 (an increase of 0.7% from 2011), its lead dropped by 14.5% to $130.48 in 2013. France's per capita space budget remained relatively unchanged between 2012 and 2013, staying at about $32 (a 10.5% decrease from 2011). Luxembourg's per capita budget maintained second place with $50.00 for both years (a 13.6% increase from 2011); Belgium's amount grew to $23.87 (barely increasing from $23.55 in 2011), with funding from both states directed toward participation in ESA (Luxembourg contributed 0.37%, and Belgium 4.2% to ESA's 2012 Space Budget, and 0.35% and 4.4% respectively to the 2013 budget). While, Norway had advanced its position in its per capita space budget beyond Belgium and Germany, increasing its amount by 13.3% to $23.8 in 2012, it was surpassed in the following year by both countries, spending a reduced $22.35 for 2013. And in 2012, Japan's per capita budget decreased by 2.4% while also being overtaken by Russia's 12.2% increase; the gap between the two expanded even further in 2013, though that is partially due to currency exchange discrepancies as both countries increased their spending significantly.[79] In 2012, the per capita space budgets of 11 European states decreased (including the Netherlands, Sweden, Denmark, Austria, Finland, Portugal, Ireland, Spain, Italy, Germany, and Belgium) with the most substantial decrease being that of the Netherlands, dropping by 30.9%; the decrease of the other states mentioned did

[79] The Space Report 2013, 52-53, and The Space Report 2014, 52-53.

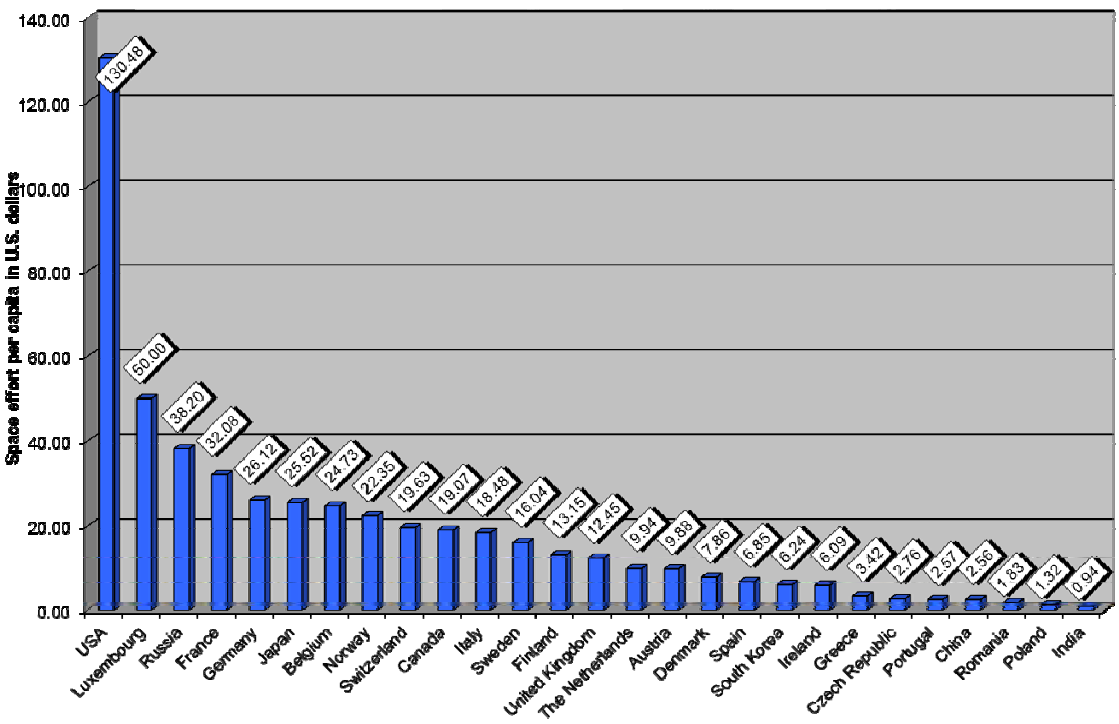

Figure 2.6: Public space budgets per capita (selection) in 2013 (source: Space Report 2014/Euroconsult/Population Reference Bureau)

not exceed 13%. Nevertheless, the same number of states have experienced an upswing in per capita space funding since 2011 (including Romania, Canada, the United Kingdom, Luxembourg, Norway, Russia, France, the Czech Republic, Greece, Switzerland, and the United States). Authoritative sources differ on the situation in India and China due in part to their socio-economic characteristics.

In 2013, while Luxembourg and Denmark showed little change from the previous year, a large majority of the states considered experienced growth in their per capita space funding. Poland had the most dramatic change at 216.3%, along with South Korea`s strong increase of 54.8%, and eight other European states saw growth of over 14% (i.e. Greece, Czech Republic, the Netherlands, Romania, Germany, Italy, Sweden, and Ireland); the US had a 14.5% reduction from the previous year, while France`s decrease was an even larger 19.1%

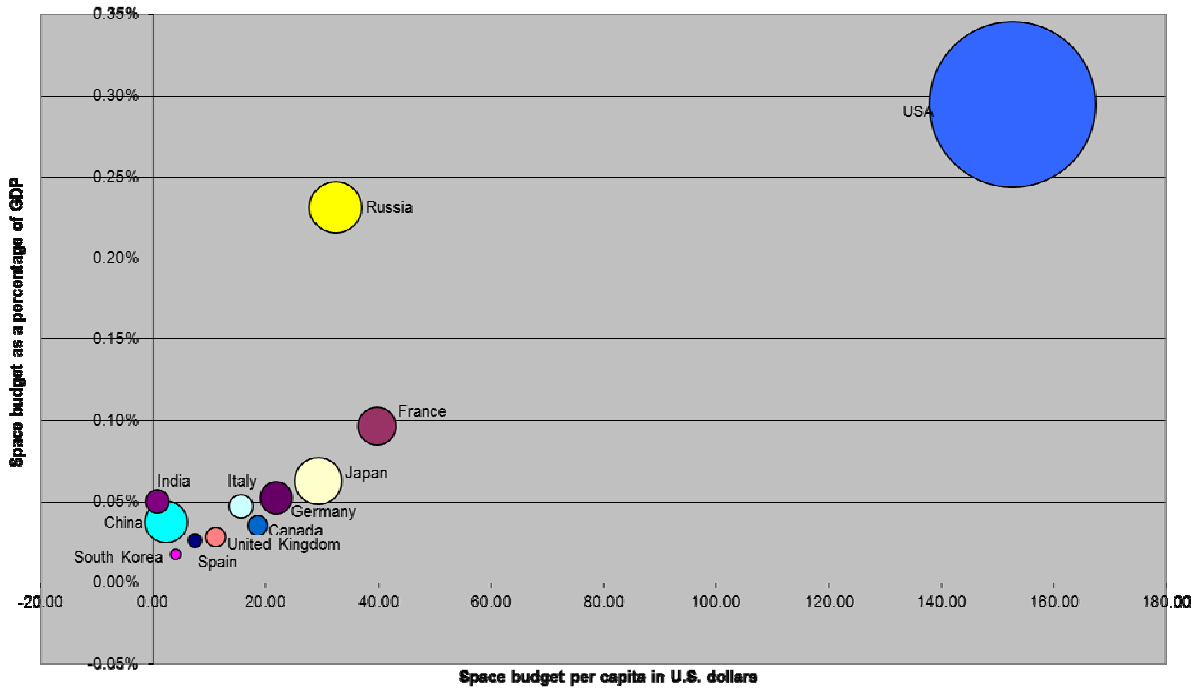

Figure 2.7: Public space budgets as share of GDP mapped against space budgets per capita in 2012. The bubble size indicates the absolute space budget (Based on Space Report 2013 and Euroconsult data)

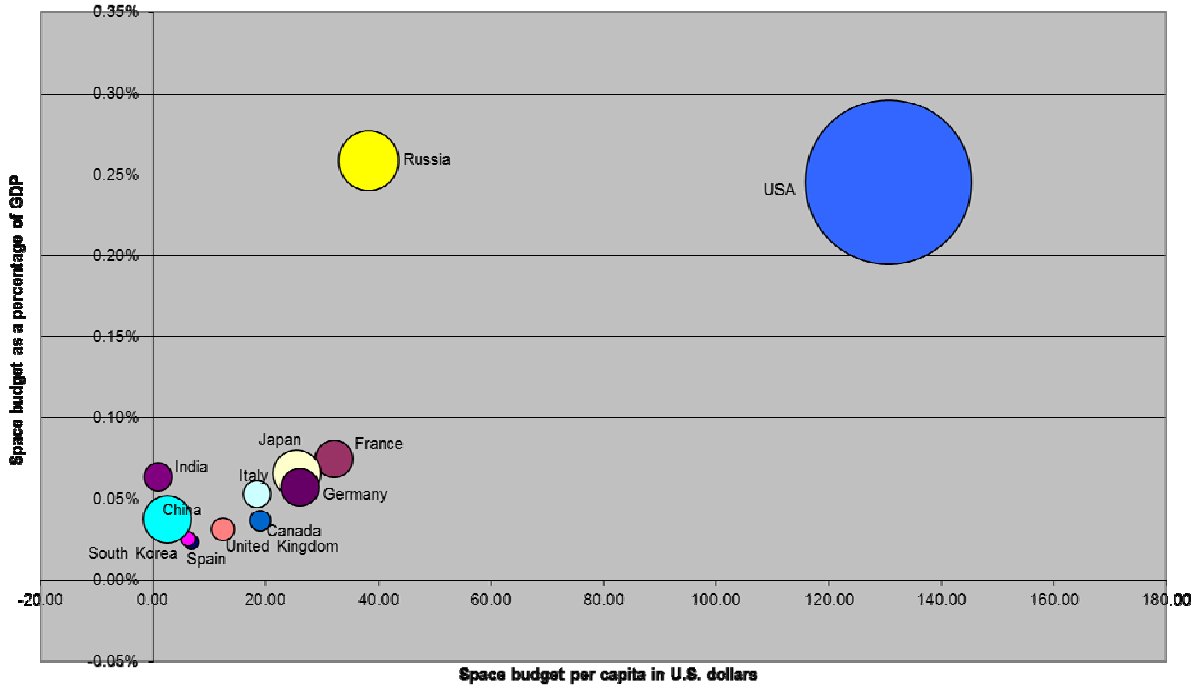

Figure 2.8: Public space budgets as share of GDP mapped against space budgets per capita in 2013. The bubble size indicates the absolute space budget (Based on Space Report 2014 and Euroconsult data)

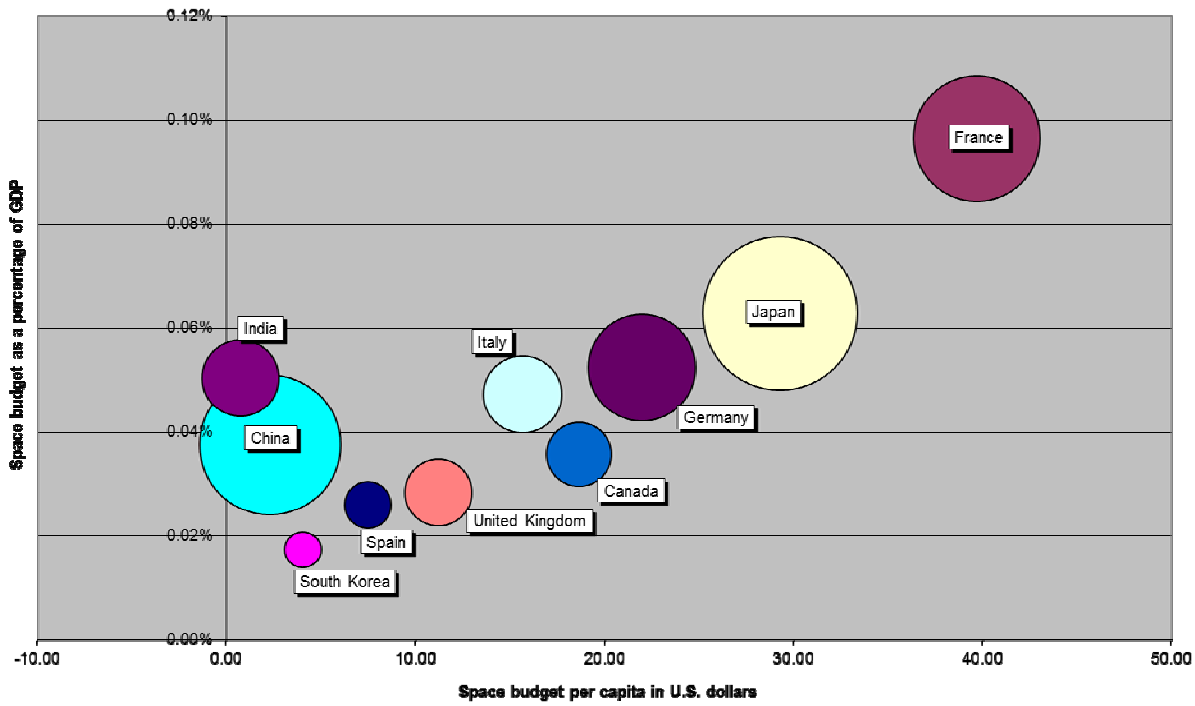

Figure 2.9: Public space budgets as a share of GDP mapped against space budgets per capita in 2012, not including the U.S. and Russia. The bubble size indicates the absolute space budget (Based on Space Report 2013 and Euroconsult data)

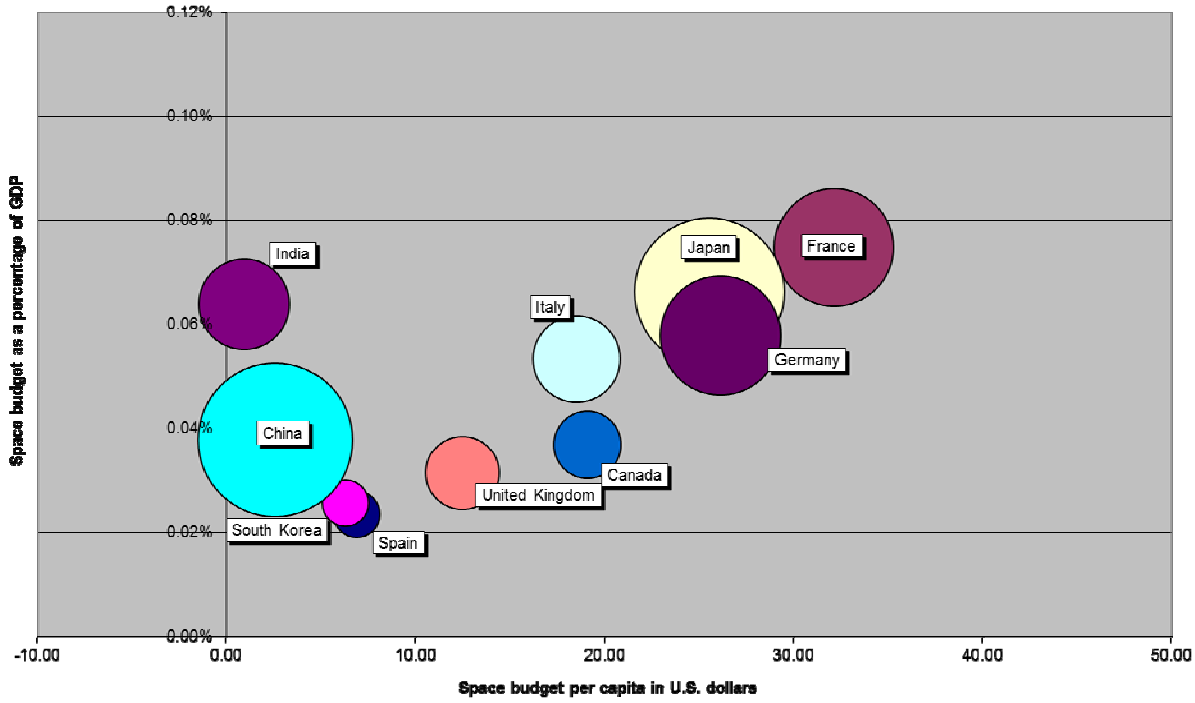

Figure 2.10: Public space budgets as a share of GDP mapped against space budgets per capita in 2013, not including the U.S. and Russia. The bubble size indicates the absolute space budget (Based on Space Report 2014 and Euroconsult data)

2.3 Overview of Commercial Space Markets

In 2013, global industry revenues, including revenue from satellite services, satellite manufacturing, launch industry, and ground equipment continued to grow as shown in both Satellite Industry Association (SIA) and Space Report 2014 assessments. The SIA reported global satellite revenues at $177.4 billion in 2011, at $189.5 billion in 2012, and $195.2 billion in 2013[80]; whereas the Space Report lists total commercial revenues for 2011, 2012, and 2013 to have been $216.99 billion, $225.87 billion, and $240.07 billion, respectively.[81] However, it must be clarified that these authorities appear to use different methods of assessment. In fact, total revenue is slowly on the uptick, with the SIA reporting continued growth following the industry bottoming out at 5% in 2010. In 2010, the industry generated revenue of $168.0 billion; but revenue growth increased by 6% in 2011 to generate $177.4 billion, and then by 7% in 2012 to generate $189.5 billion.[82] However, the rate of growth lowered to 3% in 2013, albeit still above the worldwide economic growth rate, generating $195.2 billion. As indicated in previous assessments, there is a discrepancy in the findings of SIA and the Space Report, amounting to a difference of $36.37 billion between the 2012 figures, and $30.67 billion in 2013 figures; a likely consequence of the different reporting methodologies. The following section presents key figures and data on commercial space activities divided by field of activity, based primarily on available SIA figures generated by the Tauri Group, in addition to previous Futron reports.

2.3.1 Satellite Services

In 2012 and 2013, the satellite services industry continued to advance amid tepid global financial conditions. Yet while growth is positive, its rate has diminished from 16% in 2008 to 5% in both 2012 and 2013. The growth can be credited to the industry's inherently global nature, allowing it to tap into the potential of emerging markets that had weathered the previous crisis with greater resilience. Worldwide satellite capacity jumped by 64% from 900 36 MHZ transponder equivalents in 2011 to exceed 1400 transponder equivalents in 2012.[83] However, in the following year, budget crunches in the US likely resulted in the reduction of orders for transponder equivalents to around 800 for the year 2013.[84]

The industry continues to expand its technology development programmes with additional investments in larger spacecraft with enhanced power and transponder capacity. Moreover, the industry exhibits the right mixture of investing in innovative technologies and new services while consolidating current operations, which has boosted the industry's revenue for both reporting years.[85]

While growth appears to be slightly increasing in the satellite industry, satellite services have maintained a consistent share portion among the other segments, including satellite manufacturing, launch services, and ground equipment; maintaining a share portion of 59.9% in 2012, a slight decrease from the 60.8% share in 2011; the satellite services share portion returned to 60.8% in 2013. Satellite services earned $107.8 billion in 2011, $113.5 billion in 2012, and $118.6 billion in 2013, due mostly to the increase in direct to home (DTH) satellite services. However, the rate of revenue growth for satellite services has continued to diminish, declining from 16% growth in 2008, to rest at 5% for both 2012 and 2013.[86]

Satellite services can further be deconstructed into their component parts, including consumer services (satellite radio (DARS), and consumer satellite broadband), fixed satellite services (e.g. transponder agreements, and managed services), as well as mobile services (voice and data), and remote sensing. The following is a breakdown of the industry's key developments and trends, according to the nature of the services provided.

Consumer Services

As mentioned above, consumer services are made up of satellite television, radio, and broadband services. Direct Broadcast Services (DBS) also include direct-to-home satellite television. This section of the industry showed considerable development in 2012 and 2013, fuelled by the quantitative expansion in emerging markets and the qualitative increase in new technologies and services in

[80] "State of the Satellite Industry Report." May. 2014. Satellite Industry Association and The Tauri Group 24 May 2014 <http://www.sia.org/wp-content/uploads/2014/05/SIA_2014_SSIR.pdf >.
[81] The Space Report 2012, 32; The Space Report 2013, 26; and The Space Report 2014, 24.
[82] State of the Satellite Industry Report 2014, 4.
[83] Satellite Telecommunications Report – 2012 Year-End Summary. Futron: 1.
[84] Satellite Telecommunications Report – 2013 Year-End Summary. Futron: 1.
[85] See generally State of the Satellite Industry Report 2014.
[86] Ibid. at 11.

developed ones. While demand revenue increased from 2011, its rate of growth slipped from 9.5% in 2011 to 5.3% in 2012 and 4.8% in 2013. While in 2011, DBS revenue was $84.4 billion, it increased by just 4.7% to $88.4 billion in 2012, and by another 4.7% to $92.6 billion in 2013. This growth was mainly attributed to the number of HDTV channels in recent years, e.g. this growth amounted to 3853 channels or a 42% increase by 2011, 4768 channels or a 24% increase by 2012, and around 6246 channels or a 31% increase by 2013.[87] In 2012 and 2013, consumer satellite television services accounted for about 78% of total satellite services revenue, with the share of available HDTV channels servicing Europe and Asia increasing to 41%, while the share of available HDTV channels in the Americas reduced from 70% in 2011 to around 59% by 2013. In fact, while the annual growth rate of DBS was expected to exceed that of the rest of the satellite services' sector with DBS replacing more traditional services such as video distribution, the growth rate of satellite radio and satellite broadband advanced in both 2012 and 2013.[88] By 2013, there were over 200 million satellite pay-TV subscribers worldwide, with 42% of global revenues attributed to the US; satellite radio revenue grew from $3.0 billion in 2011 to increase by 13.3% to $3.4 billion in 2012, and by another 11.8% to reach $3.8 billion in 2013. Similarly, satellite broadband revenue grew by 25%, from $1.2 billion in 2011 to $1.5 billion in 2012, and by 13.3% to $1.7 billion in 2013.[89] Additionally, the majority of worldwide broadband satellite revenue continued to flow from the US, generating around 70% of the revenue generated in 2013. All major satellite operators have increased their investments in new technologies and products in developed markets, while new services entered into operation by the end of 2013.

Fixed Satellite Services

Fixed Satellite Services (FSS) refers to the use of spacecraft that utilise land terminals in fixed positions to broadcast. Whereas Consumer Services covers satellite broadband Internet, communications and network televisions and radio broadcasts, FSS relates to commercial signal agreements, such as transponder agreements and managed network services. From 2011 to 2013 the FSS outlook remained positive, as operators continued to profit from previous investments in new capacity, as well as from the sustained demand for satellite TV, radio, and broadband services.

While some reports had anticipated a decrease in new satellite investment leading into 2012 and 2013, the effect of the current boom in FSS is expected to continue throughout the decade. Industry-wide FSS revenue climbed by 4.7% to $15.7 billion in 2011, by another 4.5% to $16.4 billion in 2012; and remained unchanged at $16.4 billion in 2013. The growth is explained by the continued demand for video and broadband, mainly from the Americas, but with additional growth in Europe and Asia. The revenue generated by Eutelsat is a clear example of this upward trend with its 2012 revenue climbing to €1.222 billion ($1.537 billion); these were increases of 4.6% and 3.3% from the previous year's revenues of €1.168 billion and €926.4 million respectively.[90] By year-end 30 June 2013, Eutelsat's revenue increased by another 5.1% to €1.284 billion ($1.670 billion).[91]

To handle the increase in demand, coming especially from HDTV consumers, commercial operators invested in technological upgrades that let them meet the needs of consumers while still making significant profits. Transponder agreement revenue continued to expand in 2011 and 2013, with growth evident across multiple regions. Similarly, while the number of HDTV channels has jumped in successive years from around 1500 in 2009 to over 6000 in 2013, with nearly 59% serving the Americas, growth continues in Europe and Asia.[92]

Remote Sensing

Remote sensing refers to commercial companies that provide optical and radar images to the open market; however, they are mostly used by government entities that have been increasingly outsourcing such capabilities over the past few years. While commercial remote sensing revenue increased by 42.9% in 2009, it stayed at the $1 billion benchmark throughout 2010, growing by 10% to $1.1

[87] Ibid.
[88] Ibid.
[89] Ibid.

[90] Eutelsat Communications. "Eutelsat Communications -- Solid Full Year 2011-2012 Results." 30 July 2012 Eutelsat 16 May 2014 <http://www.eutelsat.com/home/investors/financial-information/financial-press-releases-2013-20/2011-2012/press-list-container/eutelsat-communications----solid.html>.
[91] Eutelsat Communications. "Eutelsat Communications Reports Full Year 2012-2013 Results." 30 July 2013. Eutelsat 16 May 2014 <http://www.eutelsat.com/home/investors/financial-information/financial-press-releases-2013-20/2012-2013/press-list-container/eutelsat-communications-reports.html>.
[92] State of the Satellite Industry Report 2014, 11-14.

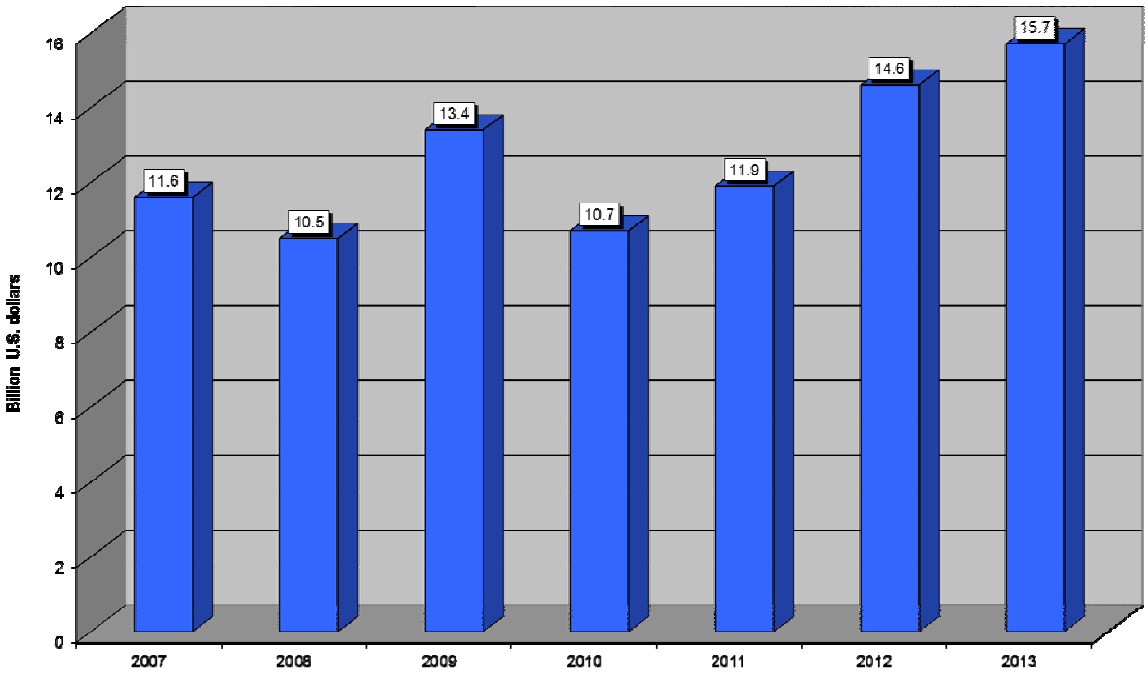

Figure 2.11: World satellite manufacturing revenue (Source: SIA)

billion in 2011, by 18.2% to reach $1.3 billion in 2012, and by 15.4% to $1.5 billion in 2013.[93] US government demand in addition to good industry performance were the dominant factors boosting remote sensing services providers' revenue over the course of 2011 to 2013.

A total of 12 civilian remote sensing satellites were launched in 2012; an increase of 20% from the 10 remote sensing satellites launched in 2011 (not including government-built, university-built, or research satellites).[94] Additionally, 14 military surveillance satellites were launched in 2011; however, the number of military surveillance satellites launched in 2012 was 64.3% less, amounting to 5 satellites for that year. In 2013, around 16 civilian remote sensing satellites were launched, in addition to 11 military surveillance satellites. While the total number of civilian and military remote sensing satellites in orbit increased in 2012 and 2013, the civil industry continues to outpace military spacecraft by a significant margin, indicating a shift in where government funding is directed, and suggesting that states are looking more toward PPPs in this field.

Mobile Satellite Services

Mobile satellite services offer both mobile data service and mobile voice service (including satellite phones). Over the course of 2011 and 2012, mobile satellite services earned revenue of $2.4 billion each year, thereafter increasing by 8.3% to $2.6 billion in 2013. Within its segments, revenue earned by mobile voice services has remained relatively unchanged since 2009, staying at $700 million in 2012, and increasing to $800 in 2013; whereas mobile data services revenue has increased by $100 million increments since 2009, reaching $1.8 billion in 2012, and staying at that level in 2013. The latter segment comprises nearly 70% of all mobile satellite services revenue.[95]

2.3.2 Satellite Manufacturing

The total revenue of satellite manufacturers that built satellites both for governmental and commercial launches in 2011 amounted to $11.9 billion; midway between the revenues earned in the previous two years, and an increase of 11% from 2010. Satellite manufacturing revenue increased by another 23% in 2012, earning $14.6 billion; it increased by a further 7.5% to reach $15.7 billion in 2013.[96] As displayed in Figure 2.11, manufacturing revenue exceeded the growth trend forecasted by Futron in 2010, with actual revenue surpassing the $15 billion revenue

[93] Ibid. at 11.
[94] Ibid. at 17.
[95] Ibid. at 11.
[96] State of the Satellite Industry Report 2014, 16.

expected to be reached in 2013.[97] It should be noted that the US earned 56.2% of 2012 manufacturing revenue, amounting to $8.2 billion, with 61% of those earnings coming from US government contracts.[98] In 2013, the US earned 69.2% of 2013 manufacturing revenue, amounting to $10.9 billion, with 75% of those earnings came from US government contracts.[99]

2.3.3 Launch Sector

The year 2012 ushered in a total of 20 successful commercial launches, with 27 commercial services payloads carried into orbit. These payloads made up 19.4% of the 139 payloads launched in 2012 in 78 launch events. In 2012, US companies once again conducted commercial launches, whereas in 2011 none were conducted. Two of the 13 launches conducted by US launchers were commercial; amounting to 10% of the total commercial launches of 2012. Russia had the most launches for 2012, with 7 out of its 24 launches conducted for commercial purposes; those launches held a 35% share of total commercial launches for the year – 20 percentage points lower than the share in 2011. Europe conducted 10 launches for 2012, of which 6 were commercial; its share in commercial launches increased in 2012 to a 30% share for the year. China's 2 commercial launches resulted in 10% share of commercial activity, while the multinational Sea Launch AG had a 15% share. The revenue from the 20 launches amounted to an estimated $2.4 billion, an increase of 25.2% or $486 million from 2011. Following its absence from commercial launches in 2011, the US re-emerged in 2012 generating $108 million, 64.8% lower than the $307 million commercial revenue it generated in 2010. Europe generated the lion's share of revenue, reaching $1,320 million (a 50.0% increase from 2011), followed once again by Russian commercial launch revenue at approximately $595 million (another decrease amounting to 15.8%). Multinational revenue took the next position, this time generating $300 million (a 50% increase from 2011), and China's revenue amounted to $90 million (a decrease of 35.7%). The 25.2% increase in industry revenue was a result of the increase in net profits by European and multinational commercial launch service providers, along with US re-emergence in providing commercial launch services in 2012. However, these figures should only be considered as indicative of the sector as they do not depict current commercial launch contracts because contracts are typically prepaid one to two years prior to launch; instead they take into account the value of the activity conducted in 2012.[100]

In 2013, there were a total of 22 successful commercial launches, which carried 22 commercial services payloads into orbit; there was one launch failure of the Multinational Sea Launch AG to launch one satellite. Of the 114 payloads that were launched in 2013, when not considering the additional 98 cubesats launched in 2013, these commercial payloads made up 20.2%. In 2013, the US conducted a total of 6 commercial launches, while an additional 13 were non-commercial. The US share of commercial launches amounted to 26.1% of the total commercial launches of 2013; about 16.1 percentage points higher than its share in 2012. Russia again had the most launches for 2013, with 12 out of its 32 launches conducted for commercial purposes; those launches held a 52.2% share of total commercial launches for the year – 17.2 percentage points lower than the share it held in 2012. Europe conducted 7 launches for 2013, of which 4 were commercial; its share in commercial launches decreased in 2013 to a 17.4% share for the year. China had no commercial launches in 2013, while the multinational Sea Launch AG had a 4.3% share, despite the fact that the company experienced a launch failure. The revenue from the 23 launches amounted to an estimated $1.91 billion, a decrease of 20.9% or $504 million from the revenue generated in 2012. In 2013, the US generated $340 million in commercial launch revenues, more than tripling its earnings in 2012, returning revenue levels to previous levels. While Europe was in third position as to the number of launches in 2013, it generated the second largest amount of revenue, reaching $710 million (a 46.2% decrease from the $1,320 million in 2012). In 2013, Russia generated the highest commercial launch revenue at approximately $759 million (increasing by 27.6% from $595 million in 2012). Multinational revenue took the last position, this time generating $100 million in 2013 (a decrease of 66.7% from the $300 million gained in 2012). This 20.9% decrease in industry revenue can be seen from the reduced launches and net profits by European and multinational commercial launch service

[97] 2010 Futron Forecast of Global Satellite Services Demand: Executive Summary.
[98] State of the Satellite Industry Report 2014, 16.
[99] State of the Satellite Industry Report 2014, 18.

[100] Federal Aviation Administration. Commercial Space Transportation: 2012 Year in Review. Washington DC: FAA, Jan. 2013: 6.

providers, along with the absence of commercial activity by China in 2013.[101]

When considering European launch activities in total, i.e. commercial and non-commercial, Arianespace reported a 31.2% increase in revenue for 2012, following its windfall revenue that exceeded industry expectations in 2011.[102] In 2011, Arianespace earned €1.013 billion ($1.340 billion), albeit with a subsidy of €145 million ($191.4 million) from ESA to avoid losses for the year.[103] Revenues grew in 2012, with operating costs now spread among three launch systems (Ariane 5, Soyuz, and Vega), to amount to €1.329 billion ($1.75 billion); this time, receiving a €70 million contribution from ESA to generate a mere €1.7 million ($2.25 million) profit. However Arianespace expected to report a decrease of 27.8% amounting to around €960 million ($1.32 billion) in revenue for 2013.[104] By the end of 2013, the company's backlog stood at €4.3 billion ($5.92 billion) for its heavy-lift Ariane 5 series, medium-lift Soyuz 2 ST vehicles, and light Vega launch series; with plans to conduct 14 launches in the following year. In 2012, six European launches were carried out by Arianespace onboard the Ariane 5 ECA launcher, one onboard the Ariane 5 ES-ATV launcher, along with two Soyuz-ST launches and one Vega launch from Kourou, French Guiana. Europe's Ariane 5 ES-ATV launcher made its third flight on 23 March 2012, carrying the ATV-3, Edoardo Amaldi; the ATV second launch occurred in February 2011, following the maiden flight in March 2008.[105] ESA's fourth ATV mission was launched on 5 June 2013, carrying the ATV-4, Albert Einstein to the international space station;[106] the final ATV-5, Georges Lemaître is slated for some time in 2014.[107] Following Arianespace's new ability to launch Soyuz spacecraft from the Guiana Space Centre in French Guiana, a milestone in cooperation between Europe and Russia, Arianespace launched 2 Soyuz 2 spacecraft in 2012. The Soyuz 2-ST launcher continued to be a hallmark of European and Russian commercial cooperation, launching the second pair of satellites for Europe's Galileo global navigation satellite system on 12 October 2012, one year following the launch of Galileo's first pair of in-orbit validation navigation satellites in October 2011.[108] The launcher also lifted CNES's Pleiades 1B satellite on 1 December 2012, its twin Pleiades 1A having been launched on 16 December 2011. Finally, Europe's Vega Launcher made its debut launch on 13 February 2012, carrying an assortment of European small and microsatellites geared for scientific and development purposes. Vega can carry a 1,500 kg satellite into a 700-kilometer orbit, priced commercially at around €32 million ($42 million) per launch, and is expected to be price-competitive with converted Russian ballistic missiles; if sufficient market demand exists, the price could drop to €22 million ($28.5 million).[109]

[101] Federal Aviation Administration. Commercial Space Transportation: 2013 Year in Review. Washington DC: FAA, Jan. 2014: 6.

[102] De Selding, Peter. "Arianespace Revenue Rose 31.5 Percent for 2012." 12 Apr. 2013. Space News 14 Feb. 2014 <http://www.spacenews.com/article/financial-report/34824arianespace-revenue-rose-315-percent-for-2012>.

[103] Messier, Doug. "Arianespace Makes Profit With Large ESA Subsidy." 25 Apr. 2012. Parabolic Arc 14 Feb. 2014 <http://www.parabolicarc.com/2012/04/25/arianespace-makes-profit-with-large-esa-subsidy/>

[104] De Selding, Peter. "Cost Savings Minimal in Latest Ariane 5 Contract." 8 Jan. 2014. Space News 24 Feb. 2014 <http://www.spacenews.com/article/financial-report/38985cost-savings-minimal-in-latest-ariane-5-contract>.

[105] "ATV-3 launch." 23 Mar. 2012. ESA News 22 May 2012 <http://www.esa.int/esaCP/SEM9UR2T00H_index_0.html>.

[106] "ATV-4: Albert Einstein." 27 June 2013. ESA 14 Feb. 2014 <http://www.esa.int/Our_Activities/Human_Spaceflight/ATV/ATV-4_i_Albert_Einstein_i>.

[107] SpaceNews Staff. "Europe's ATV Poised To Launch to Space Station." 19 Mar. 2012. SpaceNews 14 Feb. 2014 <http://www.spacenews.com/article/europes-atv-poised-launch-space-station>.

[108] "One Soyuz Launcher, Two Galileo Satellites, Three Successes for Europe." 21 Oct. 2011. ESA - News. 24 Apr. 2012 <http://www.esa.int/esaCP/SEM167GURTG_index_0.html>

[109] De Selding, Peter. "Vega Expected to be Price-competitive With Russian Rockets." 23 Jan. 2012. Space News 23 May 2012 <http://www.spacenews.com/launch/012312-vega-expected-price-competitive-with-russian-rockets.html>.

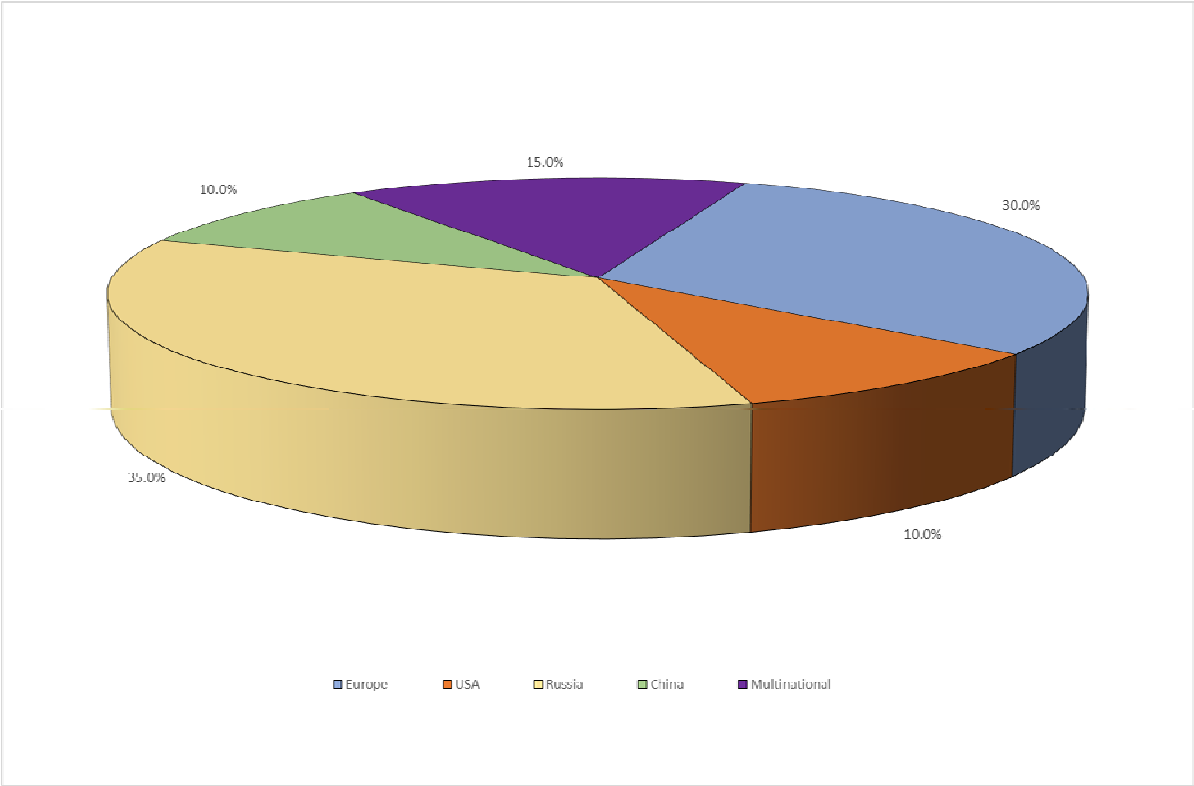

Figure 2.12: Commercial Launch Activity by Country in 2012 (Source: FAA)

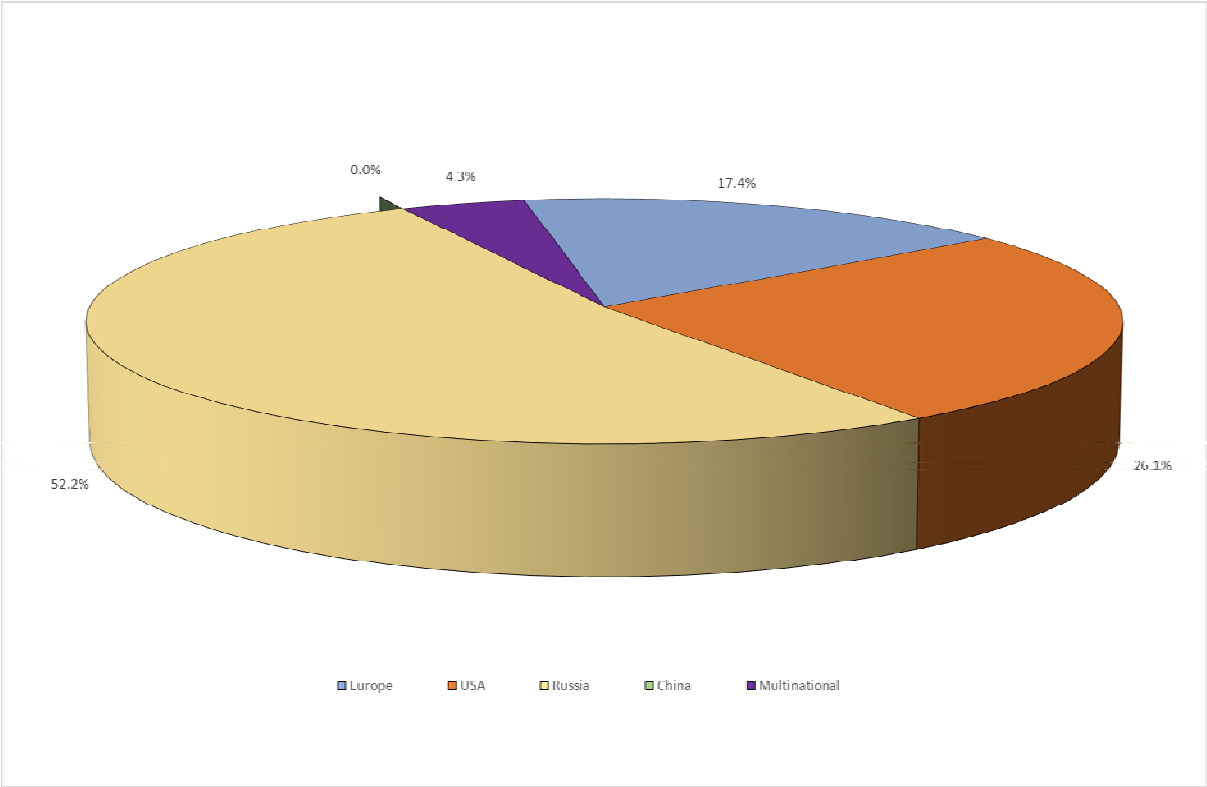

Figure 2.13: Commercial Launch Activity by Country in 2013 (Source: FAA)

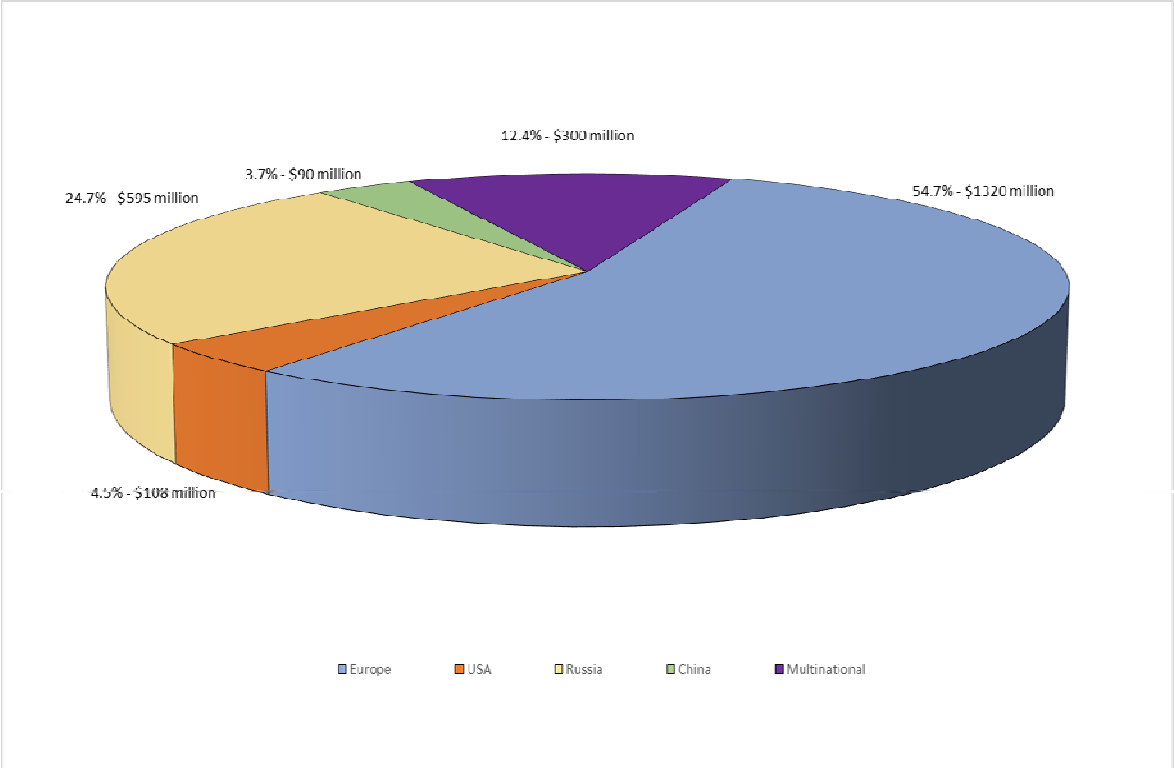

Figure 2.14: Commercial Launch Revenues by Country in 2012 (Source: FAA)

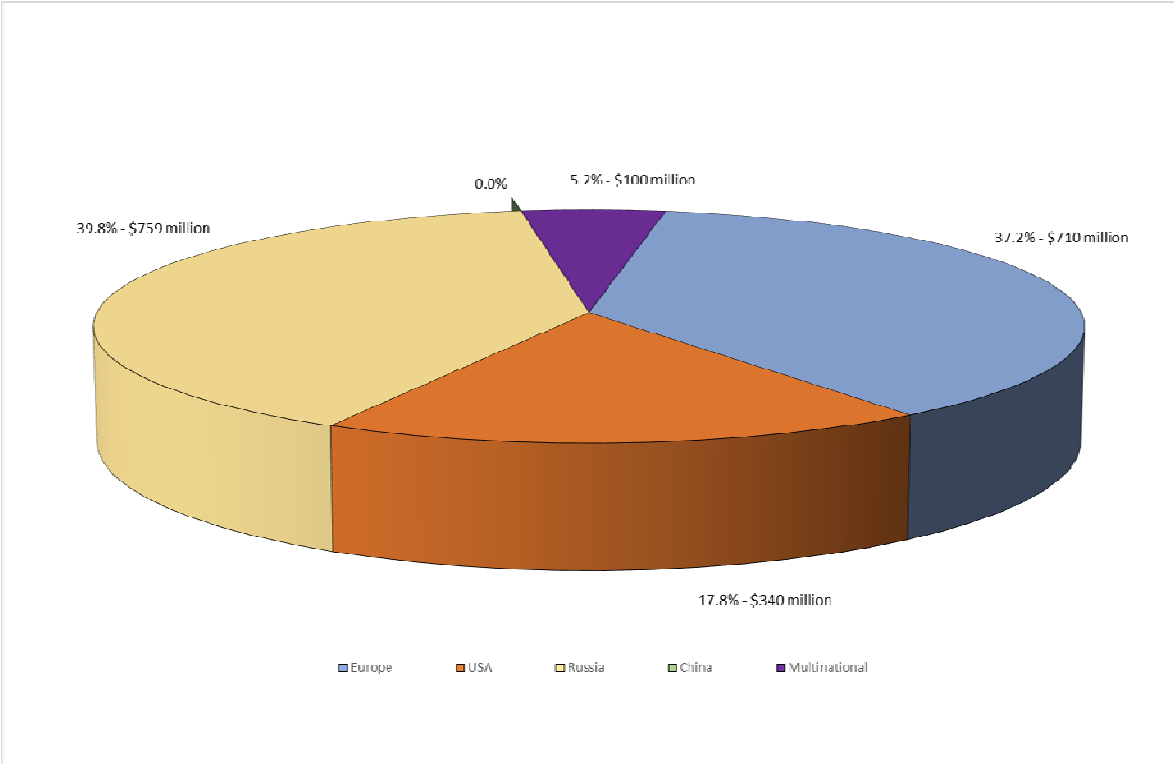

Figure 2.15: Commercial Launch Revenues by Country in 2013 (Source: FAA)

	Total Revenue	2011	2012	2013
TomTom		€1.273 billion ($1.648 billion)	€1.057 billion ($1.397 billion)	€963.454 million ($1.326 billion)
Garmin		$2.759 billion	$2.716 billion	$2.632 billion
	Products			
TomTom	Automotive Systems	€235 million ($304.3 million)	€212 million ($280.2 million)	€192 million ($264.3 million)
Garmin	Automotive / Mobile	$1.591 billion	$1.492 billion	$1.302 billion
	Geographical Sales			
TomTom	Europe	€937.483 million ($1.21 billion)	€772.818 million ($1.021 billion)	€710.101 million ($977.525 million)
	North America	€256.592 million ($332.26 million)	€215.408 million ($284.657 million)	€177.725 million ($244.656 million)
	Rest of World	€79.142 million ($102.42 million)	€68.908 million ($91.060 million)	€75.628 million ($104.110 million)
Garmin	Europe	$983.004 million	$945.336 million	$955.900 million
	Americas	$1.527 billion	$1.513 billion	$1.433 billion
	Asia	$248.06 million	$256.882 million	$243.056 million

Table 2.1 Understanding TomTom & Garmin variables

2.3.4 Ground Equipment

Ground equipment revenue includes 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 that incorporate GPS chip sets.

While the PND market has been in decline since 2008, marginal growth was gleaned in 2011 amounting to a 0.9% increase from $31.9 billion in 2010; revenues held steady at $32.2 billion for both 2011 and 2012. In 2013, revenue dropped by 3% to around $31.2 billion. This low growth can be attributed to the migration from standalone devices to embedded chipsets for devices such as smart phones.[110] While satellite navigation equipment represented a consistent 58.8% share of overall ground equipment revenue in 2012, that share dipped to 56.2% in 2013. Overall ground equipment revenues continued their slow expansion albeit with lowered growth rates since 2008 (i.e. 2% in 2011, following 3% in 2010, and 8% in 2009). In 2012, ground equipment revenue grew by 4%, reaching $54.9 billion; thus the ground equipment segment held a 29% share of the $189.5 billion in world satellite industry revenue in 2012. In 2013, ground equipment revenue grew by only 1.1% to $55.5 billion, representing a 28.4% share of the $195.2 billion in world satellite industry revenue in 2013.

The revenue profiles for Garmin and TomTom, the two companies leading the PND market were dissimilar for both 2012 and 2013. Whereas both companies saw diminishing revenue in each consecutive year, the loss appeared to have affected Garmin less strongly. Garmin's total revenue for 2012 reached $2.716 billion, a 1.6% decrease from the previous year; it decreased by another 3.1% to $2.632 billion in 2013. TomTom's total revenue reached €1.057 billion ($1.397 billion) in 2012, experiencing another decrease of 17.0% from the €1.273 billion ($1.648 billion) earned in 2011; it decreased

[110] State of Satellite Industry Report 2014, 27.

by another 8.9% to €963.454 million ($1.326 billion) in 2013.[111]

2.3.5 Insurance Sector

Insurance costs have continued to decrease as the space industry has continued to demonstrate increased hardware reliability, low accident rates and promising growth in recent years.[112] More competition results from a safer market, which results in a change in consumer behaviour as well. Indeed, the perceived reliability spacecraft and launch services in recent years is likely to have led to SES's decision to authorize the shipment of its SES-8 satellite to Florida to be prepared for launch on SpaceX's Falcon 9 v1.1 launcher, despite insurance industry concerns about the Falcon 9's upper-stage engine not properly completing its second ignition as expected.[113] The SES-8 was successfully launched on 3 Dec. 2013, insured by SES for $200 million for the launch and first year of orbit. The biggest claim for 2013 was for the loss of Intelsat 27, following its launch failure on 1 Feb. 2013 due to loss of telemetry on board a commercial Sea Launch Zenit-3SL launcher.[114] Another $70 million claim was expected for a damaged solar array on South Korea's 7 year-old Koreasat 5 telecommunications satellite owned by KT Corp., launched in 2006.[115]

[111] "TomTom Annual Report and Accounts 2013." TomTom 30 May. 2014. <http://corporate.tomtom.com/common/download/download.cfm?companyid=TOMTOM&fileid=638911&filekey=86013D50-A248-483B-BDC2-7C8391123481&filename=TomTom_Annual_Report_2012.pdf>.

[112] De Selding, Peter. "Insurance Premiums Stay Flat Despite W3B Satellite Failure." 20 May 2011. Space News 24 Apr. 2012 <http://www.spacenews.com/satellite_telecom/110520-insurance-premiums-flat.html>.

[113] De Selding, Peter. "SES Approves Satellite Shipment for Falcon 9 Launch Despite Questions." 4 Oct. 2013. Space News 17 Feb. 2014 <http://www.spacenews.com/article/launch-report/37547ses-approves-satellite-shipment-for-falcon-9-launch-despite-questions>.

[114] Clark, Stephen. "Sea Launch rocket, Intelsat satellite fall into Pacific." 1 Feb. 2013. Spaceflight Now 17 Feb. 2014 <http://www.spaceflightnow.com/sealaunch/is27/130201failure/#.UwlIPi1wa70>.

[115] De Selding, Peter. "SES Approves Satellite Shipment for Falcon 9 Launch Despite Questions." 4 Oct. 2013. Space News 17 Feb. 2014 <http://www.spacenews.com/article/launch-report/37547ses-approves-satellite-shipment-for-falcon-9-launch-despite-questions>.

2.4 Sectoral Overview

2.4.1 Launch Sector

Despite its crucial importance for the satellite industry, the launch sector is an enabler rather than a primary economic activity. The revenue it generates historically has been far less significant than that originating from the satellite manufacturing and satellite services businesses.

Whereas the year 2012 experienced decreased activity for the launch sector from 2011, with a total of 78 launches, 2013 saw increased activity with 81 launches conducted by launch providers from Russia, the United States, Europe, China, India, Japan, Iran, North Korea, South Korea, and the multinational Sea Launch AG (see Tables 2.2 and 2.3).

Important events marked both reporting years. For instance, in 2012, the 4 non-commercial launch failures were: an Unha 3 launch carrying the North Korean Kwangmyongsong 3 payload in April; a Safir 2 launch carrying the Iranian Fajr payload in May; another Safir 2 launch carrying the Fajr 2 payload in September; and a mission failure of the Orbcomm OG2-01 launched on SpaceX's Falcon 9 in October. There was also one commercial launch failure, i.e. a Proton M launch carrying the Telkom 3 and Express MD2 payloads in August. In 2013, the launch sector experienced 2 non-commercial launch failures: the Proton M launch carrying the Glonass M46, Glonass M48, and Glonass M49 payloads in July; and a Long March 4B launch carrying the CBERS 3 payload in December. There was also one commercial launch failure, with a Sea Launch AG Zenit 3SL launcher carrying the Intelsat 27 payload in February.

When looking at specific countries, Russia remained the world leader in the number of launches for 2012 and 2013; of the total launches per year, Russia accounted for approximately 30.8% in 2012, with an increased 39.5% in 2013. China had been in the second position in 2012, with a 24.4% share, but lost its position to the United States in the next year in conducting 18.5% of the year's launch activity. The United States in turn saw its share increase from 16.7% to 23.5% by the end of 2013. Europe and the multinational Sea Launch saw their launch activities recede by several percentage places, further down the ranking Japan and India would exhibit increasing

Launchers	Number of launch systems active in 2012	Total number of launches	Commercial launches	Non-Commercial Launches
Russia	7	24	7	17
China	8	19	2	17
USA	10	13	2	11
Europe	4	10	6	4
Iran	1	3	0	3
Multinational	1	3	3	0
India	2	2	0	2
Japan	2	2	0	2
North Korea	1	2	0	2
South Korea	0	0	0	0
Total	**36**	**78**	**20**	**58**

Table 2.2: Worldwide launches in 2012 per country, number of launched systems, and commercial status (Source: FAA)

Launchers	Number of launch systems active in 2013	Total number of launches	Commercial launches	Non-Commercial Launches
Russia	10	32	12	20
USA	12	19	6	13
China	7	15	0	15
Europe	4	7	4	3
Multinational	1	1	1	0
India	2	3	0	3
Japan	3	3	0	3
South Korea	1	1	0	1
Iran	0	0	0	0
North Korea	0	0	0	0
Total	**40**	**81**	**23**	**58**

Table 2.3: Worldwide launches in 2013 per country, number of launched systems, and commercial status (Source: FAA)

shares in global launch activity occurring in 2013 (see Figures 2.16 and 2.17).[116]

In 2012, Russia launched 24 vehicles using seven different launch system configurations; it launched 32 vehicles using ten different launch configurations in 2013. The US used a set of ten different launch configurations for a total of 13 launches in 2012; in 2013, it used twelve different launch configurations for 19 launches. In 2012, China once again conducted 19 launches, this time using eight configurations; in 2013, China used seven different launch configurations for 15 launches. And India used two launcher configurations for both its 2 launches in 2012, and 3 launches in 2013. In 2012, Europe used its Ariane 5 ECA and ES-ATV launchers, its Soyuz 2 ST launcher, and its Vega launcher for its 10 launches (6 Ariane 5 ECA, 1 Ariane 5 ES-ATV, 2 Soyuz 2 ST, and 1 Vega); in 2013, it used these four configurations for its 7 launches. Japan had 2 launches using its 2 launchers in 2012, followed by 3 launches with three configurations in the following year; while Iran used its one launcher for its 3 launch attempts in 2012, with a gap in the following year; and the Multinational provider Sea Launch AG using one launch configuration for 3 launches in 2012, while attempting only 1 launch in 2013. North Korea was active in 2012 with 2 launches on one launch configuration, while South Korea was active in the following year with 1 launch on its single launcher. With many options available in terms of launch systems, the different launch system configurations used in 2012 were 36, although this increased by 4 to the 40 used in 2013.

[116] Commercial Space Transportation: 2012 Year in Review, 3, and Commercial Space Transportation: 2013 Year in Review, 3.

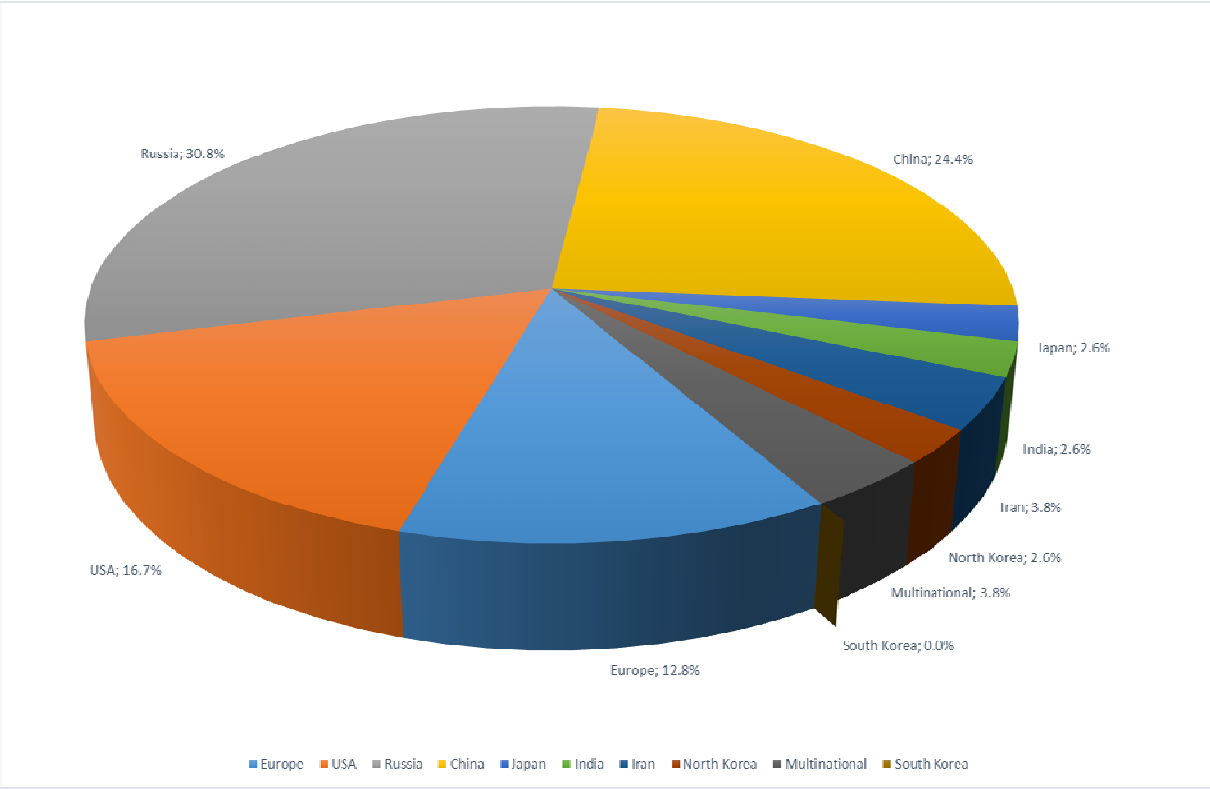

Figure 2.16: Worldwide launches by country in 2012 (Source: FAA)

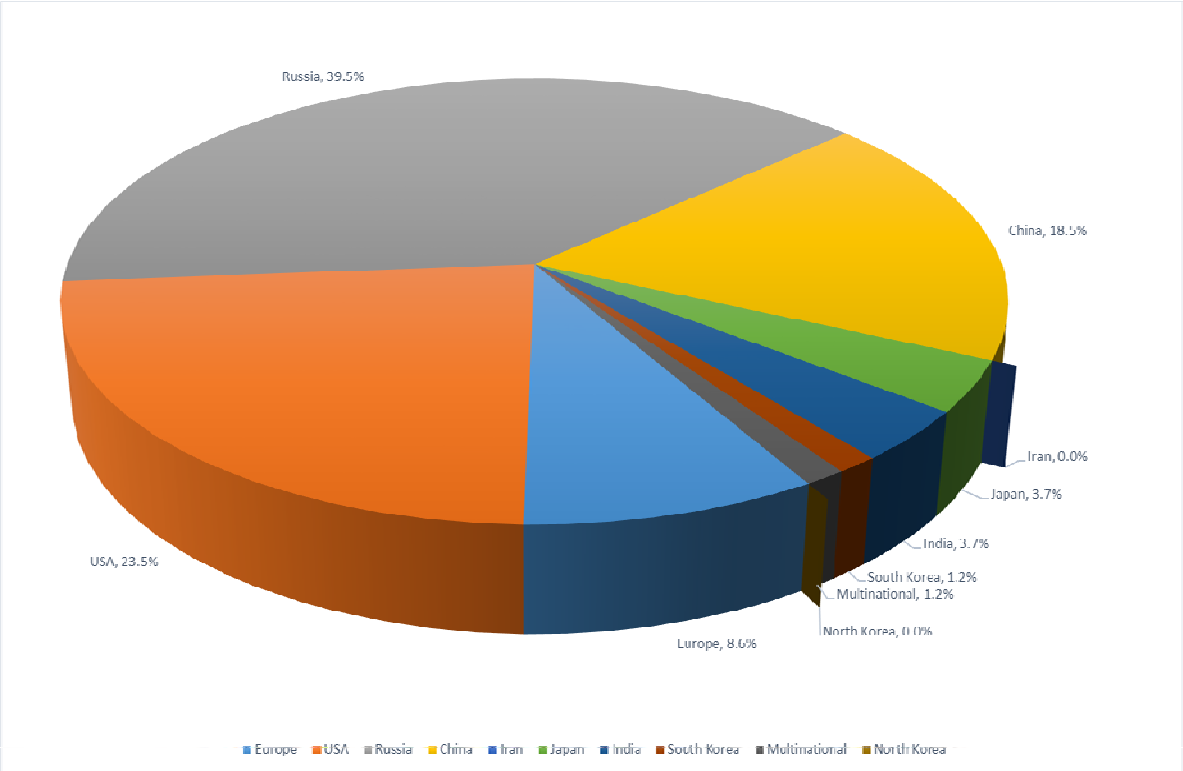

Figure 2.17: Worldwide launches by country in 2013 (Source: FAA)

With Ariane 5's dual payload capacity in mind, the activity of the two leaders of commercial launches (Europe and Russia) should be considered as nearly equivalent, with Europe leading in commercial revenue in 2012, but surpassed by Russia in the following period. When considering non-commercial launches, Russia's dominance is not quite apparent, as it now contends with China for first place. In 2012, the two countries shared the same first position, both with 17 non-commercial launches; in 2013, Russia beat China by 5 launches, and the US by 7 launches. In the past 3 years, Russia has consistently held an average share at around 30% of non-commercial launches; in 2012 it had a 29.3% share, and in 2013 it grew to 34.5%. China has taken second position in non-commercial launch activity, sharing the lead with Russia in 2012 with its 29.3% share, though dipping to 25.9% in 2013. In 2012, the US conducted 19.0% of non-commercial launches, followed by 22.4% in 2013.

The ratio of commercial to non-commercial payload launches appears unchanged from previous years, however the number of payloads launched increased significantly in 2012 and 2013. While the number of payloads in 2012 was slightly more than in 2011, it was nearly doubled in 2013 due mostly to what appeared to be the exponentially increasing number of cube satellites and microsats that were launched. The majority of non-commercial activity came from Russia, China, and the US. China, with its 17 non-commercial launches in 2012, and its 15 launches in 2013, is especially notable as a country that is rapidly developing its national programmes in remote sensing and navigation systems, as well as its own space station. A total of 27 non-commercial payloads from China were launched in 2012, followed by 21 payloads in 2013. Similarly, many of Russia's 87 payloads had non-commercial functions with 36 payloads involved in such programmes as ISS replenishment, the GLONASS system, etc. The US re-emerged in terms of launching commercial payloads in 2012 and 2013, following zero launches in 2011, although the its ratio in commercial to non-commercial payloads (not including microsatellites) was around 1 to 7 in 2012, and 1 to 4 in 2013.

Regarding the global share of payloads launched in 2012 and 2013 (see Figures 2.18 and 2.20), Russia took first place in both years, albeit with a 15.3 point decrease in its stake in 2012 where 34 payloads were launched, representing a 24.5% share on the worldwide scale. In 2013, launching a total of 87 payloads, Russia held a 41% share of payloads launched on the worldwide scale, marking a return to previous levels held in 2011 and 2010. Moreover, when excluding the 98 cubesat payloads from the assessment, Russia's share in payloads launched in 2013 reached 44.7% of the remaining total. The US was surpassed by China for second place in 2012, launching 28 payloads, which amounted to a 20.1% share; however, it regained its position in 2013, having launched a total of 69 payloads, resulting in a 32.5% share of payloads launched on the worldwide scale. However, when not considering the cubesat payloads in the assessment, the US share dropped substantially, tying it with China at 17.5%. On the other hand, China overtook the US in 2012, with its 30 payloads launched amounting to a 21.6% share for that year; in 2013, 23 payloads were launched, amounting to 10.8% on the worldwide scale – yet when discounting China's three cubesat payloads launched for that year, its share of payloads launched in 2013 tied with the US at 17.5%, as mentioned. Europe launched 18 payloads with a share of 18.0% in 2012, and 14 payloads with a share of 6.6% in 2013 (11.4% when excluding total cubesat payloads from the assessment). Japan overtook India in 2012 with 10 payloads at a share of 7.2%, while India had 4 payloads launched at a share of 2.9%; in 2013 India regained its lead, launching 9 payloads at a share of 4.2%, to Japan's 8 payloads launched at a share of 3.8%.

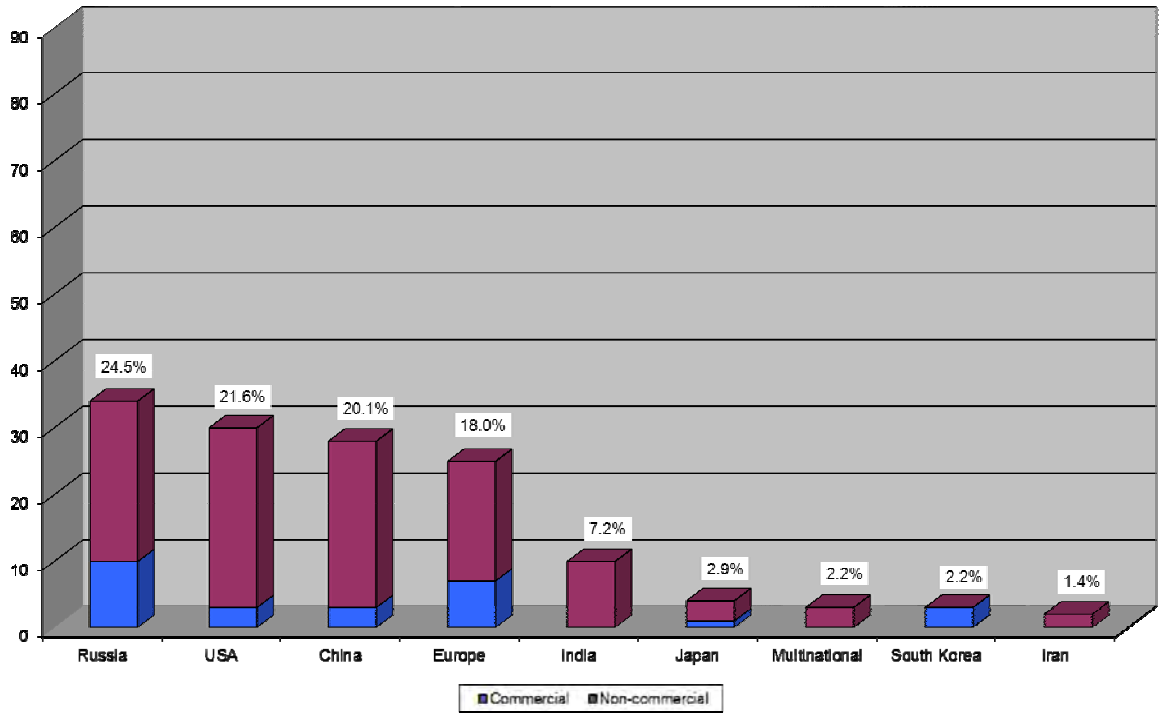

Figure 2.18: Total payloads launched in 2012 by country, share and commercial status (Source: FAA)

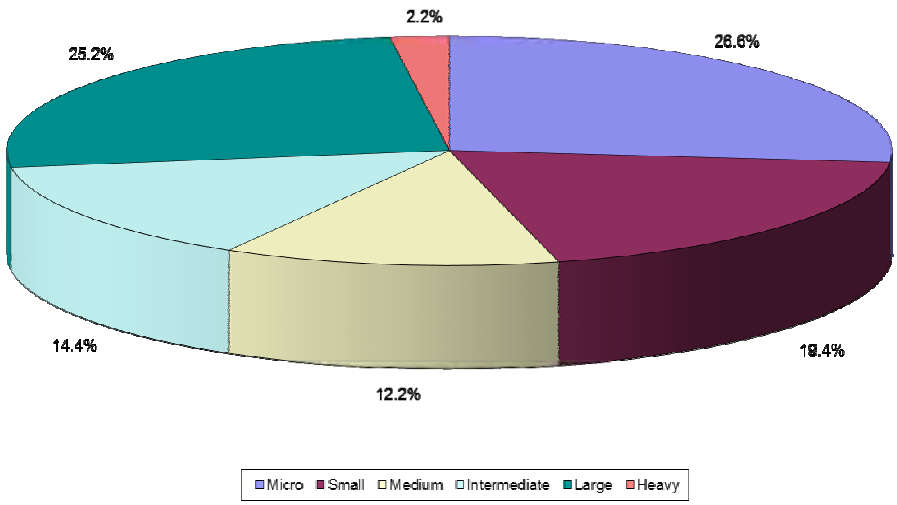

Figure 2.19: Distribution of the payloads launched in 2012 by mass class (Source: FAA)

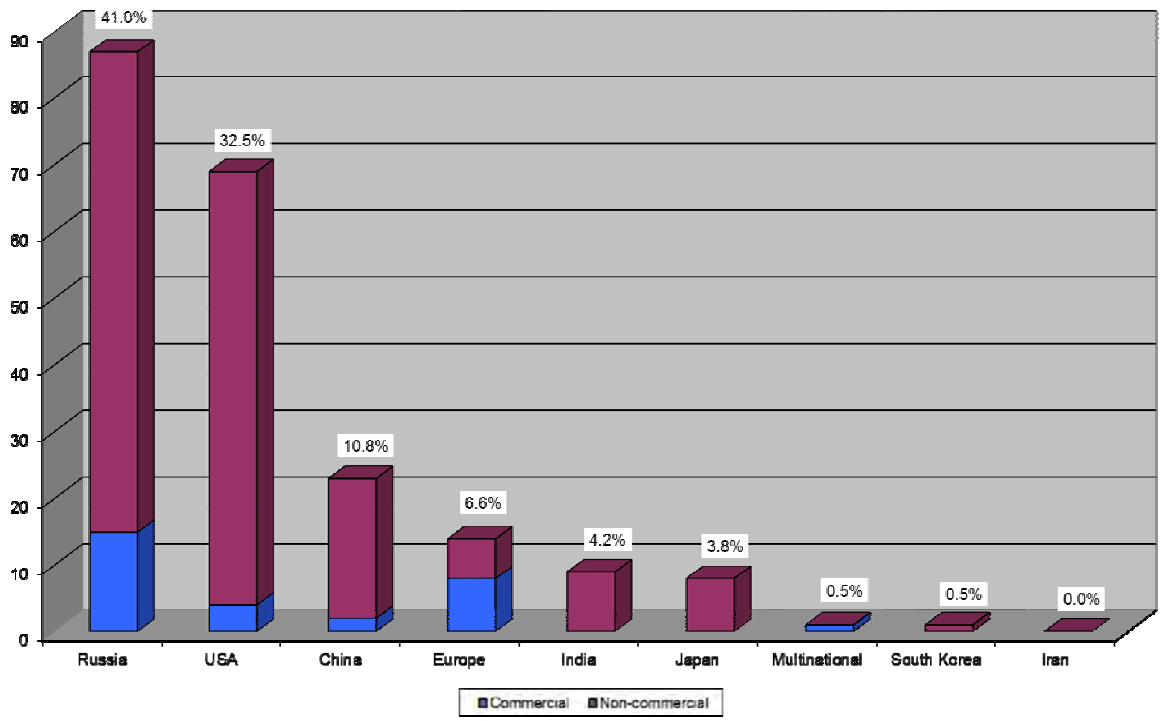

Figure 2.20: Total payloads launched in 2013 by country, share and commercial status (Source: FAA)

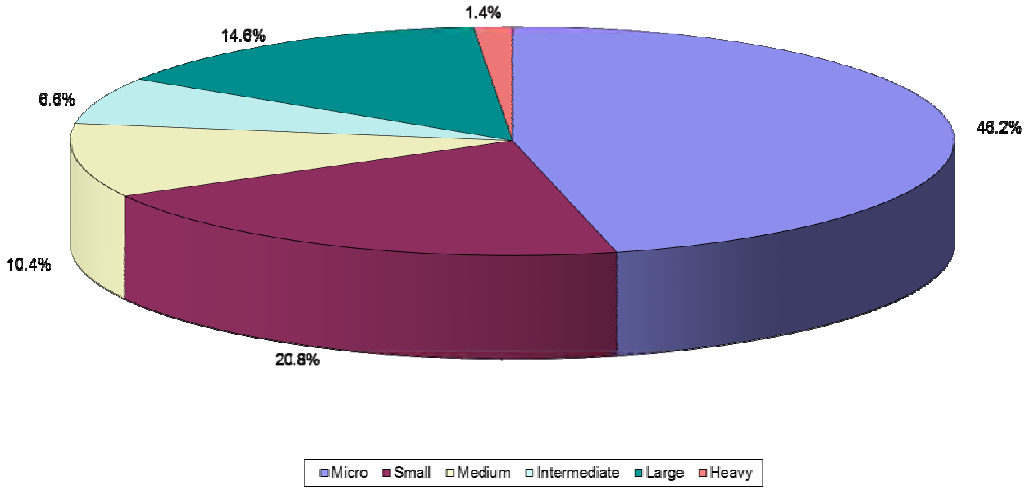

Figure 2.21: Distribution of the payloads launched in 2013 by mass class (Source: FAA)

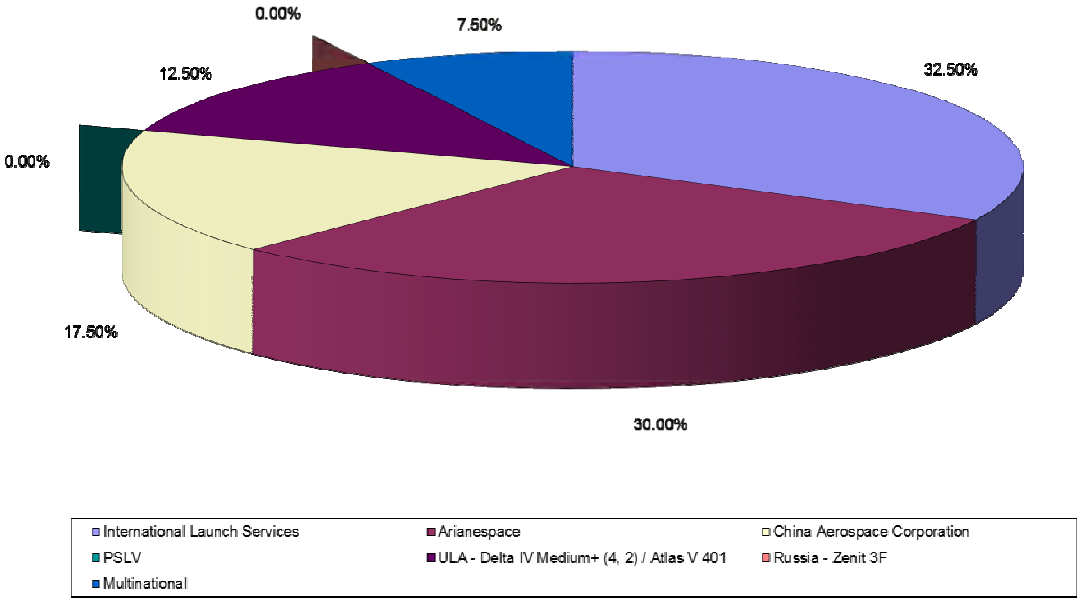

Figure 2.22: Share of launch contracts for GEO satellites in 2012 by launch service provider

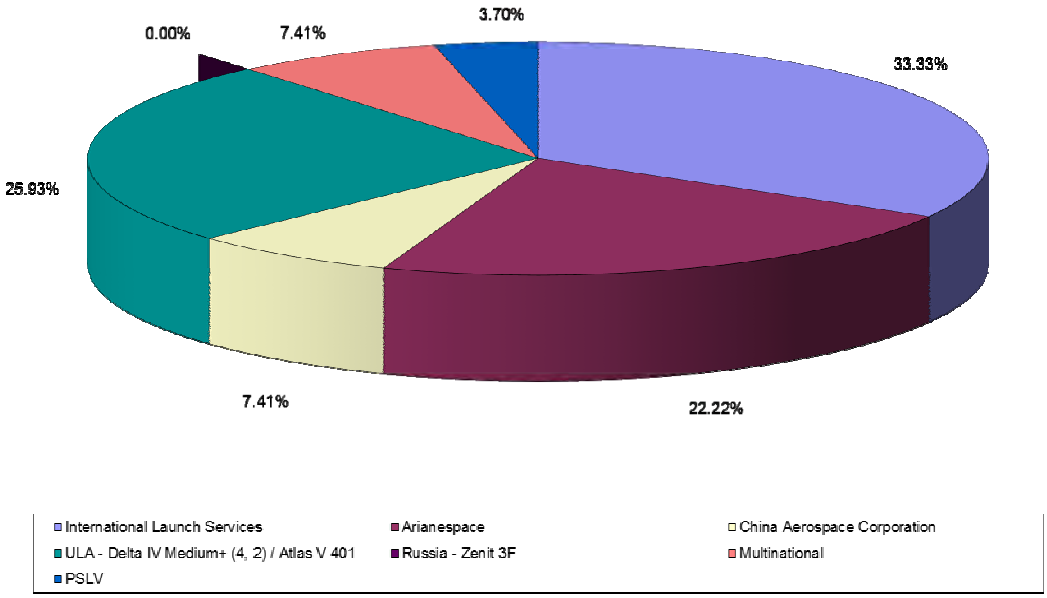

Figure 2.23: Share of launch contracts for GEO satellites in 2013 by launch service provider

Concerning the distribution of payload sizes, there were some significant changes over the 2012 and 2013 periods. In both periods, "Micro" was the mode with 37 payloads at 26.6% of the total in 2012 (an increase of 13.1 points relative to 2011), and 98 payloads at 46.2% of the total in 2013 (a further increase of 19.6 points from 2012). Large payloads were second place in 2012, with 35 launched at 25.2% (up 1.1 points from 2011); yet they were outpaced by Small payloads in 2013, launching 31 payloads for that year, amounting to 14.6% of the total (down 10.6 points). In 2012, Small payloads were in the third place, with 27 payloads at 19.4% (down 6.1 points from 2011), 20 Intermediate at 14.4% (up 3.9 points), 17 Medium at 12.2% (down 9.6 points), and lastly, 3 Heavy payloads at 2.2% (down 2.4 points). In 2013, Small payloads were in second place, with 44 payloads at 20.8% (up 1.3 points from 2012), Large payloads were in third place, Medium payloads were in fourth place, with 17 payloads at 12.2% (down 1.9 points), 14 Intermediate at 6.6% (down 7.8 points), and lastly, 3 Heavy payloads at 2.2% (down 2.4 points).[117]

In 2012, Arianespace held the top position in terms of market share, with 31.6%, followed by International Launch Services with 29.0% (see Figures 2.22 and 2.23). In 2013, while more launch systems were called upon, they were used for fewer GEO satellite launches. This time International Launch Services held the top position with 33.3% market share, next ULA with 25.9%, followed by Arianespace with 22.2%.

2.4.2 Manufacturing Sector

Looking at the market share of satellites launched and ordered in a given year provides a good indication of the vitality of domestic space industries, while also providing clues to global trends in the space industry.

In 2012, 139 payloads were launched (including an estimated 14 crewed or cargo missions to the ISS or Chinese Tiangong 1 space station, 1 test launch of the US X-37B spacecraft). Russia manufactured 24.5% of the launched payloads, while China made 21.6%, and the US made 20.1%. Europe accounted for 18.0% of the payloads launched, while Japan accounted for 7.2%, India produced 4.9%, Iran and Multinational each provided 2.2%, and North Korea accounted for 1.4%.[118] In 2013, 212 payloads were launched (including an estimate of 98 cubesats, and 15 crewed or cargo missions to the ISS or Chinese Tiangong 1 space station). Russia manufactured 41.0% of the launched payloads, while the US made 32.5%, and China produced 10.8%. Europe accounted for 6.6% of the payloads launched, while India produced 4.2%, and Japan accounted for 3.8%. Multinational and South Korea each accounted for 0.5% respectively.[119]

Of the 124 satellites launched in 2012, 100 were non-commercial. China's CAST took the lead in manufacturing non-commercial satellites, with 22 satellites, followed by the Reshetnev Company which produced 7 non-commercial satellites, showing increased presence in this market for both players; on the other hand Space Systems Loral (SS/L) and EADS Astrium (confirming their strong share in the commercial market), took the lead in commercial payloads manufacturing 7 and 4 satellites respectively. Whereas SS/L's figures resulted from commercial orders, EADS Astrium also launched 5 non-commercial satellites. Finally, 2 of the 14 Russian satellites were designated for commercial activities, along with 1 commercial CAST satellite.[120]

[117] Micro payloads have a mass of 91 kg or less, and are mainly science satellites, technological demonstrators or small communications satellites. Small payloads weigh between 92 and 907 kg and are very often Earth Observation satellites, similar to the Jason or the RapidEye series. Medium payloads weigh between 908 and 2,268 kg, and 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, weighing between 2,269 and 4,536 kg, comprise medium satcoms and big scientific satellites. Large payloads, between 4537 and 9,072 kg, refer to big satcoms, as well as to the Soyuz and Progress spacecraft flying to the ISS. Finally, Heavy payloads, exceeding 9,072 kg, are linked to ISS activity, such as the cargo spacecraft, ATV, HTV, etc. *See* Commercial Space Transportation: 2011 Year in Review, 32.

[118] Commercial Space Transportation: 2012 Year in Review, 7. Payloads are assigned to the nation that commissioned them, not according to the nationality of the manufacturer.

[119] Commercial Space Transportation: 2013 Year in Review, 14-17. Payloads are assigned to the nation that commissioned them, not according to the nationality of the manufacturer.

[120] Commercial Space Transportation: 2012 Year in Review, 29-32.

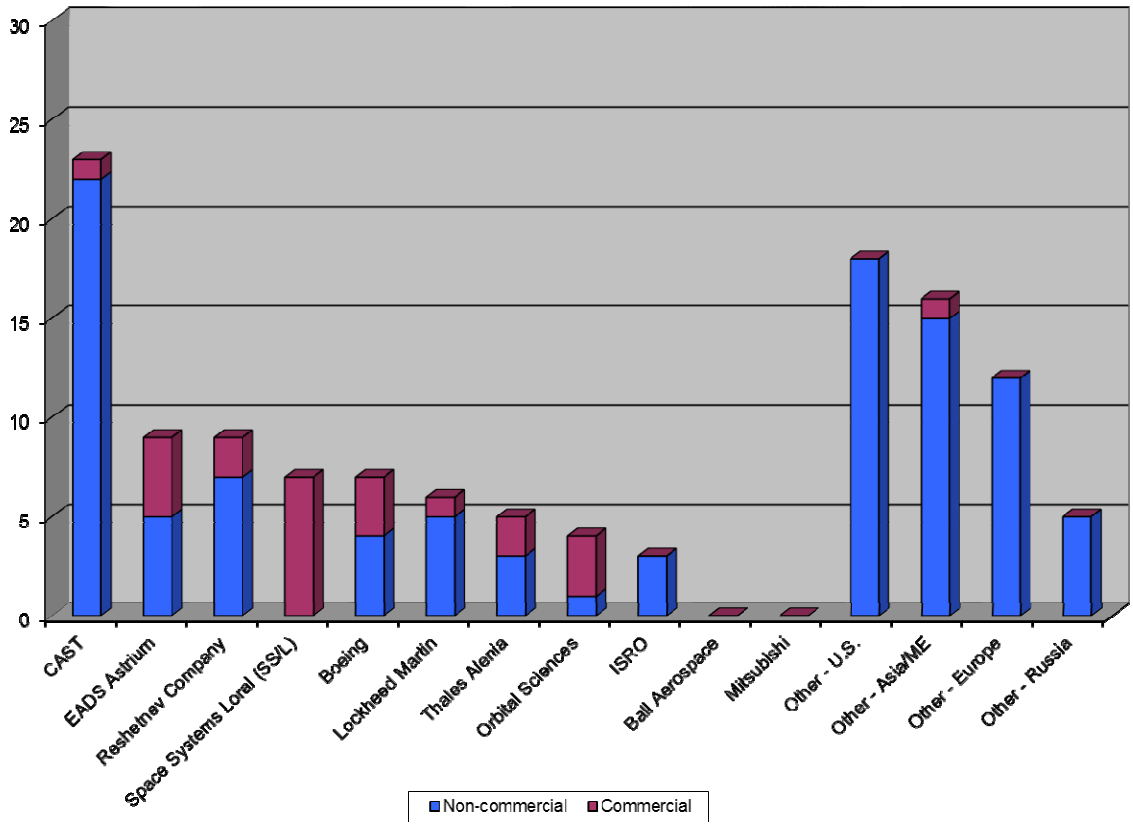

Figure 2.24: Satellites launched in 2012 by manufacturer and commercial status (Source: Futron)

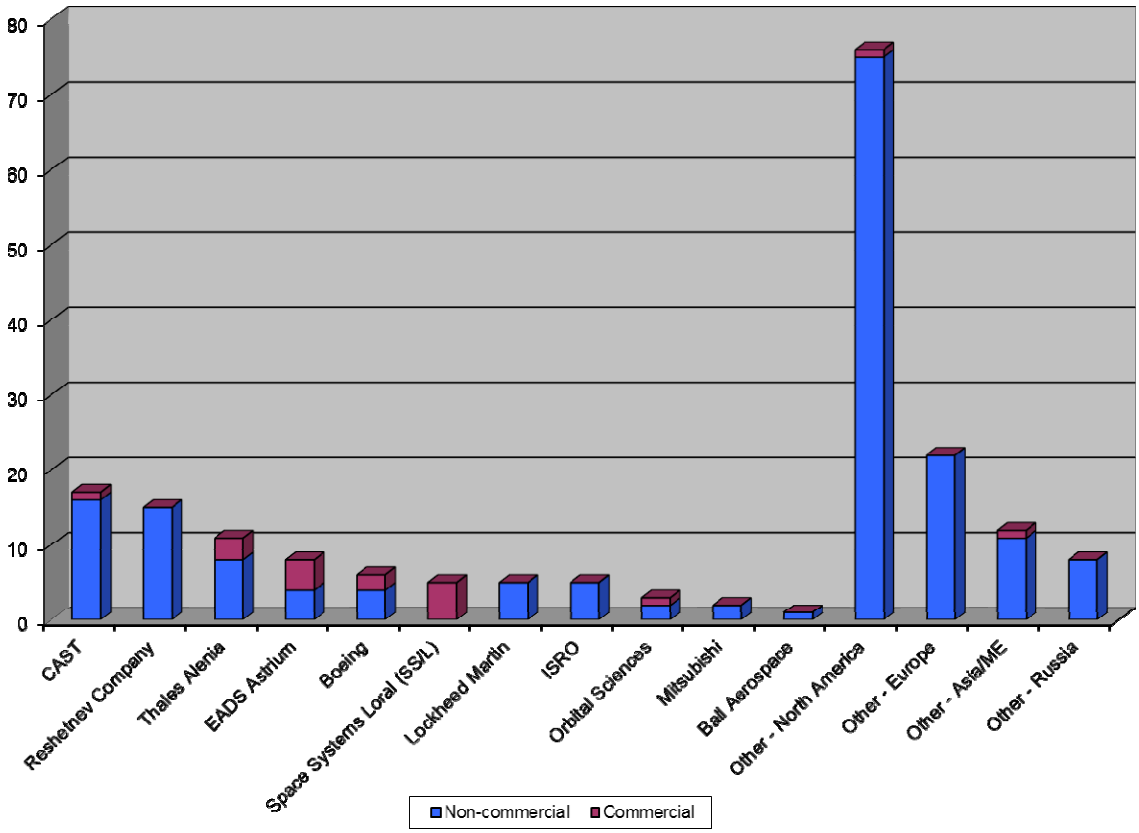

Figure 2.25: Satellites launched in 2013 by manufacturer and commercial status (Source: Futron)

Of the 196 satellites launched in 2013 (not including the 15 crewed or cargo missions to the ISS or Chinese Tiangong 1 space station, or Chang'e 3 Moon lander and rover), 182 were non-commercial. Similar to the previous year, China's CAST took the lead in manufacturing non-commercial satellites, with 16 satellites, followed by the Reshetnev Company with 15, strengthening its previously established presence; on the other hand Space Systems Loral (SS/L) and EADS Astrium took the lead in commercial payloads launching 5 and 4 satellites respectively. SS/L's figures resulted purely from commercial orders, whereas EADS Astrium also produced 4 non-commercial satellites. A majority of the satellites developed by Thales Alenia (8 of 11) were non-commercial in nature, as was the case with Lockheed Martin (5), Boeing (4 of 6), ISRO (5), Orbital Sciences (2 of 3), Mitsubishi (2), and Ball Aerospace (1). Of the 196 satellites launched in 2013, 98 were cubesats (49 of which had been developed in US institutions), and 44 small satellites developed globally.[121]

Next, in 2012, 32.3% of the 124 satellites launched were GEO-stationary satellites (Figure 2.26).[122] In this field, 50.0% of the satellites came from the US (7 by SS/L, 5 by Boeing, 4 by Lockheed Martin, 3 by Orbital Sciences, and an additional satellite classified under Other – US); while 22.5% were from Europe (5 by Thales Alenia Space and 4 by EADS Astrium); 12.5% from China (5 by CAST); 2.5% from India (1 by ISRO); and, 12.5% for Russia (3 Reshetnev Company, and 2 Other – Russia). In contrast, concerning the non-GEO orbiting satellites, Europe held a 20.2% share (5 EADS Astrium, and 12 Other – Europe); Russia held 10.7% (6 Reshetnev Company, and 3 Other – Russia); China held 21.4% (18 CAST); India held 2.4% (2 by ISRO); and Other – Asia/ME held a 19.0% share with 16 non-geo satellites. The US developed the majority of non-GEO-stationary satellites in 2012 with a share of 26.2% (2 by Lockheed Martin, 2 by Boeing, 1 by Orbital Sciences, and 17 additional satellites classified under Other – US).

In 2013, 13.8% of the 196 satellites launched were GEO-stationary satellites; that number was partially skewed since all 98 microsats launched in 2013 were mainly launched to LEO orbits with a few to SSO (Figure 2.27).[123] In this field, 55.6% of the satellites came from the US (5 by SS/L, 5 by Boeing, 3 by Lockheed Martin, and 2 by Orbital Sciences); while 14.8% were from Europe (1 by Thales Alenia Space and 3 by EADS Astrium); 7.4% from China (2 by CAST); 11.1% from India (3 by ISRO); 3.7% from Other – Asia/ME with 1 satellite; and, 7.4% for Russia (2 Reshetnev Company). In contrast, concerning the non-GEO orbiting satellites, Europe held a 21.9% share (10 Thales Alenia Space, 5 EADS Astrium, and 22 Other – Europe); Russia held 12.4% (13 Reshetnev Company, and 8 Other – Russia); China held 8.9% (15 CAST); India held 1.2% (2 by ISRO); Japan held 1.2% (2 Mitsubishi), while Other – Asia/ME held a 6.5% share with 11 non-geo satellites. Yet again, in 2013 the US developed the majority of non-GEO-stationary satellites with a share of 47.9% (1 by Boeing, 2 by Lockheed Martin, 1 by Orbital Sciences, 1 by Ball Aerospace, and 76 additional satellites (49 of which being microsats) classified under Other – US). The strong influence of national programmes remained throughout 2012 and 2013, considering the GLONASS constellation completion in MEO and Beidou navigation system in GEO.

Demand for commercial GEO-stationary satellites decreased even further in 2012 reaching 15 orders, even fewer than the previous 23 contracts awarded in 2011. However, it returned to 23 orders in 2013. In 2012, 9 manufacturers were represented in this market, a decrease from the 11 in 2011. Boeing and SS/L each had 4 GEO commercial satellite orders, while Lockheed Martin had none. Both China Great Wall Industry Corp (CGWIC) and Orbital Sciences had 2 orders each. And EADS Astrium, Thales Alenia, and Israel Aerospace Industries each had 1 order. In 2013, 9 manufacturers were again represented in this market. This time Boeing had 7 orders, while SS/L had 6, and Lockheed Martin none. EADS Astrium won 4 orders, while CGWIC and ISRO were each awarded 2 commercial GEO satellites. Both Thales Alenia and Reshetnev were each awarded 1 contract (Figure 2.28).

[121] Commercial Space Transportation: 2013 Year in Review, 14-17.
[122] Commercial Space Transportation: 2012 Year in Review, 29-32.
[123] Commercial Space Transportation: 2013 Year in Review, 14-17.

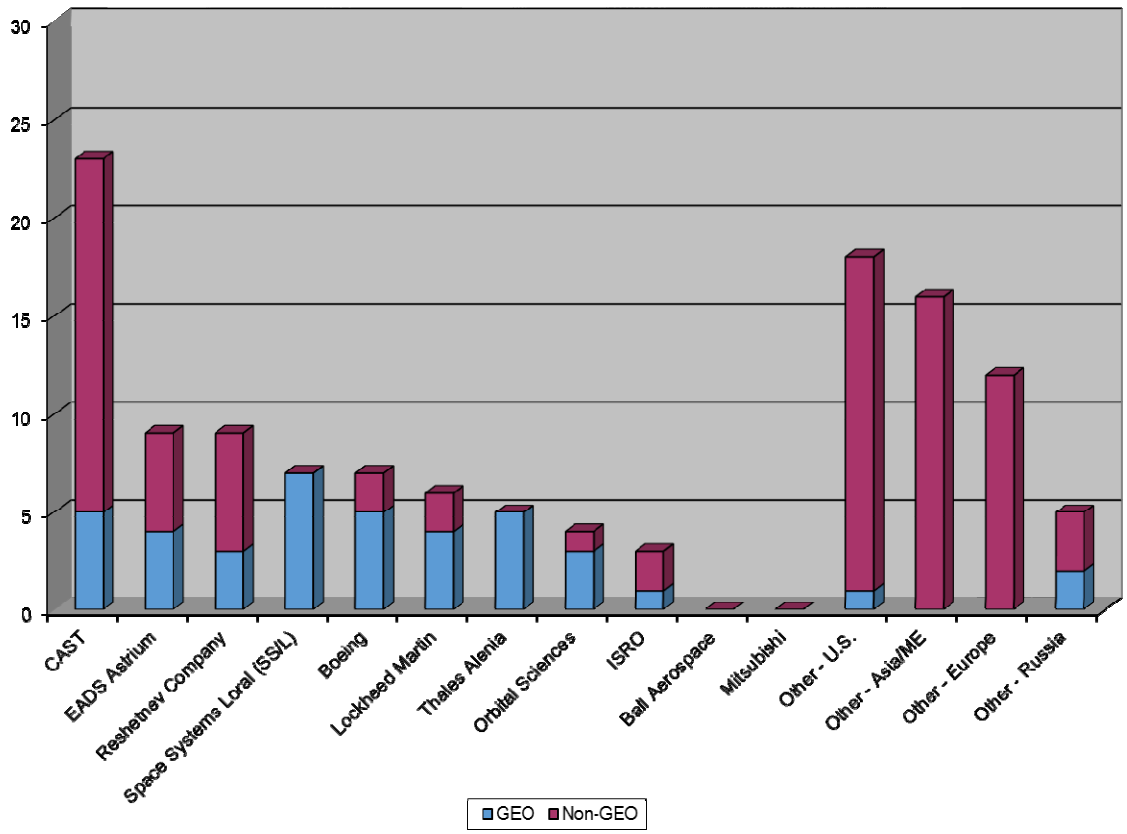

Figure 2.26: Satellites launched in 2012 by manufacturer and orbit type (Source: Futron)

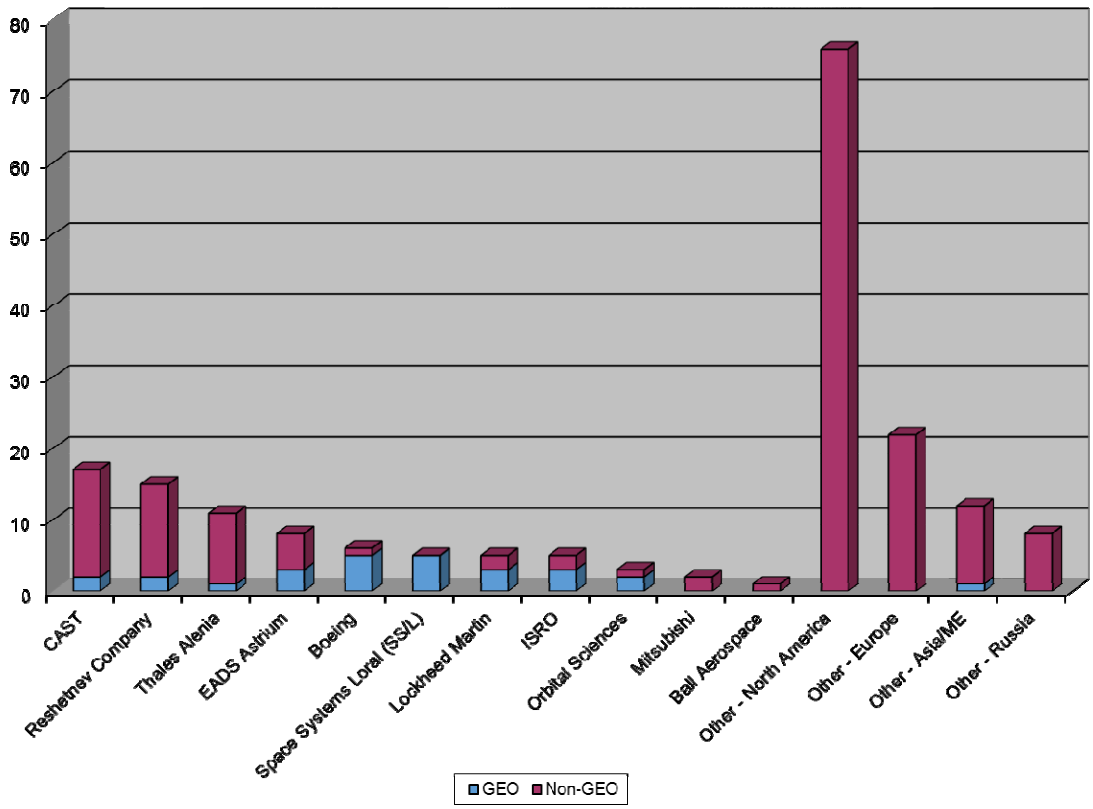

Figure 2.27: Satellites launched in 2013 by manufacturer and orbit type (Source: Futron)

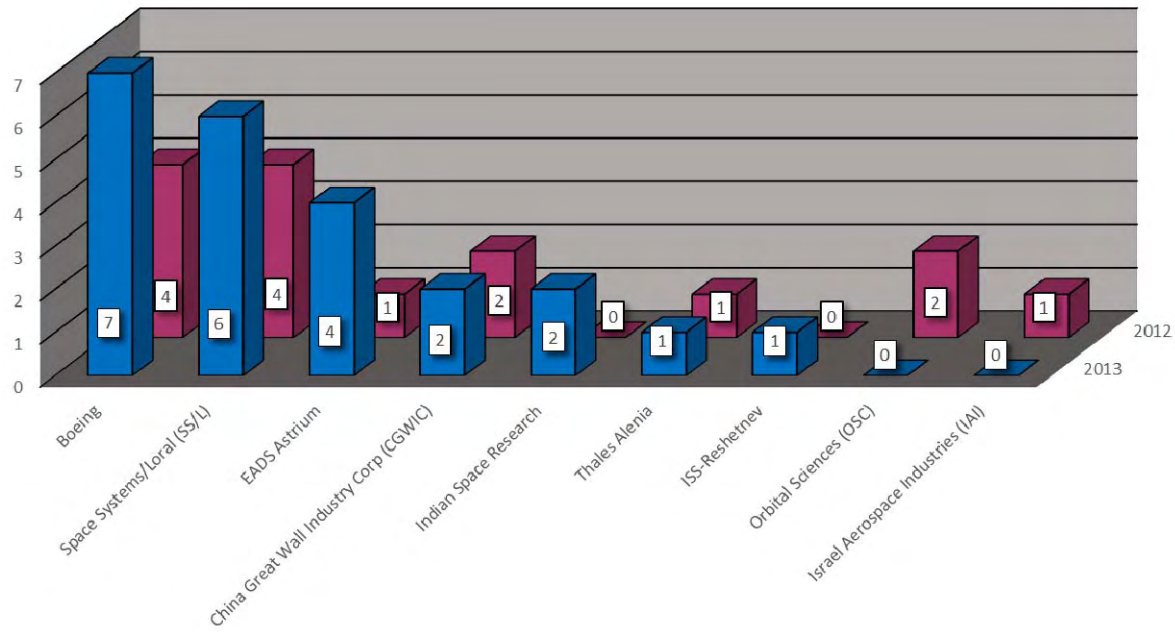

Figure 2.28: GEO satellite orders in 2012 & 2013 by manufacturer

In 2012, the lion's share of orders for geostationary satellites went to US prime spacecraft manufacturers; Boeing took 4 commercial GEO satellite orders (i.e. ABS 3A, Intelsat 29e, Satmex 7, and SES 9), while SS/L also took 4 orders (i.e. Echostar 18, NBN 1A, NBN 1B, and Star One C4), and Orbital Sciences 2 orders (i.e. Amazonas 4A, and Amazonas 4B). This amounted to 66.7% of commercial GEO communication satellite orders for 2012. On the other hand, European prime manufacturers stayed in the market with 1 order each, e.g. EADS Astrium (i.e. Express AM7) and Thales Alenia (i.e. Eutelsat 8 West B), accounting for 13.3% of the activity. China's CGWIC took two orders (i.e. CongoSat 1, and SupremeSat 3), resulting in another 13.3% share of the contracts awarded. And Israel Aerospace Industries was awarded a contract to develop the AMOS 6 communications satellite, resulting in a 6.7% share. [124]

In 2013, European prime spacecraft manufacturers appeared to regain their competitive footing, catching up with US prime manufacturers for orders. While total commercial GEO communication satellite orders in the US accounted for 56.5% of the contracts awarded, European contracts made up 21.7% of the available awards. Boeing took 7 orders (i.e. Inmarsat 5F4, Intelsat 33e plus three future Intelsat Epic satellites, Satmex 9, and ViaSat 2), while SS/L had 6 orders (i.e. AsiaSat 9, Eutelsat 65 West A, Intelsat 34, JCSat 14, Jupiter 2/Echostar 19, and Star One D1). EADS Astrium had 4 orders (i.e. DirecTV Latin America Sat, Express AMU 1, Intelsat 32, and Telstar 12-Vantage), while Thales Alenia had 1 order (i.e. SGDC 1). Moreover, India's ISRO and China's CGWIC had 2 orders each, representing an 8.7% share each of the contracts awarded; ISRO (i.e. GSAT 15, and GSAT 16), and CGWIC (i.e. APStar 9, and Nicasat 1). And lastly, Reshetnev had a 4.3% share when tasked to develop the AOneSat 1 satellite. [125]

2.5 International Sectoral Comparison

In order to assess the scope and dynamism of the activities, strategies and plans of the main space-faring nations, key space activities, such as the ability to launch missions, and also the number and type of missions launched, must be considered.

2.5.1 Launch Sector

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

[124] "Satellite Orders Report - 2012 Year-End Summary." Futron 23 Apr. 2014 <http://www.futron.com/upload/wysiwyg/Resources/FoF/2012/FutronSM2012-EOY.pdf>.

[125] "Satellite Orders Report - 2013 Year-End Summary." Futron 23 Apr. 2014 <http://www.futron.com/upload/wysiwyg/Resources/FoF/2013/FutronSM2013-EOY.pdf>.

Whereas a total of 84 orbital launches was carried out by eight countries in 2011, there was a total of 78 orbital launches by nine countries in 2012, and 81 orbital launches by eight countries in 2013 (Figure 2.29). The rank order among the top four launching states stayed similar to 2011, with Russia maintaining its lead position with 24 launches in 2012, and 32 launches in 2013. China lost its second place position to the US in 2013, with 15 launches for the year, where in 2012 it had 19 launches. On the other hand, the US conducted 13 launches in 2012, and 19 in 2013. Europe kept its fourth position for both years, with 10 launches in 2012, and 7 launches in 2013. In 2012, both Multinational and Iran conducted 3 launches, however 2 of Iran's launches were unsuccessful. Additionally, India, Japan, and North Korea each conducted 2 launches for the year; while North Korea's first launch in 2012 had failed, its second launch in December 2012 was successful. In 2013, India and Japan each conducted 3 launches while South Korea successfully launched its Naro-1, and Multinational had 1 failed launch. Overall, the trend remained consistent with previous years, with the pace of respective launching states performing to their capacities.

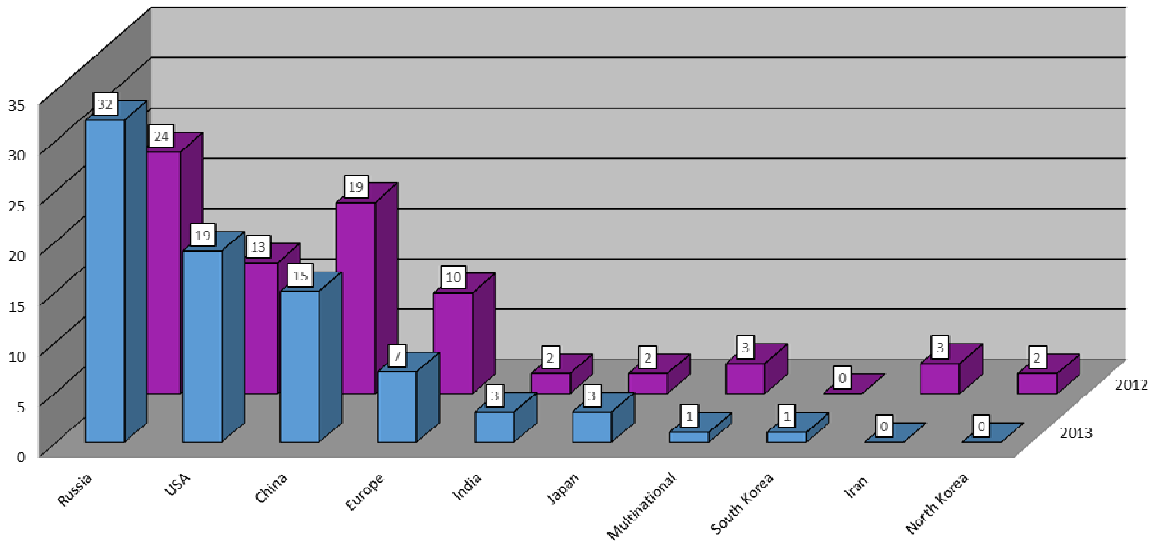

Figure 2.29: Total worldwide orbital launches per country/institution 2013/2012 (Source: FAA)

The number of missions provides a perspective that is particularly interesting and useful for a complete picture of the launches both in 2012 and 2013 (Figure 2.30 and 2.31). In 2012, the number of missions increased from 133 payloads to 139. The range and hierarchy of the number of missions launched was roughly similar to previous cycles, although China surpassed Russia in terms of second-most missions launched. The US conducted a total of 36 missions (a share of 25.9% of the total missions launched), followed by China with 27 (19.4%), and Russia with 22 (15.8%). Japan moved to fourth position with 9 (6.5%) missions, followed by ESA and France each with 5 (3.6%) missions. The share of the remaining listed states shares did not each exceed 3% of the launch total. The US, China, and Russia stayed well ahead compared to the other states involved, and reached a combined 61.2% of the total number of missions for 2012.

In 2013, the number of missions dramatically increased to 212, however that number is heavily skewed due to the quantity of microsat missions launched within that year. It should be mentioned that whereas 37 microsatellites and 27 small satellites were launched in 2012, 98 microsatellites built mainly by governments, universities, and non-profits and 44 small satellites were launched in 2013. That said, the range and hierarchy of the number of missions launched was as in previous years, with the US, Russia, and China in the top three positions. The US conducted a total of 86 missions (*including nearly 60 microsatellite missions*, for a share of 40.6% of the total missions launched), followed by Russia with 31 (14.6%), and China with 18 (8.5%). ESA and Germany both moved ahead of Japan, each with 6 missions (2.8%). The year 2013 saw increased mission activities from many states, mainly from the development of microsatellites for academic and non-profit technological demonstration purposes. If the total 98 microsatellites were removed from consideration, of the remaining 114 missions

conducted the US would have a 22.8% share, while Russia would have 25.4%, and China's share would be 15.8%; combining to about 64% of the total missions launched 2013.

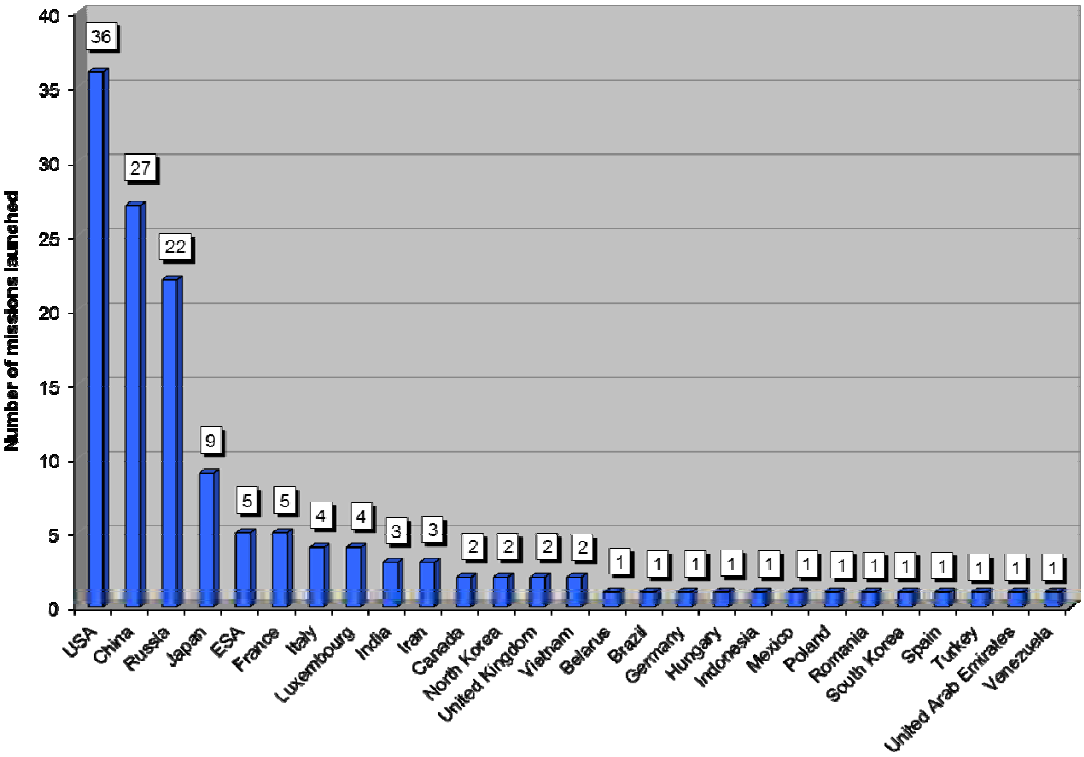

Figure 2.30: Number of missions launched into space by country/institution in 2012 (Source: FAA)

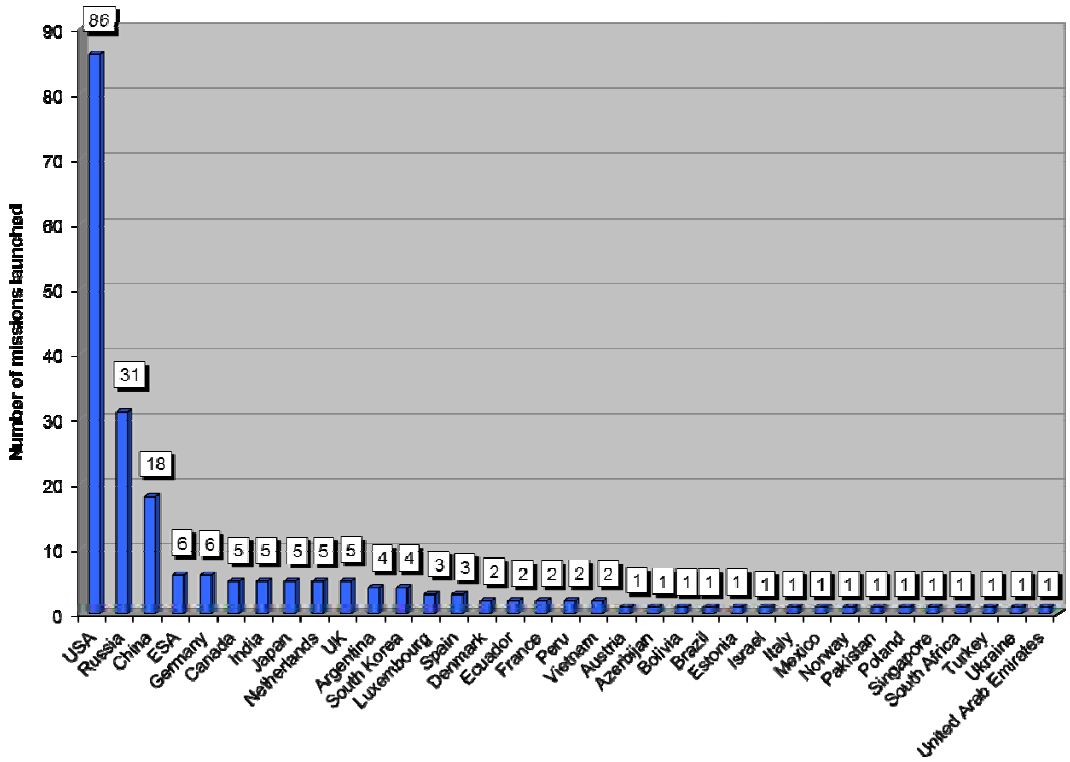

Figure 2.31: Number of missions launched into space by country/institution in 2013 (Source: FAA)

Europe taken as a whole (including ESA) reached 18.7% of the missions conducted in 2012; amounting to third place in number of missions behind the US and China. In 2013, Europe surpassed both China and Russia for the second position in number of missions conducted, amounting to 17.9%. While France continued the highest number of missions among European countries, with 5 missions for 2012, its number dropped to 2 in 2013. On the other hand, while Germany conducted only 2 missions in 2012, in 2013 it conducted the highest number of missions among European countries with 6 missions. In both years it is clear that the hierarchy differs when comparing the number of missions to launches, especially with respect to the US and Russia. As with the US, China and ESA were better represented in this category in both years than in launch activity. Internal European activity is also more discernible through this perspective, with France following ESA for the lead among European countries in 2013, while Germany was ahead of other European countries in 2013.

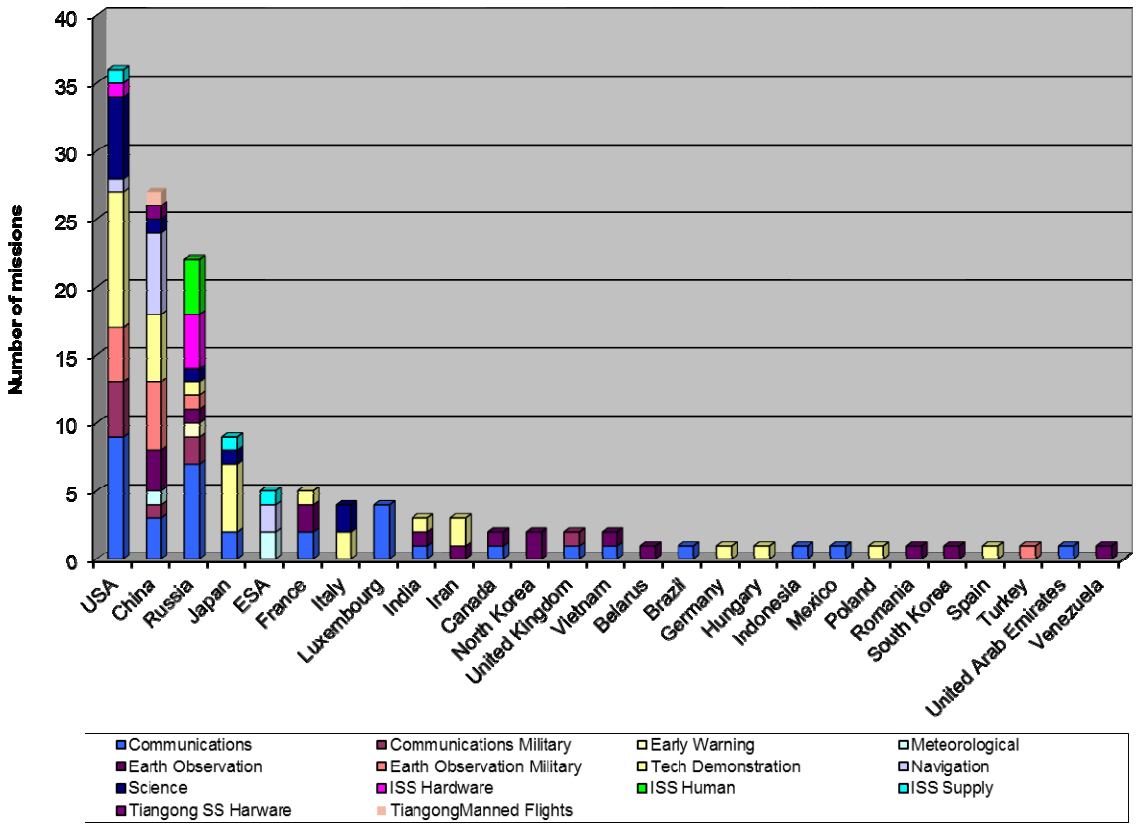

Figure 2.32: Types of missions launched into orbit in 2012 (Source: FAA)

In 2012, US missions were again focused on communication activities, in addition to science and tech demonstrations (Figure 2.32). On the other hand, Russia balanced its communications activity (both civil and military) with navigation missions and resupplying the ISS. China focused its activities toward communications, Earth observation, science missions; along with the launch of several navigation satellites and its space station missions. The US, Russia, and China each launched military dual-purpose satellites, but where the Russia focused on military communications, both the US and China focused more on reconnaissance satellites. On the other hand, aside from the UK launching 1 military communications satellite and Turkey launching a reconnaissance satellite, the remaining states either focused on civil communications or Earth observations satellites.

In 2013, most of the US missions were focused on technical demonstrations, with a large portion of these tests coming from academia and non-profit institutions; that was followed by numerous scientific and communication activities (Figure 2.33). Russia continued to focus on developing communications capacity (both civil and military) in addition to focusing on navigation missions, and resupplying the ISS. China focused its activities toward Earth observation activities (both civil and military), along with several science missions and missions involving its space station. Once again, the US, China, and Russia each launched military dual-purpose satellites, the US launching equal numbers of

military communications and reconnaissance satellites, while Russia concentrated its activity on military communication, and China focused on reconnaissance activities. This time, India launched 1 military communications satellite, while Japan also launched 2 military reconnaissance satellites; the remaining states either focused on technology demonstrations, with some communications satellites as well.

Regarding the areas of activity, technology demonstrations saw the biggest share of activity in the past two years, with a 22.3% share in 2012, and a 39.2% share in 2013. Moreover, communications (both civil and military) made up a large share of the missions launched, amounting to 30.9% in 2012, and 23.1% in 2013. Science missions surpassed the number of remote sensing missions in 2013, with 13.2% in 2013, from 7.9% in 2012. Remote sensing (both civil and military) reached 19.4% in 2012, and 11.8% in 2013. Navigation activity amounted to a 6.5% share in 2012, while it went down to 2.8% in 2013; while ISS (supply and hardware) stayed about the same for both years. Finally, meteorological activity diminished from 2012 to 2013, while Early Warning systems had an increase in that same time.

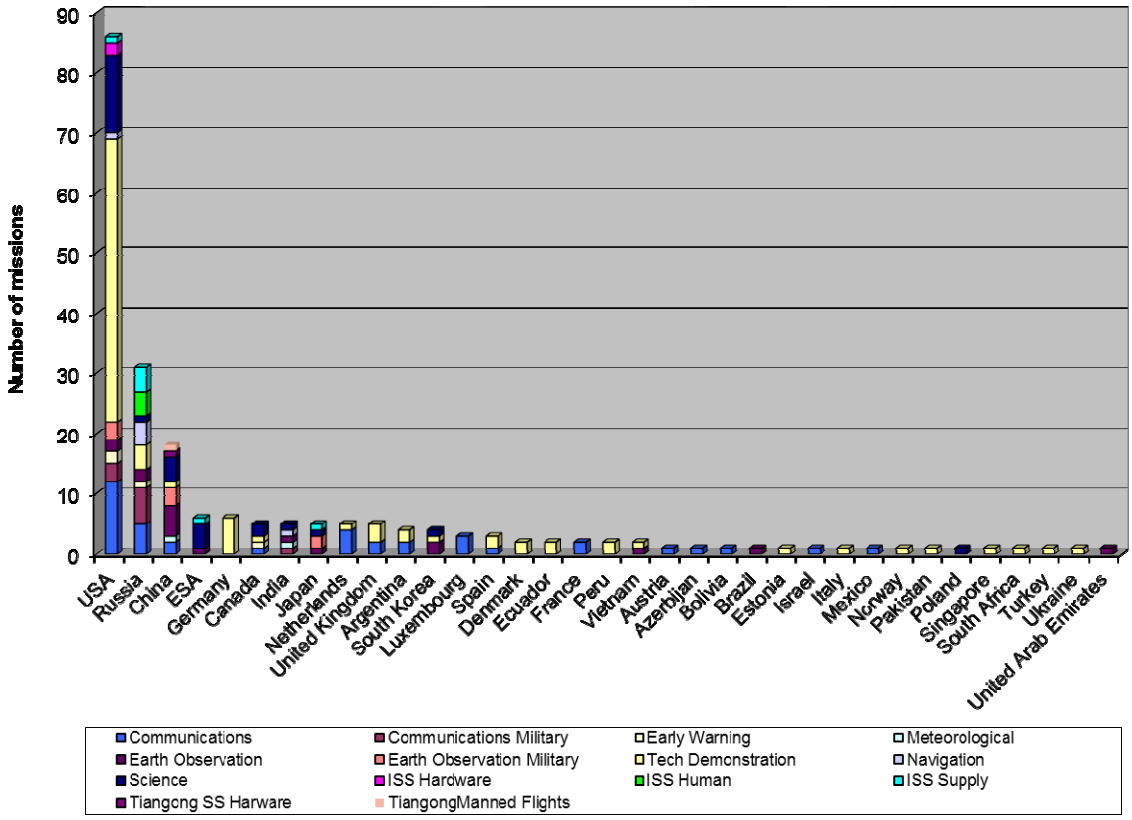

Figure 2.33: Types of missions launched into orbit in 2013 (Source: FAA)

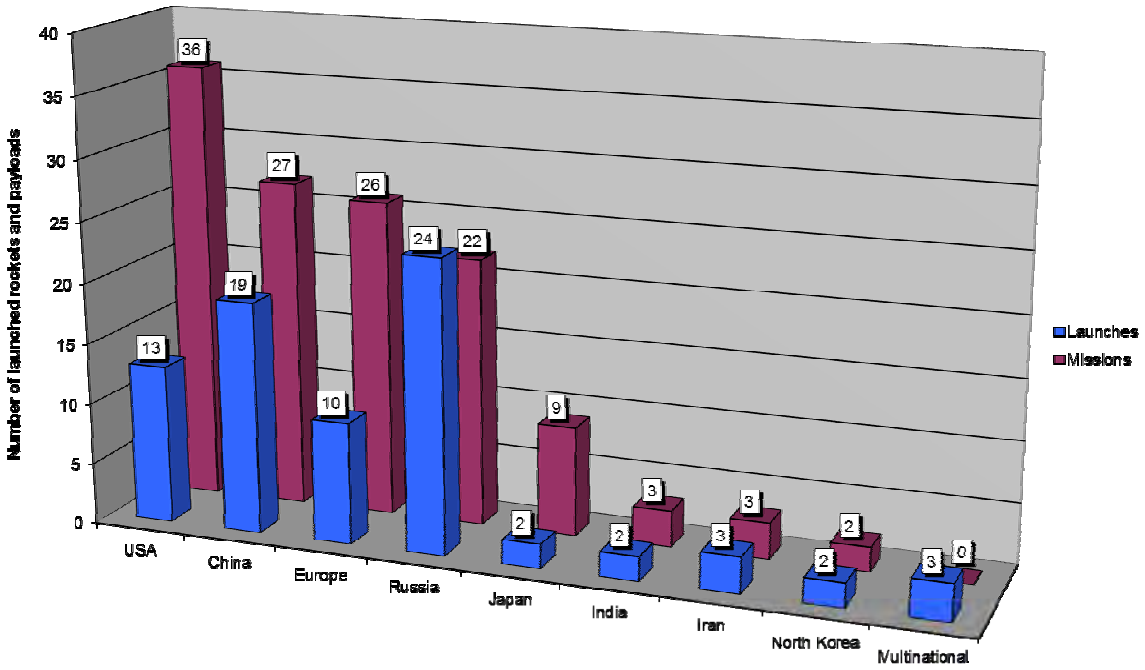

Figure 2.34: Assessment of major space powers' activities in 2012 (Source: FAA)

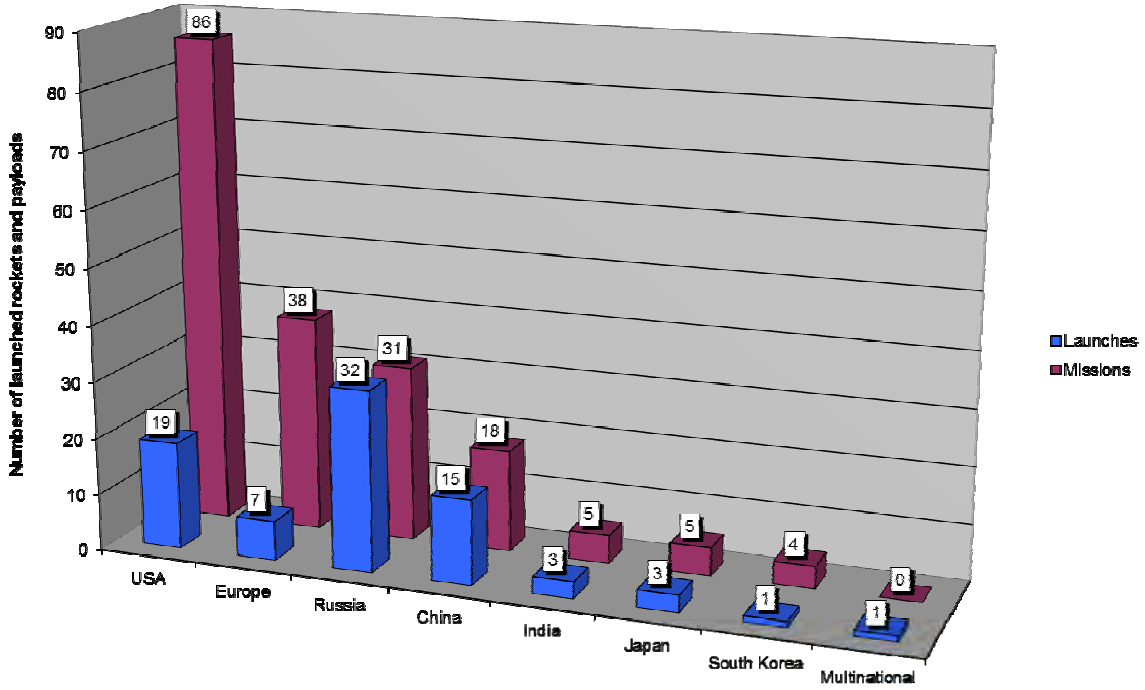

Figure 2.35: Assessment of major space powers' activities in 2013 (Source: FAA)

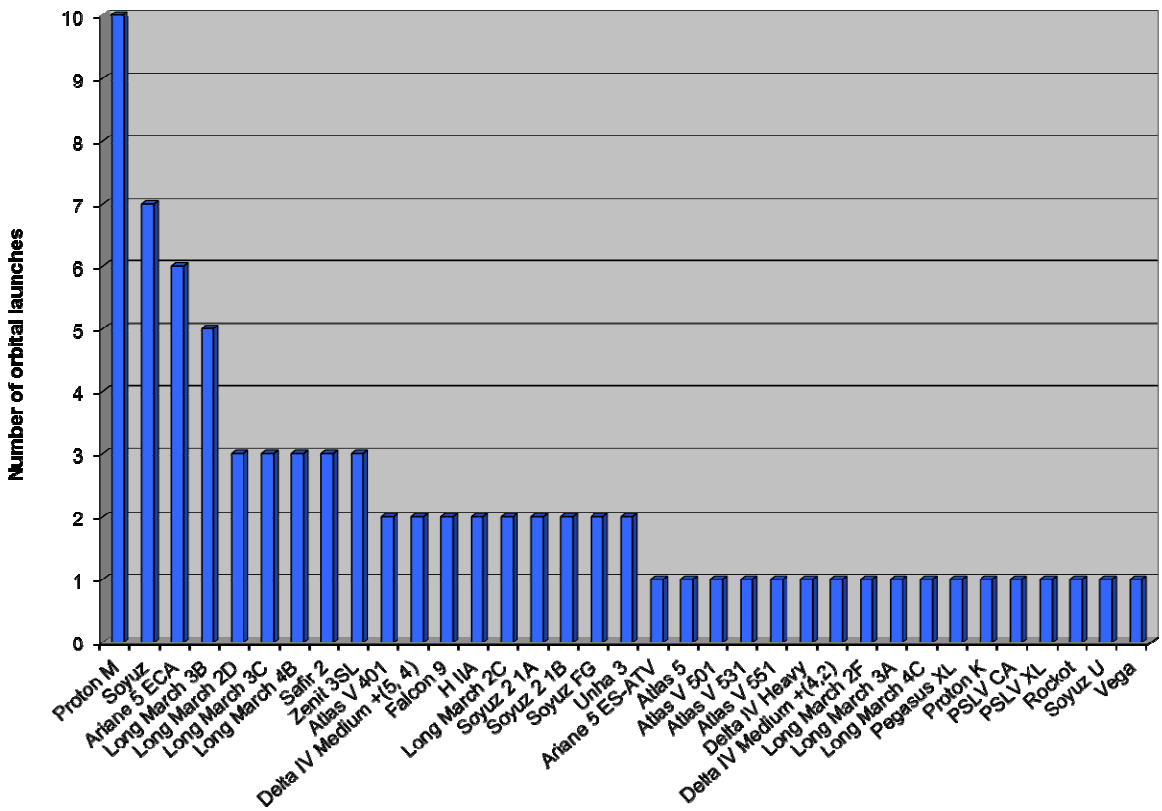

Figure 2.36: Worldwide orbital launches per launch system in 2012 (Source: FAA)

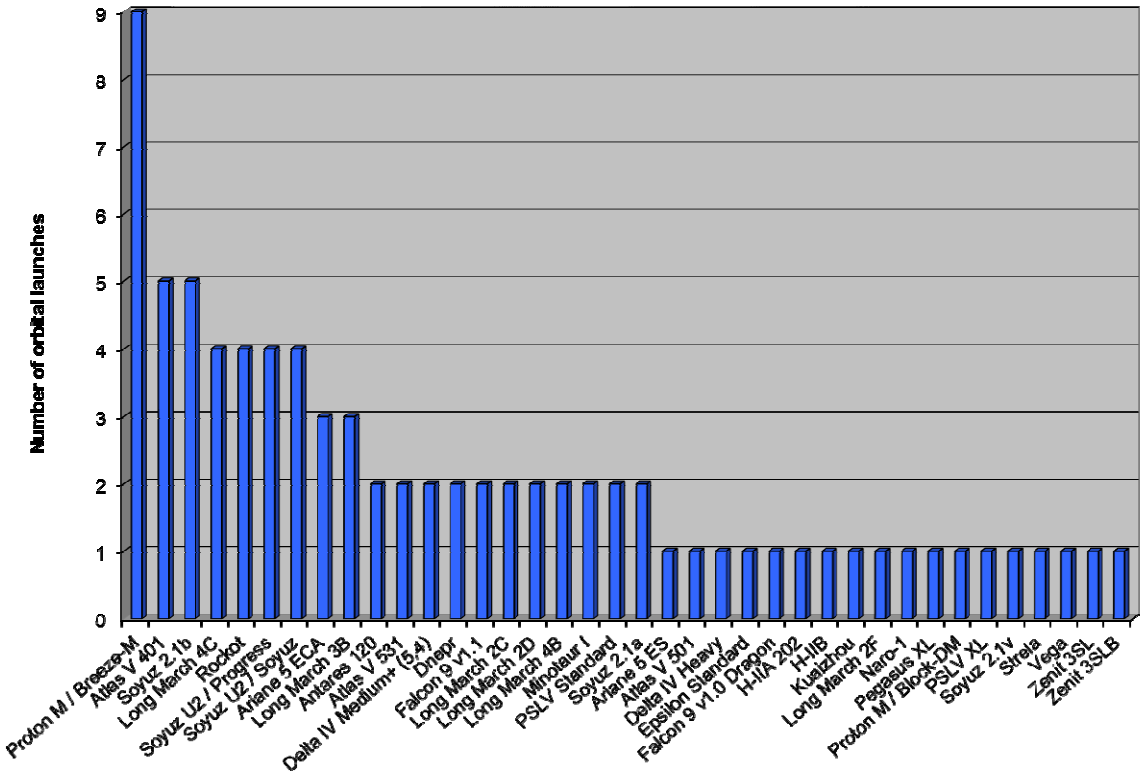

Figure 2.37: Worldwide orbital launches per launch system in 2013 (Source: FAA)

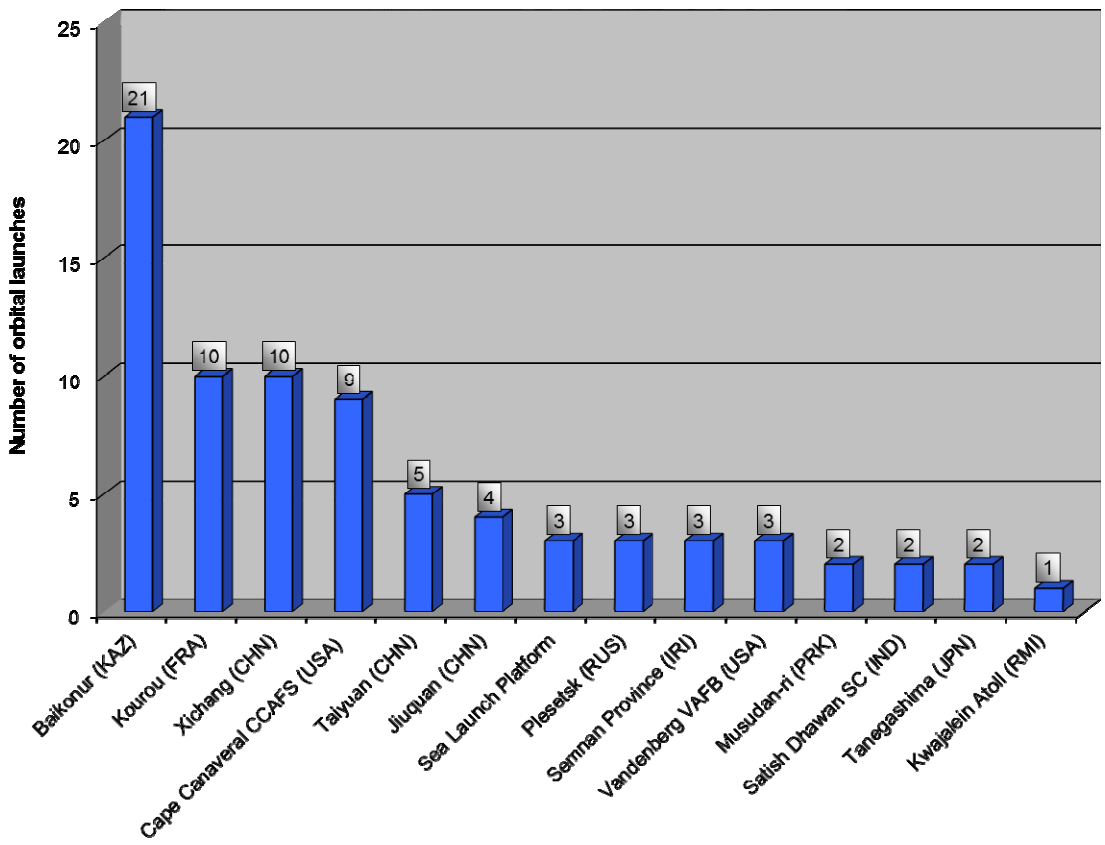

Figure 2.38: Worldwide orbital launches per launch site in 2012 (Source: FAA)

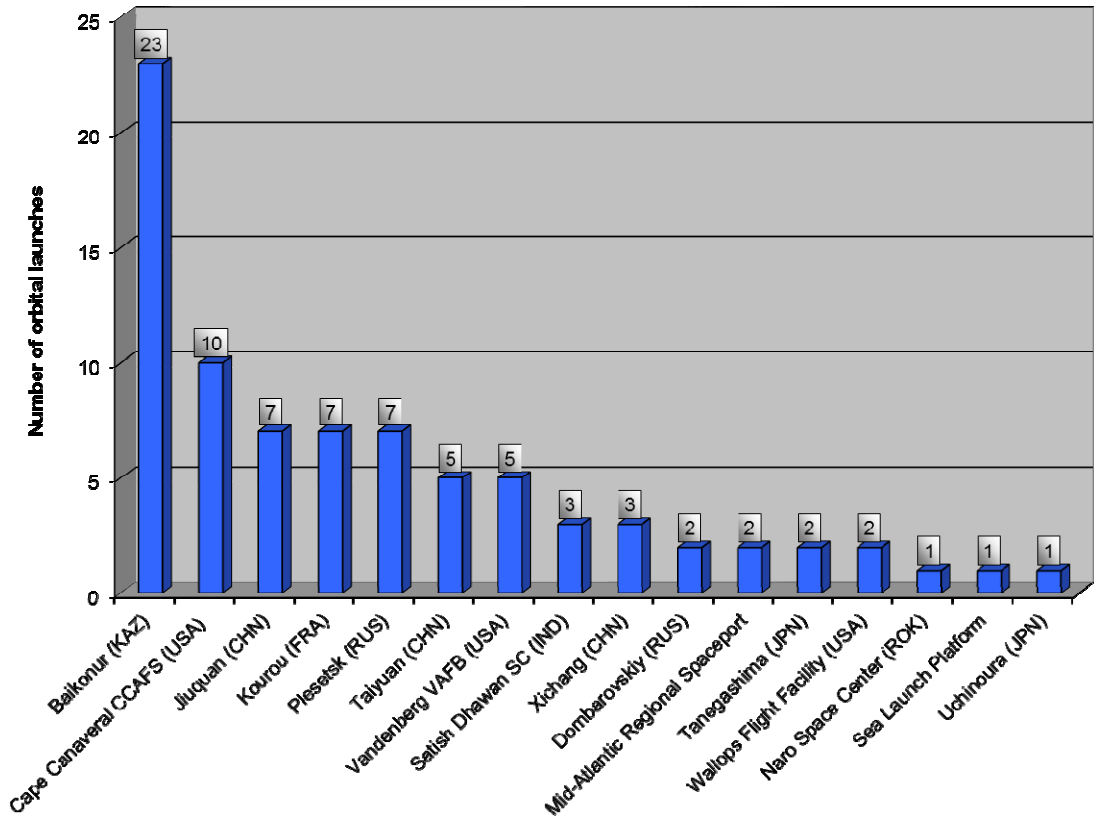

Figure 2.39: Worldwide orbital launches per launch site in 2013 (Source: FAA)

In terms of the number of launchers per launch system (Figure 2.36 and 2.37) Russia maintained its lead in 2012 with 10 Proton M and 7 Soyuz launches, while Europe's 6 Ariane 5 ECA launches came in third position, followed by China's Long March 3B in fourth position with 5 launches. China's Long March 2D, 3C, and 4B would share the 5th position with Sea Launch's Zenit 3SL and Iran's Safir 2, each with 3 launches. Next, conducting 2 launches apiece, the Soyuz 2 1A, 2 1B, and Soyuz FG shared 6th position with Japan's H IIA, North Korea's Unha 3, and the US' Atlas V 401, Delta IV Medium +(5,4), and SpaceX's Falcon 9. The other listed launchers each conducted one launch in 2012. In 2013, Russia again had the leading spot with 9 Proton M launches, but its Soyuz 2 1B tied for second position to the US Atlas V 401 each with 5 launches. Russia's Rockot, and Soyuz U2 launchers shared the 3rd position with China's Long March 4C, each conducting 4 launches. On the other hand, Europe's Ariane 5 ECA dropped to 4th position, along with China's Long March 3B, each conducting 3 launches. Europe's Vega launcher had 1 successful launch both in 2012 and in 2013.

In 2012, Russian launchers spread across 6 configurations (mainly Proton M and Soyuz variations) and amounted to 30.8% of the launches (24 launches) in 2012, while China's launchers were distributed in 8 configurations of the Long March launcher amounting to 24.4% (19 launches). The US, with its 10 launch configurations (including the Falcon 9, Pegasus XL, and various Atlas V and Delta IV) amounted to 16.7% (13 launches) Next, Europe with the Ariane 5 ECA and ES-ATV, its Vega launcher along with its own Soyuz 2 amounted to 12.8% (10 launches). The major change in 2012 was the addition of the Vega launcher conducting its inaugural flight on 13 February 2012. In 2013, Russian launchers spread across 5 active configurations, amounting to 39.5% of the launches (32 launches) in 2013, while US rockets were distributed among 12 active configurations, amounting to 23.5% (19 launches). China had only 3 active launchers, amounting to 18.5% of the launches (15 launches), and finally Europe maintained its 4 launcher configurations, amounting to 8.6% (7 launches). The Ariane 5 has the advantage of the ability to carry two payloads, which should be considered when assessing the European figure.

While the total number of active launch configurations (including their variations) had remained at 35 in 2012, it decreased to 31 in 2013. However, this reduction is less significant when considering that some launcher configurations have several variations which were not used in that period, for instance the both the U.S. Delta IV and Atlas V launcher configurations each have several variations, or likewise Russia with its variations of the Soyuz 2 launcher.

Space transportation infrastructure is another factor that helps assess space capacity, as spaceports are integral for independent access to space (Figures 2.38 and 2.39). The number of spaceports used by a country, as well as the frequency of launches conducted from them, are important indicators of the momentum of a country's space activities.

Baikonur (operated by Russia) was the most active area for launches with 21 launches in 2012, (i.e. 26.9% of total launches); Kourou and Xichang tied for second, each with 10 launches (12.8%), followed by Cape Canaveral with 9 launches (11.5%). China`s Taiyuan had 5 launches (6.4%) while its Jiuquan launch site had 4 launches (5.1%). Next the Sea Launch Platform, Russia`s Plesetsk, Iran`s Semnan Province, and the US Vandenberg Air Force Base each had 3 launches (3.8%), while North Korea`s Musudan-ri, India`s Satish Dhawan, and Japan`s Tanegashima launch site had 2 launches (2.6%), and 1 launch (1.3%) was conducted from Kwajalein Atoll, in the Marshall Islands.

In 2013, Baikonur was again the most active launch site with 23 launches (28.4%) followed by Cape Canaveral with 10 launches (12.3%). This time, Jiuquan, Kourou, and Plesetsk all shared the 3rd spot, each with 7 launches (8.6%), while Taiyuan and the Vandenberg facility shared the 4th position with 5 launches (6.2%). India`s Satish Dhawan and China`s Xichang both had 3 launches (3.7%), while Russia`s Dombarovskiy, Japan`s Tanegashima, the commercial Mid-Atlantic Regional Spaceport and Wallops flight facility each had 2 launches (2.5%); South Korea's Naro Space Center, the Sea Launch Platform, and Japan's Uchinoura launch site each had 1 launch (1.2%) in 2013. While Europe is stable with the spaceport in Kourou, it runs the risk of being further outdistanced by the US, Russia, and China, which benefit from the numerous launch sites available and increased activity. This risk is counterbalanced with the availability of the launcher Ariane 5 launcher family, in addition to the Vega launcher, and the Europeanized Soyuz 2 launcher operating out of Kourou. In 2012, Russian sites hosted 30.8% of total launches followed by 24.4% in China, 16.7% for the US, and 12.8% for Europe. In 2013, Russian sites hosted 39.5% of total launches followed by 23.5% for the US, 18.5% in China, and 8.6% for Europe. The situation could change in the next years due to Russia`s development of a new launch facility in the Far East that is expected to be ready by

2015, and be capable of supporting cosmonaut launches by 2018.[126]

2.6 Transatlantic Industrial Comparison

Europe (i.e. all actors) and the United States are the two major space actors that invest the most in space activities (cf. Figure 2.1). They also have the most diverse and competitive industrial bases. An overview of their respective structures and capabilities is therefore necessary to assess the health and competitiveness of their industrial bases. This follows in the next two subsections, beginning with Europe.

2.6.1 State of the European Industry

The financial results of Europe's space manufacturing industry in 2012 and 2013 provide insight into the European space industry's developments and character operating as both a strategic sector and infrastructure supplier. The trends reviewed in this section are mainly based on statistics generated by ASD-Eurospace.[127]

As can be seen in Figure 2.40, there has been a trend of regular increases in turnover, rebounding from the dip experienced in 2009 due to the financial crisis. The turnover grew from €6.145 billion ($8.197 billion) in 2010 to reach €6.815 billion ($9.395 billion) in 2013. While turnover had increased in 2011, a sluggish atmosphere had prevailed with a further decrease of 11.5% GEO satellite orders; in the next year, orders had dropped even further 30.4%, however they rebounded by 43.8% in 2013 (returning to the same number of orders as in 2011, i.e. 23).[128]

Employment levels are another way to gauge the strategy of the main companies in the space sector (Figure 2.41). In 2011, an estimated 897 jobs were created, followed by 535 additional jobs in 2012, and 505 additional jobs created in 2013. This growth, while sluggish, appears to be steady with jobs increasing by several hundreds increments in each passing year, despite decreased order intakes in recent years.

In Europe, there has been a shift in priorities toward funding institutional civil programmes at the expense of military ones. ESA's role has grown steadily since 2004, while other public entities have maintained their positions after a sharp decrease in 2009; this shift may be explained by the reduced presence of the military as a customer. In 2011, sales to European customers were 81.3% of final sales, while exports represented 18.7% of final sales[129]; that ratio changed to 79.7% to 20.3% in 2012[130], and 76.8% to 23.2% in 2013.[131] Institutional programmes (both civil and military) were the main source of revenue for the European industry reaching 65.4% in 2012, while commercial programmes generated 34.6% of final sales[132]; in 2013, revenue from institutional programmes generated 67.6% of European industry revenue.[133]

When looking at the European space industry by sector (Figure 2.43), there was a moderate overall increase in turnover, and that increase had the greatest impact in launcher developments and production which grew by around 10% in both 2012 and 2013. Similarly, scientific programmes saw significant growth in 2012, but nominal change in 2013. On the other hand, satellite applications (e.g. navigation systems and telecommunications systems) only marginally increased in 2011 and 2012, while support and test sectors experienced fluctuations, dipping significantly in 2012, only to increase again in 2013.

[126] Katia, Moskvitch. "Russia to Kick Off Construction of a New Spaceport." 21 July 2010. BBC 24 Apr. 2012 <http://www.bbc.co.uk/news/science-environment-10698433>.
[127] ASD-Eurospace. "Facts & figures – The European Space Industry in 2013." 18th edition. June 2014.
[128] "Satellite Orders Report - 2013 Year-End Summary." Futron 23 Apr. 2014: 2 <http://www.futron.com/upload/wysiwyg/Resources/FoF/2013/FutronSM2013-EOY.pdf>.
[129] ASD-Eurospace. "Facts & figures – The European Space Industry in 2011." 16th edition. June 2012: 9.
[130] ASD-Eurospace. "Facts & figures – The European Space Industry in 2012." 17th edition. June 2013: 9.
[131] ASD-Eurospace. "Facts & figures – The European Space Industry in 2013." 18th edition. June 2014: 13.
[132] ASD-Eurospace. "Facts & figures – The European Space Industry in 2012." 17th edition. June 2013: 8.
[133] ASD-Eurospace. "Facts & figures – The European Space Industry in 2013." 18th edition. June 2014: 6.

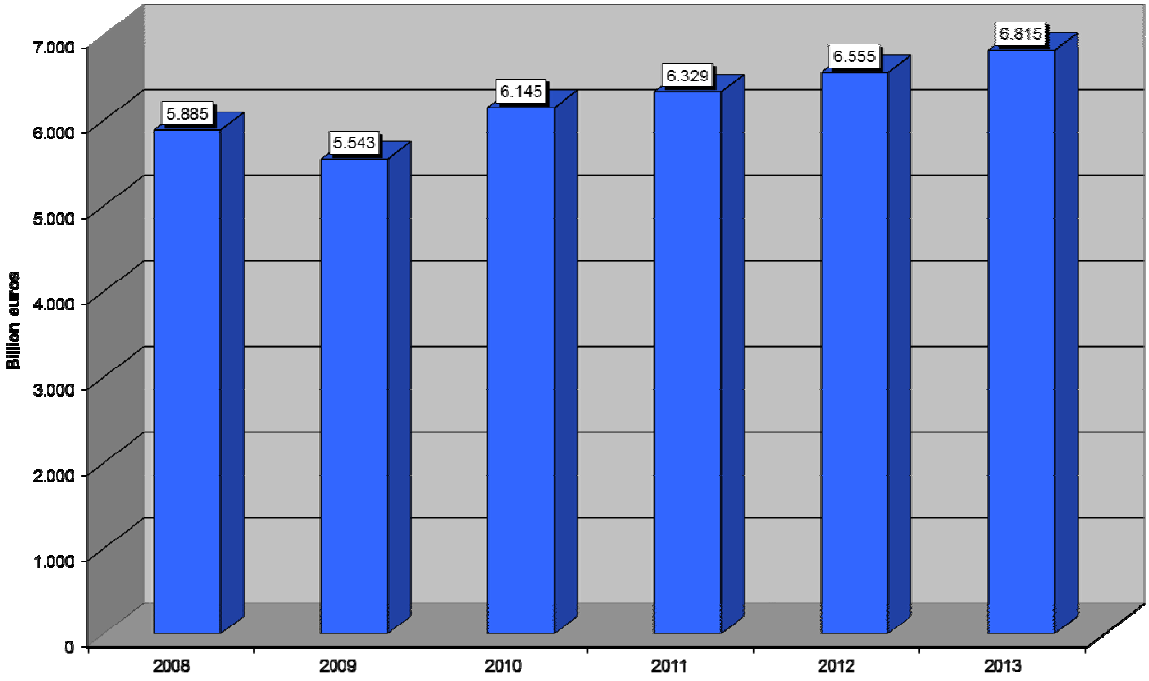

Figure 2.40: Estimated consolidated turnover of the European space sector in Euros
(copyright by Eurospace – all rights reserved, used with permission, reproduction forbidden)

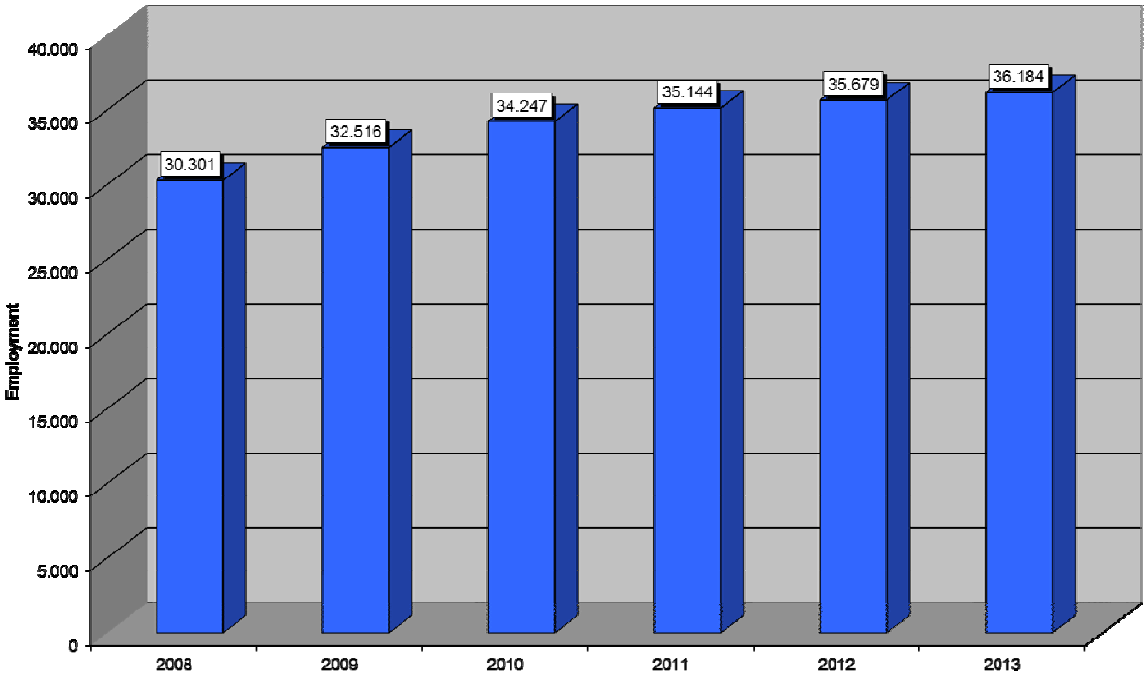

Figure 2.41: European space industry employment
(copyright by Eurospace – all rights reserved, used with permission, reproduction forbidden)

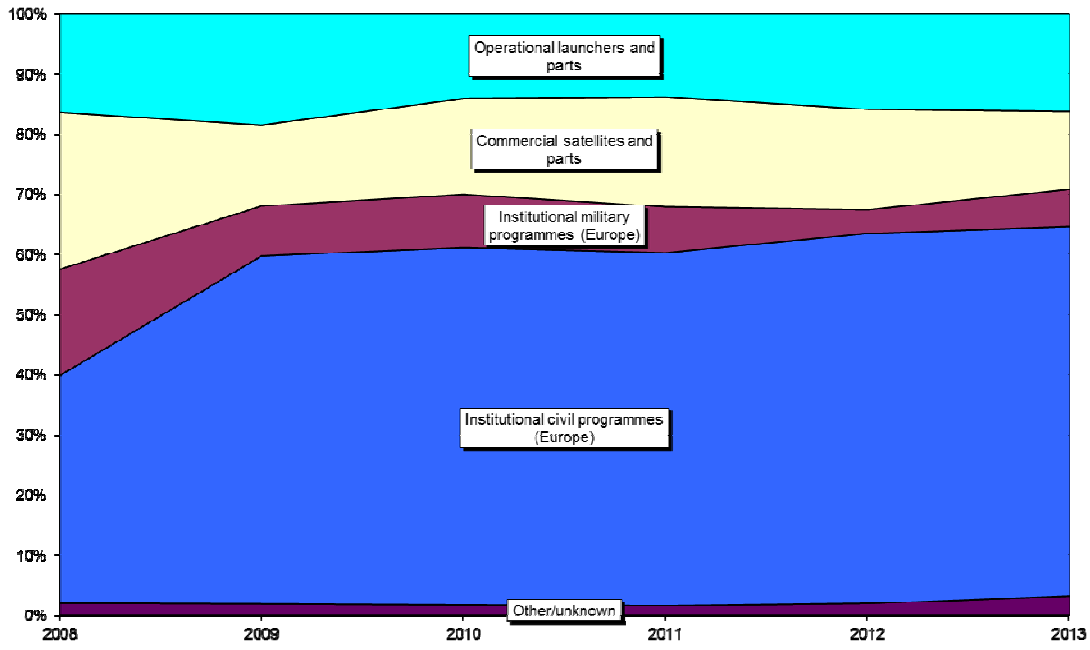

Figure 2.42: Estimated share of European space industry consolidated turnover per institutional customer (copyright by Eurospace – all rights reserved, used with permission, reproduction forbidden)

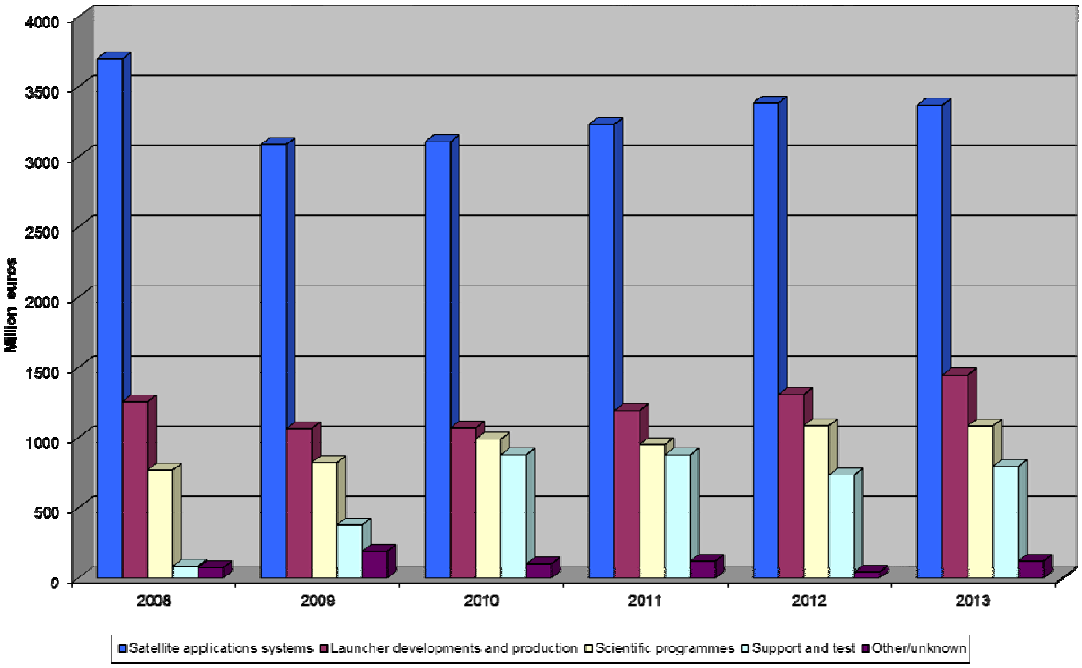

Figure 2.43: Estimated share of European space industry consolidated turnover per sector (copyright by Eurospace – all rights reserved, used with permission, reproduction forbidden)

While Figure 2.43 displays the impact of the turnover per sector, and provides a historical timeline, it is possible to drill down further into each category to assess the impact of the increase in turnover. Between 2010 and 2013, the effect varied among the three parts of the satellite applications sector (i.e., telecommunication, earth observation, and navigation/localisation systems). Revenue from telecommunications systems in the European sector grew by 19.8% from €897.02 million to €1.075 billion in 2011, followed by a decrease of 8.6% to €983 million in 2012, and a further reduction of 17.6% to €810 million in 2013. Similarly, navigation systems increased revenue by 15.7% in 2011, reaching €373 million from €322.5 million in 2010; followed by a decrease of 4.6% to €356 million in 2012, and an 11.2% increase to €396 million in 2013. On the other hand, whereas Earth observation systems revenue remained unchanged entering 2011, earning €739 million from €736.9 million in 2010; it saw a 19.2% increase amounting to €881 million in 2012, followed by a 7.2% decrease to €818 million in 2013.[134]

Next, when looking at the launcher development and production section, it should be noted that launcher developments in Europe are funded almost exclusively by ESA. In 2011 and 2012, expenditure on launcher development reached about €400 million wherein 2013, expenditure on launcher development increased to just under €600 million. Launcher business will be strongly affected by the decisions taken at the upcoming 2014 ESA Ministerial Council meeting. Operational launcher systems revenue increased from an estimated €700 million in 2010 and 2011 to reach nearly €900 million in 2012 and 2013.[135] Next, scientific programmes saw a substantial increases in revenue for 2012 and 2013, generated particularly from the design, development, and production of spacecraft with unique science programme features, while human spaceflight and microgravity segments experienced decreases in sales in 2013.[136] These scientific programmes are promoted almost exclusively by European institutions, with ESA at the forefront.

2.6.2 State of the United States Space Industry

The trends reviewed in this section are mainly based on the 2013 Year-End Review and Forecast report issued by the Aerospace Industry Association (AIA).[137] While the US aerospace industry operated with a constant increase in sales especially between from 2010 through 2013, revenue generated within its space industry had experienced a flux growing from $44.4 billion in 2010 to crest at $46.8 billion in 2011, and then gradually declining to $44.8 billion according to the 2013 preliminary assessment. However, this decrease had been anticipated in previous years due to foreseen budget cuts, and increased competition from low-cost countries such as India, China, and Russia. It should be mentioned that the data published by the AIA differs significantly from Eurospace in its collection methodology and should therefore not be taken as a direct comparison in terms of revenue, employment and exports.

In 2013, an estimated 71,000 people were employed in the US space industry; a 3000 decrease from the estimated 74,000 employed in 2012. However, in 2011, the AIA estimated that 71,000 people were employed. This swing in employment is not shared by the European counterpart which has experienced a steady increase in employment in since 2011, however this variation may exist in part due to incomplete information available by the US Census Bureau.

While budget cuts in US spending are partly to blame for the reduced revenues, the industry is optimistic about export growth, with signs beginning to show in 2013 due to the implementation of Export Control Reform. With this reform, the US space industry is less restricted from exporting technology beyond its domestic market. Deciphering the situation of U.S. exports is difficult because the figures are only available for aerospace taken as a whole. However it can be noticed that there has been a constant increase of total civil exports from $75.28 billion in 2011 to $86.81 billion in 2012, and $98.83 billion in the 2013 preliminary assessment. However, with the specific civil aerospace export data suppressed by the Census Bureau since 2009, it is difficult to quantitatively determine which part the space sector has been or is likely to be affected by the liberalisation in civil export controls.[138]

Thisnotwithstanding, the military figures are more accurate, allowing a better assessment of the trends in sales. After sales of spacecraft, satellites & parts fell to $91 million in 2011, they experienced substantial increases

[134] Ibid. at 16.
[135] Ibid. at 14.
[136] Ibid. at 16.

[137] Aerospace Industry Association. "2013 Year-End Review and Forecast." 2014 <http://www.aia-aerospace.org/assets/2013_AIA_Annual_report_webversion.pdf>.
[138] Ibid. at 17.

in following years, reaching $126 million in 2012, and $207 million in 2013; this increase was also apparent in the total of military exports (e.g. complete aircraft, aircraft engines, missiles/rockets and parts, and spacecraft satellites and parts, etc.), however the increases experienced were hardly as striking. In 2011, while total military exports amounted to $10.051 billion, it jumped to $12.571 billion in 2012, and $13.104 billion in 2013.[139]

While in 2011, 71.5% of the sales in the U.S. aerospace sector were to the domestic market, in 2012 that figure decreased to 67.0%; and in 2013, it dipped further to 65.2%. To summarize, these figures show that the aerospace industry is no longer solely dependent on the domestic market. This tendency is even more pronounced if one looks at the space domain only, especially following the changes underway in the US export control reform.

Specifically on this reform, b December 2013, the Obama administration's efforts, including reviews of what should remain on the USML and what could be moved to the less restrictive CCL, were in their final phases. A 45-day public comment period had followed the publication of the administration's revised proposed new USML Category 15, which ended in July 2013. After that period, an interagency group began reviewing the nearly 400 pages of comments, including feedback from companies, trade organizations, and members of the general public. That review was completed on 10 December 2013, with the next step requiring the Commerce Department to begin the formal process of getting approval from the Office of Management and Budget (OMB). After approval, the final rules will then be reviewed by Congress in late March or April in 2014, taking effect 180 days later. It should be noted that changes may be expected to the section of the draft Category 15 rule that kept "man-rated sub-orbital, orbital, lunar, interplanetary or habitat" spacecraft on the USML, which could impact vehicle developers like Virgin Galactic and XCOR Aerospace that plan to operate in spaceports that are being developed outside the US. Another mainly academic issue is on the definition of a 'defense service', where some critics have balked at its vagueness.[140] Moreover, the proposed changes on Earth observation satellites appear to be outdated, with new rules covering optical, radar and hyperspectral imaging satellites, and setting clear technical parameters for what will remain on the USML; however, many of the technologies the rules are designed to restrict are easily available outside the US, and are being integrated into satellites owned by many nations.[141]

[139] Ibid.

[140] "Export Control Reform Process is Wrapping Up." 15 Dec. 2013. Space Politics 29 Apr. 2014 <http://www.spacepolitics.com/2013/12/15/export-control-reform-process-is-wrapping-up/>.

[141] "Proposed ITAR Changes a Mixed Bag for U.S. Satellite Industry." 14 June 2013. SpaceNews 29 Apr. 2014 <http://spacenews.com/article/satellite-telecom/35794proposed-itar-changes-a-mixed-bag-for-us-satellite-industry>.

3. Space Industry Evolutions

3.1 Europe

The Arianespace commercial launch company expected to post a loss for 2013, following substantial gains in 2012. Whereas Arianespace had reported a final 2012 revenue of €1.329 billion ($1.75 billion), a 31.2% increase from the €1.013 billion ($1.34 billion) earned in 2011[142]; it expected to report a decrease of 27.8% amounting to around €960 million ($1.32 billion) in revenue for 2013.[143]

Eutelsat reported total revenue for the twelve months ending 30 June 2012 to be €1.222 billion ($1.54 billion), a 4.6% increase from the previous period. In the next 2012–to–2013 period, the total revenue increased by 5.1%, amounting to €1.284 billion ($1.67 billion).[144] Around 68% of the revenues generated in both periods came from European regions. The Americas and the Middle East generated about 13.7% and 11.7% respectively, while Africa made up 5.3%, and Asia averaged 1.4%.[145] For the last six months of 2013, the operator reported revenue of €647.4 million ($891.2 million), up 2.2% over the same period a year earlier.[146] These figures do not consider the impact of the acquisition of Satmex, which was due to close at the beginning of 2014. The acquisition of Satmex, financed with a €930 million ($1.28 billion) 6-year bond issue in December 2013, is meant to enhance Eutelsat's presence in Latin America; over the next two years, Eutelsat aims to build additional capacity, mainly in video broadcasting, in the fastest growing regions (i.e. Latin America, Russia, the Middle East, and Africa).[147]

On 22 June 2012, it was revealed that Spanish telecommunications infrastructure provider Abertis Telecom was to sell a 7% stake in Eutelsat through the sale of shares to the China Investment Corp. (CIC), based in Beijing, China. Formerly Eutelsat's largest shareholder, Abertis Telecom, had previously sold a 16% share of Eutelsat to investors on 13 January 2012, in a transaction valued at about €1 billion ($1.3 billion).[148] Desiring an industry leadership role, and greater financial consolidation, Abertis appears to be actively pursuing a controlling interest in Hispasat. By 21 February 2012, Abertis had begun steps to purchase a 13.23% equity stake in Hispasat from telecommunications operator Telefonica.[149] Upon approval from the Spanish government, that transaction would see Abertis' stake in Hispasat grow to 46.6%, with the other shareholders Eutelsat and the Spanish government having 27.7% and 25.7%, respectively.

Hispasat reported a 3.5% increase in revenue in 2011 generating €187.5 million ($249.4 million). Its revenue increased by another 6.9% amounting thus to €200.3 million ($264.7 million) in 2012.[150] In 2013, revenue edged up by 0.57% reaching €201.4 million ($277.2 million). As observed by the Hispasat chairwoman, the company's focus on internationalisation has enabled it to grow and counteract the adverse exchange rate effect in its source markets; therefore, sales efforts were intensified to reinforce its customer base with a more diversified quality offering for the coming years. Of the total revenue earned in 2013, 44.4% was generated from clients in Europe and North Africa, while 55.6% came

[142] De Selding, Peter. "Arianespace Revenue Rose 31.5 Percent for 2012." 12 Apr. 2013. Space News 24 Feb. 2014 <http://www.spacenews.com/article/financial-report/34824arianespace-revenue-rose-315-percent-for-2012>.
[143] De Selding, Peter. "Cost Savings Minimal in Latest Ariane 5 Contract." 8 Jan. 2014. Space News 24 Feb. 2014 <http://www.spacenews.com/article/financial-report/38985cost-savings-minimal-in-latest-ariane-5-contract>.
[144] Reference Document 2012-2013. Eutelsat Communications 25 Feb. 2014: 136 <http://www.eutelsat.com/files/contributed/investors/pdf/reference-document-2012-2013.pdf>.
[145] Ibid.
[146] Press Release. "Eutelsat Communications First Half 2013-2014 Results." 14 Feb. 2014. Eutelsat Communications 25 Feb. 2014 <http://www.eutelsat.com/files/contributed/news/press/en/2014/PR1114-H12013-14.pdf>.
[147] Ibid.
[148] De Selding, Peter. "Chinese Investment Firm Taking 7 Percent Stake in Satellite Fleet Operator Eutelsat." 22 June 2012. Space News 25 Feb. 2014 <http://www.spacenews.com/article/chinese-investment-firm-taking-7-percent-stake-satellite-fleet-operator-eutelsat>.
[149] De Selding, Peter. "Abertis Buys Out Telefonica To Increase Hispasat Stake." 22 Feb. 2012. Space News 25 Feb. 2014 <http://www.spacenews.com/article/abertis-buys-out-telefonica-increase-hispasat-stake>.
[150] De Selding, Peter. "Hispasat Profit Down Despite Strong Showing in the Americas." 20 June 2013. Space News 20 Feb. 2014 <http://www.spacenews.com/article/financial-report/35897hispasat-profit-down-despite-strong-showing-in-the-americas>.

from Latin America. In this period, Hispasat introduced new video, data and broadband services, in addition to providing services to telecommunications operators, audio-visual broadcasters, and to business and government sectors.[151]

Telenor Satellite Broadcasting of Norway reported a 1.80% decrease in revenue for the year ending 2012, along with another decrease of 0.92% in 2013, driving its recent decision to implement a programme to improve its operating efficiency. The Oslo-based satellite fleet operator had experienced a drop in revenue in the last quarter of 2012, following the retirement of its Thor 2 satellite.[152] At the end of that year, Telenor reported revenue of 980 million kroner ($175.4 million) for 2012. In 2013, Telenor reported revenue of 971 million kroner ($158.6 million).[153] Telenor plans to enhance its commercial broadcasting capacity with the launch of the Thor 7 satellite planned for late 2014.

In early November 2013, the imaging company RapidEye AG, a subsidiary of the Blackbridge group, officially changed its name to Blackbridge. Several subsidiaries had been absorbed into the parent company over a two-year process, RapidEye's continuity of imagery products and geospatial solutions are considered to be secure. Aside from the name change, the business, staff, and products & services remained unaffected.[154] Having filed for bankruptcy protection after breaching several of its loan covenants, RapidEye AG was purchased in 2011; thereafter in 2012, its main operations were moved to Berlin, Germany from Brandenburg.[155] While expecting to generate about $45 million in revenue in 2012, the company stated that the development and launch of a second-generation constellation would be affordable if annual revenue increased by another $5 million, to $50 million. RapidEye's initial constellation of five medium resolution satellites entered full commercial operations in early 2009, and are expected to function beyond 2018.[156]

Inmarsat reported a 2.2% reduction in revenue in 2013, generating $1.25 billion as opposed to the $1.28 billion earned in 2012 (not including revenue derived from cooperation with LightSquared). Continued subscriber growth was seen in the company's Fleet-Broadband, XpressLink, and SwiftBroadband services. Inmarsat's FleetBroadband maritime product has been successful beyond Inmarsat's forecasts, with total active terminals exceeding 41,000 at the end of 2013, and its hand-held satellite telephone earned a 51% increase in revenue reaching $21.6 million in 2013 from $14.3 million in the previous year, mainly due to the growing popularity of its ISatPhonePro hand-held device with over 84,000 active subscribers at the beginning of 2013.[157] Nevertheless, the low growth in total revenue is mainly attributed to reduced US government business for the use of 3rd party satellite sources in 2013, following the autumn budget crisis and prolonged US troop pull-out from Afghanistan.[158]

Europe's Astrium space hardware and services provider reported an increase of 17% in revenue for 2012, with a corresponding increase in pre-tax profit, and a 13.6% reduction in backlog rocket and satellite deliveries.[159] Astrium's revenue for 2012 totalled €5.82 billion ($7.7 billion), up from €4.96 billion ($6.4 billion) in 2011. Astrium's new orders reached nearly €3.8 billion ($5.02 billion) in 2012, with its backlog reaching €12.7 billion ($16.78 billion) by 31 December 2012. The acquisition of satellite solutions provider Vizada in December 2011 meant that Astrium needed more investment in research and development, along with integration charges in the following year. In 2013, Astrium generated about the same revenue as the previous year, earning €5.78 billion, with new orders increasing by 62.3% to

[151] Press releases 2014. "HISPASAT continues growing thanks to exports outside Europe." 5 Mar. 2014. Hispasat 6 Mar. 2014 <http://www.hispasat.com/en/press-room/press-releases-2014/128/hispasat-sigue-creciendo-gracias-a-la->.

[152] De Selding, Peter. "Retirement of Thor 2 Takes Toll on Telenor's Revenue." 13 Feb. 2013. Space News 26 Feb. 2014 <http://www.spacenews.com/article/retirement-of-thor-2-takes-toll-on-telenor%E2%80%99s-revenue>.

[153] De Selding, Peter. "Telenor Revenue Down Slightly for Second Consecutive Year." 12 Feb. 2014. Space News 26 Feb. 2014 <http://www.spacenews.com/article/financial-report/39471telenor-revenue-down-slightly-for-second-consecutive-year>.

[154] Press Releases. "RapidEye is now BlackBridge." 6 Nov. 2013. BlackBridge 26 Feb. 2014 <http://www.blackbridge.com/rapideye/news/pr/2013-blackbridge.htm>.

[155] De Selding, Peter. "RapidEye Sats Assigned Longer Life Expectancy." 18 Jan. 2013. Space News 26 Feb. 2014 <http://www.spacenews.com/article/civil-space/33241rapideye-sats-assigned-longer-life-expectancy>.

[156] Ibid.

[157] Press Release. "Inmarsat plc Reports Preliminary Full Year Results 2013."6 Mar. 2014. Inmarsat 6 Mar. 2014 <http://www.inmarsat.com/wp-content/uploads/2014/03/Inmarsat_plc_Preliminary_Results_2013.pdf>.

[158] De Selding, Peter. "Inmarsat Revenue Down as US Government Business Remains Weak." 7 Nov. 2013. Space News 6 Mar. 2014 <http://www.spacenews.com/article/financial-report/38041inmarsat-revenue-down-as-us-government-business-remains-weak>.

[159] De Selding, Peter. "Vizada Acquisition Fuels Astrium Growth in 2012." 27 Feb. 2013. Space News 26 Feb. 2014 <http://www.spacenews.com/article/vizada-acquisition-fuels-astrium-growth-in-2012>.

€6.17 billion, resulting in a book to bill ratio of 1.07.[160]

Astrium Services' revenue totalled €1.45 billion ($1.92 billion) in 2012, up 68.3% from €861.8 million ($1.13 billion) in 2011, with revenue from Vizada, which accounted for €500 million ($660.7 million) in 2012, exceeding estimates. In 2013, its revenue decreased by 4.5% to €1.39 billion ($1.91 billion). Astrium Satellites delivered nine spacecraft in 2012, with revenue reaching nearly €2.1 billion ($2.78 billion), an increase of 9% from revenue earned in 2011.[161] In 2013, Astrium Satellites reported a 3.3% decrease in revenue, the total amounting to €2.02 billion ($2.78 billion). Astrium Space Transportation reported revenue of €2.27 billion ($3.0 billion), up 4.1% from the €2.18 billion ($2.86 billion) reported in 2011, after delivering seven Ariane 5 rockets during the year. In 2013, Astrium Space Transportation revenue increased by 4.4% to €2.37 billion ($3.26 billion). Additionally, the mentioned three divisions booked a combined total of €3.8 billion ($5.02 billion) in new orders in 2012, up 8.6% from the €3.5 billion ($4.59 billion) generated in 2011; followed by another 62.3% increase in orders reaching €6.17 billion ($8.49 billion) in 2013.[162]

Responding to the steep reduction in European defence spending in 2013, EADS underwent major restructuring, renaming the group as Airbus, and consolidating its Cassidian, Astrium, and Military divisions into a single "Airbus Defence & Space" division by year end. On 10 December 2013, Astrium space hardware and services division then announced plans to eliminate 2,470 Astrium positions from its pool of 18,000 employees over the following three years. Described as a part of Astrium's streamlining effort, the 2015 goal is to create a company that is leaner in middle management and bureaucracy, eliminating jobs that do not directly contribute to Astrium's product and service portfolio. The job cuts were said to mainly involve negotiated voluntary departures and the non-replacement of retiring employees, to increase Astrium's competitiveness on world markets, and its profitability within the larger Airbus space group. Airbus Defence and Space on the whole was expected to shed some 5,800 jobs, including 1,300 employees now on non-renewable short-term contracts. Of the 4,500 full-time positions to be eliminated, 2,000 are in Germany, 1,260 in France, 557 in Spain, 450 in Britain, and 180 positions will be lost in other parts of the world.[163] The company will reinvest the €400 million ($560 million) in annual savings resulting from employment streamlining into self-financed research and offering better prices to its customers. Astrium's Agile programme, an internal transformation programme designed to prepare the company to adapt to the competitive market, has been operating in an environment where, for instance, the currency exchange rate between the Euro and the Dollar has made it very hard for Europe's Ariane 5 rocket to make a profit, despite the launcher's consistent record.[164]

Astrium Services increased competition with its two US competitors, GeoEye and DigitalGlobe in 2012 and 2013 with its Pleiades 1A and Pleiades 1B high-resolution optical Earth observation satellites. The first satellite was launched on 17 December 2011, with its twin, Pleiades 1B launched a year later on 2 December 2012. In 2013, DigitalGlobe saw sharply lower year-end revenue than anticipated due to unexpected competition in the emerging market business, i.e. generating $613 million instead of the $635 million it had anticipated. Moreover, DigitalGlobe now expects to report $645 million for 2014 instead of the $699 million initially predicted.[165] Another reason for DigitalGlobe's shortfall was said to be due to the 2.5 month delay in the launch of its WorldView-3 satellite, now set for launch sometime in 2014. With the cost of developing the two-satellite Pleiades exceeding €650 million ($850 million), covered around 90% by CNES, the spacecraft now have an output of 450 images per day.[166] The other 10% the

[160] De Selding, Peter. "New Orders Eclipsed Flat Revenue in 2013 at Airbus Space Division." 26 Feb. 2014. SpaceNews 19 May 2014 <http://www.spacenews.com/article/financial-report/39626new-orders-eclipsed-flat-revenue-in-2013-at-airbus-space-division>.

[161] De Selding, Peter. "Vizada Acquisition Fuels Astrium Growth in 2012." 27 Feb. 2013. SpaceNews 19 May 2014 <http://www.spacenews.com/article/vizada-acquisition-fuels-astrium-growth-in-2012>.

[162] De Selding, Peter. "New Orders Eclipsed Flat Revenue in 2013 at Airbus Space Division." 26 Feb. 2014. SpaceNews 19 May 2014 <http://www.spacenews.com/article/financial-report/39626new-orders-eclipsed-flat-revenue-in-2013-at-airbus-space-division>.

[163] De Selding, Peter. "EADS Restructuring To Eliminate Nearly 2,500 Astrium Jobs." 10 Dec. 2013. SpaceNews 19 May 2014 <http://www.spacenews.com/article/financial-report/38588eads-restructuring-to-eliminate-nearly-2500-astrium-jobs>.

[164] De Selding, Peter. "Astrium Efficiency Initiative to Eliminate 2,000 Positions by 2015." Space News 27 June 2011: 12.

[165] De Selding, Peter. "Unexpected Competition, Launch Delay Are Drag on DigitalGlobe Revenue." 27 Feb. 2014. SpaceNews 19 May 2014 <http://www.spacenews.com/article/financial-report/39648unexpected-competition-launch-delay-are-drag-on-digitalglobe-revenue>.

[166] De Selding, Peter. "Soyuz Launches French Pleiades Imaging Satellite." 7 Dec. 2012. SpaceNews 19 May 2014 <http://www.spacenews.com/article/soyuz-launches-french-pleiades-imaging-satellite>.

bill was covered by Belgium, Spain, Sweden, and Austria, with a pro rata share of the remaining imagery and work for their respective national industries. The French Ministry of Defence has priority access to 50 images per day, while civil agencies have access to 40% of the remaining output; Astrium Services gets the remaining 60% share.[167] Astrium Services has exclusive rights to sell Pleiades imagery commercially. Additional activities by Astrium include its investment of about €300 million ($375 million) in the development and launch of the Spot 6 and Spot 7 medium-resolution satellites; Spot 6 was launched on 9 September 2012, and Spot 7 is scheduled for launch aboard India's PSLV rocket sometime in 2014.[168] Both satellites are designed to cover up to 6 million square km daily at a resolution of 1.5 meters.[169]

Thales Alenia Space, owned 67% by Thales and 33% by Finmeccanica, has 7,500 employees in France, Italy, Spain, Belgium, Germany and the United States. The group posted a total revenue of €2.1 billion ($2.78 billion) in 2012.[170] That revenue was reported to have been in excess of €2 billion in 2013.[171] Registered in both France (Thales Alenia Space SAS) and Italy (Thales Alenia Space Italia SpA),[172] Thales Alenia Space is a key supplier of satellite and orbital infrastructure solutions. Thales Alenia Space is thus a global market leader in telecommunications, navigation, space exploration and Earth observation.[173] In telecommunications, it competes in the commercial satellite market, producing its own satellites from its Spacebus platform dedicated to geostationary satellites, while supplying additional payloads for all the major contractors in the sector, and providing satellites for the low-orbit civilian constellation market including Globalstar, Iridium NEXT, and O3b satellites. The first four O3b high throughput MEO satellites were launched on 25 June 2013.[174] In the defence and security segment, it offers space segments and ground telecommunications systems (Syracuse, Sicral, COMSAT-BW), military observation systems (Helios, Pleiades, CSO – rest of Helios, SAR-LUPE), and also dual civilian and military systems (COSMO-SkyMed, Athena-Fidus, and Yahsat). Thales Alenia Space is also a major player in Earth observation and scientific missions, having been selected for the last 3 decades as the prime contractor for weather satellite programmes in Europe (METEOSAT) and for environmental missions in the context of GMES (Sentinel programmes) or space altimetry (i.e. SADKO, SWIM, and GFO-RA product lines). And for scientific missions, it developed Proteus, a multi-mission platform (class 500-700 kg), used in the SMOS, Jason, COROT and Calipso missions, in addition to being the prime contractor for the Herschel-Planck mission for ESA, and executing the Exomars programme. Thales Alenia Space also plays a major role in the Galileo programme, participating in the In-Orbit Validation (IOV) phase, as well as providing system support and the Mission Ground Segment for the full constellation. In manned space flight, Thales Alenia Space is a major contributor to the ISS, supplying more than 50% of its pressurised volume (Nodes 2 and 3, MPLM, Cupola, PMM) and is significantly involved in the ATV vehicles for ESA.[175]

OHB Technology of Germany saw its total revenue rise to €632.73 million ($836 million) in 2012; amounting in a 13.9% increase from the €555.29 million ($719 million) earned in 2011.[176] OHB forecast its full year revenue for 2013 to be over €700 million ($945 million), an increase of 10.6% from 2012.[177]

[167] De Selding, Peter. "With Pleiades in Orbit, Astrium Sets Sights on DigitalGlobe, GeoEye." Space News 9 Jan. 2012: 7.
[168] De Selding, Peter. "Indian Rocket Lofts Spot 6 Earth-observing Satellite." 17 Sept. 2012. SpaceNews 19 May 2014 <http://www.spacenews.com/article/indian-rocket-lofts-spot-6-earth-observing-satellite>.
[169] "SPOT 6 and SPOT 7 Satellite Imagery – Spot the Difference." Airbus Defence & Space 19 May 2014 <http://www.astrium-geo.com/en/147-spot-6-7-satellite-imagery>.
[170] "Eutelsat 3D Launch a Success Satellite Built by Thales Alenia Space for Eutelsat." 15 May 2013. Thales Alenia Space 27 Feb. 2014 <https://www.thalesgroup.com/en/content/eutelsat-3d-launch-success-satellite-built-thales-alenia-space-eutelsat>.
[171] "Martin Van Schaik appointed Thales Alenia Space Senior Vice President, Sales." 10 Mar. 2014. Thales Alenia Space 30 May 2014 <https://www.thalesgroup.com/en/worldwide/space/press-release/martin-van-schaik-appointed-thales-alenia-space-senior-vice-president>.
[172] 2012 Registration Document. Thales. 27 Feb. 2014: 141 <https://www.thalesgroup.com/sites/default/files/asset/document/Thales 2012 registration document bookmarked pdf.pdf >.
[173] Ibid. at 147.
[174] "First four O3b satellites successfully launched." 25 June 2013. Thales Alenia Space 27 Feb. 2014 <https://www.thalesgroup.com/sites/default/files/asset/document/first_four_o3b_satellites_successfully_launched.pdf >.
[175] See generally 2012 Registration Document. Thales. 27 Feb. 2014: 147 <https://www.thalesgroup.com/sites/default/files/asset/document/Thales 2012 registration document bookmarked pdf.pdf >.
[176] Annual Report 2012. OHB 22 Feb 2014: 2 <http://www.ohb.de/tl_files/ohb/pdf/finanzberichte_hauptversammlung/2012/OHB_GB12_E.pdf>
[177] De Selding, Peter. "Galileo Prime Contractor Expects No Trouble Finding a Profit as European Navigation Satellites Encounter New Delays." 15 Nov. 2013. Space News

RUAG Space, the largest independent supplier of space technology in Europe, developing subsystems and equipment for satellites and launch vehicles, reported a 3.6% increase in net sales for 2012, earning CHF 285 million ($311.8 million) from CHF 275 million ($292.6 million) in 2011.[178] In 2013, net sales grew by 4.9% to CHF 299 million ($335.8 million).[179] Based in Switzerland, Sweden, and Austria, the division now employs 1,151 personnel.[180] In both 2012 and 2013, its launch vehicle structures and separation systems had the highest sales volume in the industry, with RUAG Space's payload fairings used in Atlas V 500, Ariane 5, and now the Vega launch vehicles.[181] The company was also involved in the production of two European weather satellites, Eumetsat's MSG-3 and Metop-B; contributing also to the three satellites for ESA's "Swarm" research mission, successfully launched in November 2013; and provides the central onboard computers and solar array drive mechanisms for the Galileo navigation satellites.[182]

3.2 United States

The US satellite prime commercial satellite manufacturer, Space Systems/Loral (SS/L), was acquired by Canada's MacDonald, Dettwiler and Associates Ltd. (MDA) on 2 November 2012.[183] With the transaction initially having been announced in mid-2012, MDA began pre-booking orders from the US Defense Advanced Research Projects Agency (DARPA) for robotic elements of a satellite-salvage program while awaiting regulatory approval of the purchase.[184] By November 2012, MDA assumed ownership of SS/L, closing the deal at $1.069 billion, with little resistance from US regulators. However, 75% of the contracted work on the $30 million in contracts won from DARPA as part of preliminary work on a future in-orbit satellite servicing project would need to be done in the US.[185]

In the wake of the controversy created by the risk posed by LightSquared Inc.'s potential L-band interference with GPS signals, subsequently blocked by US regulators, the wireless-broadband company filed for Chapter 11 bankruptcy protection on 14 May 2012.[186] By 15 May 2013, interest in LightSquared's radio frequencies had attracted a $2.22 billion bid to purchase the company from Dish Network Corp. (a satellite TV provider from Englewood Colorado), a welcome offer by one of Lightsquare's creditors, Boeing Network and Space Systems, which is owed $112 million for the construction of two LightSquared satellites, one of which is currently in orbit.[187] On 1 November 2013, LightSquared brought a suit against several GPS manufacturers regarding misrepresentations on the interference posed by LightSquared's signals on GPS receivers, preventing the timely launch of the wireless broadband network, and driving the company into bankruptcy.[188] On 24 December 2013, a new bankruptcy plan was submitted to the courts to avoid LightSquared's sale to Dish Network, consisting of a $2.5 billion exit loan and no less than 1.25 billion in new equity contributions.[189]

The Stratolaunch project, seeking to develop the largest air-launch system in the world, made some substantial headway in realizing its goal. Unveiled on 13 December 2011 by billionaire Microsoft co-founder Paul Allen, the company's aim is to bring airport-like operations to the launch of commercial and government payloads and eventually conduct

22 Feb. 2014 <http://www.spacenews.com/article/financial-report/38168galileo-prime-contractor-expects-no-trouble-finding-a-profit-as>.

[178] RUAG Annual Report 2012. RUAG 21 Feb 2014: 98 <http://www.ruag.com/de/Konzern/Media/Geschaeftsberichte/2012/2012_e/RUAG_GFB_2012_E.pdf>.

[179] RUAG Annual Report 2013. RUAG 30 May 2014: 98 <http://www.ruag.com/de/Konzern/Media/Geschaeftsberichte/2013/2013_e/RUAG_GB_2013_EN.pdf>.

[180] Ibid. at 20.

[181] Ibid.

[182] Ibid.; see also RUAG Annual Report 2012, 24, 25.

[183] Press Release. "MDA completes acquisition of Space Systems/Loral." 2 Nov. 2012. MDA Corporation 28 Feb. 2014 <http://www.mdacorporation.com/corporate/news/pr/pr2012110206.cfm>.

[184] De Selding, Peter. "Canada's MDA Expects Space Systems/Loral Purchase To Close this Fall." 27 July 2012. Space News 27 Feb. 2014 <http://www.spacenews.com/article/canadas-mda-expects-space-systemsloral-purchase-close-fall>.

[185] De Selding, Peter. "With SS/L Purchase, MDA Corp. Finally Gains U.S. Foothold." 2 Nov. 2012 Space News 27 Feb. 2014 <http://www.spacenews.com/article/satellite-telecom/32138with-ssl-purchase-mda-corp-finally-gains-us-foothold>.

[186] SpaceNews Staff. "Troubled LightSquared Files for Bankruptcy." 21 May 2012. Space News 28 Feb. 2014 <http://www.spacenews.com/article/troubled-lightsquared-files-bankruptcy>.

[187] De Selding, Peter. "Boeing's Space Earnings Boosted by Commercial Satellite, NASA Revenue." 26 July 2013. Space News 28 Feb. 2014 <http://www.spacenews.com/article/financial-report/36473boeing's-space-earnings-boosted-by-commercial-satellite-nasa-revenue>.

[188] Rosenblatt, Joel. "LightSquared Sues GPS Manufacturers Over Alleged Broken Promises." 2 Nov. 2013. Bloomberg.com 28 Feb. 2014 <http://www.bloomberg.com/news/2013-11-02/lightsquared-sues-gps-makers-over-alleged-broken-promises.html>.

[189] Kary, Tiffany. "LightSquared Seeks Approval for New Plan With Fortress Bid (1)." 26 Dec. 2013. Bloomberg 28 Feb. 2014 <http://www.businessweek.com/news/2013-12-26/lightsquared-seeks-to-update-bankruptcy-plan-with-fortress-offer>.

human missions. While Stratolaunch initially planned to partner with SpaceX, utilizing a derivative of the Falcon 9 launch vehicle with fewer engines, the idea was amicably scrapped due to the significant modifications needed to accommodate Stratolaunch's designs, which needed an additional fin/chine configuration to help generate additional lift at supersonic speeds.[190] The contract was subsequently given to Orbital Sciences, the builder and operator of the now sparsely used Pegasus rocket. Released from its carrier aircraft, operating from a large airport or spaceport, the air-launched rocket is planned to boost up to 6,800 kg of payload to low Earth orbit, and smaller payloads to geostationary transfer orbit.[191] The Orbital Sciences rocket will have ATK Aerospace develop and produce the first two-stages of the three-stage rocket; the third-stage liquid-fuelled engine supplier was still being sought.[192]

After a period of uncertainty surrounding the funding of commercial Earth satellite imagery providers GeoEye's and DigitalGlobe's 10-year EnhancedView programme - a series of 9 one-year commitments with the US government - the solution came by unifying resources. On 22 June 2012, GeoEye was informed that the US government wished to cancel key elements of its portion of the $7 billion contract with the company, leaving GeoEye unclear how large such cuts would be.[193] Meanwhile, DigitalGlobe's contract remained unaltered. To mitigate the situation, GeoEye first tried to purchase DigitalGlobe, but this was declined. On 23 July 2012, two months after the initial merger offer, the companies agreed that DigitalGlobe would purchase GeoEye; a move in the interest of both companies to enhance competitiveness against Europe's Astrium Services Earth observation service provider.[194] On 9 January 2013, the proposed merger received a Department of Justice decision that the transaction would not be challenged on anti-trust grounds, with the acquisition taking place on 31 January 2013.[195] It would be business as usual for the duration of 2013, with DigitalGlobe's US government revenue rising 53% from the previous year, while showing no signs of being affected by the temporary government shutdown occurring in the first half of October 2013.[196]

Having upgraded its Falcon 9 rocket for missions to geostationary orbit, Space Exploration Technologies (SpaceX) expects to launch commercial telecommunications satellites, AsiaSat 6 and AsiaSat 8, in 2014. AsiaSat of Hong Kong ordered the development of the two satellites from Space Systems/Loral of Palo Alto, California, to increase the capacity of the current AsiaSat fleet in orbit. SpaceX debuted its more powerful Falcon 9 v1.1 launcher on 29 September 2013, launching the Cassiope experimental space-environment monitoring satellite to LEO for the Canadian Space Agency.[197] With an increase in length, new engines, and a larger-diameter fairing, the second launch of the Falcon 9 v1.1 lifted SES-8, its first commercial telecommunications satellite, to geostationary transfer orbit on 3 December 2013.[198] And with the further development of electric propulsion spacecraft lowering the mass of normally heavier telecommunication satellites, SpaceX could become an even bigger competitor in the telecommunications market. While having a one-launch track record only, following the launch of SES-8, SpaceX's backlog for the launch of commercial geostationary satellites is nearly $500 million.[199] SpaceX is developing a reusable first stage to reduce the cost of the Falcon 9 v1.1 launcher

[190] Leone, Dan. "Orbital Sciences Replaces SpaceX on Stratolaunch Project." 30 Nov. 2012. Space News 28 Feb. 2014 <http://www.spacenews.com/article/launch-report/32591orbital-sciences-replaces-spacex-on-stratolaunch-project>.
[191] Leone, Dan. "Orbital Tapped To Build Stratolaunch Rocket." 5 June 2013. Space News 28 Feb. 2014 <http://www.spacenews.com/article/launch-report/35647orbital-tapped-to-build-stratolaunch-rocket>.
[192] Leone, Dan. "ATK To Supply Stratolaunch Rocket Stages." 13 Aug. 2013. Space News 28 Feb. 2014 <http://www.spacenews.com/article/launch-report/36764atk-to-supply-stratolaunch-rocket-stages>.
[193] De Selding, Peter. "NGA Letters Cast Cloud Over GeoEye's EnhancedView Funding." 23 June 2012. Space News 3 Mar. 2014 <http://www.spacenews.com/article/nga-letters-cast-cloud-over-geoeyes-enhancedview-funding>.
[194] De Selding, Peter. "Astrium Services Girds for Competition with DigitalGlobe-GeoEye Combo." 15 Oct. 2012. Space News 3 Mar. 2014 <http://www.spacenews.com/article/astrium-services-girds-competition-digitalglobe-geoeye-combo>.
[195] Ferster, Warren. "DigitalGlobe Closes GeoEye Acquisition." 31 Jan. 2013. Space News 3 Mar. 2014 <http://www.spacenews.com/article/digitalglobe-closes-geoeye-acquisition>.
[196] De Selding, Peter. "DigitalGlobe Revenue Up Sharply Despite U.S. Spending Slowdown." 1 Nov. 2013. Space News 3 Mar. 2014 <http://www.spacenews.com/article/military-space/37960digitalglobe-revenue-up-sharply-despite-us-spending-slowdown>.
[197] Ferster, Warren. "Upgraded Falcon 9 Rocket Successfully Debuts from Vandenberg." 29 Sept. 2013. Space News 26 Mar. 2014 <http://www.spacenews.com/article/launch-report/37450upgraded-falcon-9-rocket-successfully-debuts-from-vandenberg>.
[198] De Selding, Peter. "SES-8 On Its Way to Geostationary Orbit Following SpaceX's Commercial Launch Debut." 3 Dec. 2013. Space News 26 Mar. 2014 <http://www.spacenews.com/article/launch-report/38485ses-8-on-its-way-to-geostationary-orbit-following-spacexs-commercial>.
[199] Ibid.

by up to 75%;[200] the first of its reusability tests was conducted on its next International Space Station cargo-supply mission on 18 April 2014.[201] SpaceX will also launch the Iridium NEXT constellation of LEO communications satellites sometime in 2015 and continuing into 2017.[202]

SpaceX is planning to use a new launch pad at Vandenberg US Air Force Base to launch the standard Falcon 9 rocket and its upcoming heavy-lift variant. SpaceX currently launches its Falcon 9 only from Canaveral Air Force Station, whereas the new pad will be built to also accommodate the developmental Falcon 9 Heavy launch vehicle, now expected to debut in 2014.[203] The company will spend between $20-30 million to renovate the site, unused since 2005; the Titan 4 was the last rocket launched from there. SpaceX will also update its launch facility in Cape Canaveral, enabling the heavy-lift rocket to launch from both coasts. SpaceX's Florida base is also undergoing general upgrades, additional hangars are being built to prepare its Falcon 9 rockets and customer payloads for launch. With an expected flight rate of 10 to 12 launches per year, the current facility (Space Launch Complex 40) will receive a 16,000 square-meter addition, including an unused Delta 2 processing building. SpaceX will receive $7.3 million from Space Florida, a state-funded agency, toward the upgrades. These upgrades include, *inter alia*, a clean room, a hazardous hypergolic fuelling facility and enough volumetric space to encapsulate a payload in a fairing in a vertical position.[204]

SpaceX launched its second Falcon 9 Dragon cargo run to the International Space Station (ISS) on 1 March 2013[205], about 10 months after its maiden Falcon 9 ISS cargo launch on 22 May 2012.[206] While the latest launch was successful, a propulsion glitch on the Dragon capsule resulted in a delay of one day prior to docking onto the ISS on 3 March 2013. The Dragon capsule detached from the ISS on 26 March 2013, re-entering Earth's atmosphere, and alighting in the Pacific on the same day. This mission was the second of the twelve commercial resupply missions to the ISS SpaceX negotiated under the terms of a $1.6 billion 2008 contract with NASA; NASA being responsible for 40% of the SpaceX manifest.[207]

Virgin Galactic successfully completed rocket-powered test flights of SpaceShipTwo (SST) on 29 April 2013 and 5 September 2013, with the spacecraft's hybrid rocket engines firing for a maximum of 20 seconds.[208] Prior to the first engine firing, the spacecraft had already performed more than 20 unpowered flight tests, involving drop tests where SST would glide back to a runway after being dropped in mid-air from its mother ship, WhiteKnightTwo, and performing a set of manoeuvres along with ballast checks.[209] Designed to be released from its carrier at an altitude of 15km, its SSTs rocket engine will ignite to propel the craft at an apex altitude up to 110km. Virgin Galactic expects be able to start flying customers in 2014. By 3 October 2013, more than 600 passengers had reserved a flight on the spacecraft, each at $250,000 per seat.[210] Among these customers are scientists along with their experiments and space tourists. Soon, other companies might also be able to provide similar suborbital space travel products, including

[200] Ferster, Warren. "Upgraded Falcon 9 Rocket Successfully Debuts from Vandenberg." 29 Sept. 2013. Space News 26 Mar. 2014 <http://www.spacenews.com/article/launch-report/37450upgraded-falcon-9-rocket-successfully-debuts-from-vandenberg>.

[201] Leone, Dan. "SpaceX's Latest Cargo Flight Delivers a Step Toward Rocket Reusability." 25 Apr. 2014. Space News 30 May 2014 <http://www.spacenews.com/article/launch-report/40346spacex%E2%80%99s-latest-cargo-flight-delivers-a-step-toward-rocket-reusability>.

[202] De Selding, Peter. "Iridium Warns of Possible Disruptions Caused by Russia Sanctions." 6 May 2014. Space News 30 May 2014 <http://www.spacenews.com/article/financial-report/40478iridium-warns-of-possible-disruptions-caused-by-russia-sanctions>.

[203] "SpaceX Breaks Ground on West Coast Launch Pad." Space News 25 July 2011: 8.

[204] Klotz, Irene. "SpaceX Expanding Florida Facilities to Meet Launch Demand." Space News 28 Nov. 2011: 5.

[205] Klotz, Irene. "SpaceX Stumbles on 2nd Cargo Run to the Space Station." 1 Mar. 2013. Space News 26 Mar. 2014 <http://www.spacenews.com/article/spacex-stumbles-on-2nd-cargo-run-to-the-space-station>.

[206] Space News Staff. "SpaceX Delivers Falcon 9 to Orbit." 22 May 2012. Space News 23 May 2012 <http://spacenews.com/launch/120522-spacex-falcon-delivers-dragon-orbit.html>.

[207] Kramer, Miriam. "SpaceX Dragon Capsule Returns to Earth After 2nd Paid Mission to ISS." 1 Apr. 2013. Space News 26 Mar. 2013 <http://www.spacenews.com/article/launch-report/34664spacex-dragon-capsule-returns-to-earth-after-2nd-paid-mission-to-iss>.

[208] Klotz, Irene. "Firm Expanding Spaceship Test Flights To Hone 'Virgin Space Experience'." 7 Oct. 2013. Space News 5 Mar. 2014 <http://www.spacenews.com/article/civil-space/37589firm-expanding-spaceship-test-flights-to-hone-'virgin-space-experience'>.

[209] Amos, Jonathan. "Sir Richard Bransonäs Virgin Galactic spaceship ignites engine in flight." 29 Apr. 2013. BBC News 5 Mar. 2013 <http://www.bbc.com/news/science-environment-22344398>.

[210] Boyle, Alan. "NBC teams up with Virgin Galactic for 'Space Race' reality TV show." 3 Oct. 2013. NBC News 5 Mar. 2014 <http://www.nbcnews.com/science/space/nbc-teams-virgin-galactic-space-race-reality-tv-show-f8C11329733>.

inter alia XCOR Aerospace, Blue Origin and Armadillo Aerospace.[211]

Having purchased Scaled Composite's 30% stake in The Spaceship Company in October 2012, Virgin Galactic - in collaboration with Aabar Investments PJS of Abu Dhabi, UAE - is looking to enter the satellite launch business. In addition to providing customers access to several minutes of microgravity conditions and a superb view of Earth's curvature aboard SpaceShipTwo, Virgin Galactic plans to develop a two-stage unmanned rocket, named LauncherOne, which is intended to carry small satellite payloads between 100kg-to-225kg into orbit with costs in the long-term of less than $10 million with regular operation.[212] For now, its SpaceShipTwo and LauncherOne activity will be localized at Spaceport America in New Mexico, USA, whose law shields spacecraft operators, manufacturers and suppliers from clients that sign liability waivers.[213] Virgin Galactic is also anchored to operate only in the US until it receives a specific waiver from the country's International Traffic in Arms Regulations (ITAR); thereafter, spaceports in the UAE, Sweden and possibly the UK are also envisioned.[214]

3.3 Russia

On 2 December 2013, Russia's President Vladimir Putin signed a decree ordering the creation of the United Rocket and Space Corporation, wherein several federal state-owned unitary space enterprises will be reorganized into open joint stock companies to be fully owned by the federal government. Next they will each contribute 100% of shares minus one-share to the new corporation's authorized capital.[215] This decree, to be implemented within two years, with initial steps to be taken in early 2014, is intended to reduce costs in the industry by consolidating the country's numerous space hardware developers and manufacturers (including 43 currently separate companies, e.g. major prime contractors Khrunichev Space Center, RSC Energia, TsSKB Progress, and Lavochkin) into a single company. The move should allow the Russian space industry to eliminate excess manufacturing capacity, in addition to streamlining the purchasing of foreign electronic components with increased purchasing power to negotiate volume-based discounts.[216] However, some critics believe that the plan will eliminate competition and may bring more confusion to the industry. Russia's spending in space has more than doubled in the last three years to over $5 billion in 2013, yet the industry spends four times more than the global norm on satellites that are poor in quality and prone to accidents. Rather than rely on the poor electronics Russia developed in previous decades, up to 80% of the equipment for new Russian spacecraft is imported from Europe or Canada. Continuity of experience is also in question. Two decades since the Soviet collapse, a brain drain has resulted in 90% of the 240,000 people employed by the Russian space sector to be either older than 60 or younger than 30 years of age.[217]

The partially Russian- and Ukrainian-owned Sea Launch AG consortium, back in operation after coming out of US Chapter 11 bankruptcy, in October 2010, experienced a launch failure on 31 January 2013, after five successful launches in the two previous years. A successful launch would have marked the completion of Intelsat's first global broadband mobility platform, with the IS-27 supporting customers in the American continents, the Atlantic Ocean, and Europe.[218] Whereas in 2012 the company broke even, 2013 was more difficult due to the initial failure, and the success of SpaceX in its launch of the SES 8 satellite on 3 December 2013. While 2014 is also expected to be a slow year, with most of the missions for that year having been sold well ahead of time, the company hopes to have 3 missions

[211] Wall, Mike. "Virgin Galactic Aims for 1st Rocket-Powered Flight This Year." 28 Feb. 2012. SPACE.com 3 May 2012 <http://www.space.com/14706-virgin-galactic-spaceshiptwo-powered-flight.html>.
[212] SpaceNews Staff. "Virgin Galactic Developing Small-satellite Launcher." 16 July 2012. Space News 5 Mar. 2014 <http://www.spacenews.com/article/virgin-galactic-developing-small-satellite-launcher>.
[213] Monteleone, James. "Spaceport Liability Waiver Unanimously Passes Senate." 30 Jan. 2013. Albuquerque Journal 5 Mar. 2014 <http://www.abqjournal.com/164742/politics/spaceport-liability-waiver-unanimously-passes-senate.html>.
[214] De Selding, Peter. "Export Regime Keeping Virgin Galactic in the U.S., for Now." 3 Dec. 2012. Space News 5 Mar, 2014 <http://www.spacenews.com/article/civil-space/32636export-regime-keeping-virgin-galactic-in-the-us-for-now>.
[215] "Putin Signs Decree on Creation of United Rocket and Space Corporation." 2 Dec. 2013. ITAR TASS 30 Apr. 2014 <http://en.itar-tass.com/russia/709849>.
[216] "Putin Signs Legal Decree Consolidating Russian Industry." 9 Dec. 2013. SpaceNews 30 Apr. 2014 <http://www.spacenews.com/article/civil-space/38551putin-signs-legal-decree-consolidating-russian-industry>.
[217] "Russia Bets on Sweeping Reform to Revive Ailing Space Industry." 26 Dec. 2013. Reuters 30 Apr. 2014 <http://www.reuters.com/article/2013/12/26/us-russia-space-idUSBRE9BP02S20131226>.
[218] "Sea Launch Prepares for the Launch of Intelsat 27." 21 Jan. 2013. Sea Launch 6 Mar. 2014 <http://www.sea-launch.com/news-q11328-Sea_Launch_Prepares_for_the_Launch_of_Intelsat_27.aspx>.

in 2015, followed by an even greater launch capacity in the years that follow.[219] In February 2013, Boeing Co, the managing partner of Sea Launch sued its Russian and Ukrainian partners for refusing to pay more than $350 million following Sea Launch's 2009 bankruptcy, leaving Boeing to cover loan guarantees of $449 million on its own. In its lawsuit, Boeing said that Russia's RSC Energia owed at least $222.3 million and that Ukraine's Yuzhnoye companies owed at least $133.4 million.[220]

3.4 Japan

Mitsubishi Electric Co. (Melco) of Japan plans to double its annual satellite-related revenue to ¥152.4 billion ($1.9 billion) by 2021, partly by having completed a major expansion of its Kamakura satellite production facility to capture demand for telecom, navigation and Earth observation satellites. Having completed the expansion on 22 March 2013, with a ¥3 billion ($36 million) investment to enlarge total facilities (satellite production, integration and test floor space) to 7,700 square meters, Melco's production capacity is said to have doubled to 8 large satellites per year.[221] Earlier in 2013, the company once again became eligible to bid on Japanese military contracts after having refunded the Ministry of Defence ¥60 billion for overcharges on services and hardware over the period of a decade.[222] With its DS2000 satellite frame proven in orbit on Japanese commercial and technology-demonstration missions, Mitsubishi will be more aggressive in the commercial market, positioning the platform as a relatively low-cost option that will also excel on being ITAR-free, which would normally keep these satellites from being exported to China for low-cost launch services. The DS2000 should also be compatible with the relatively low-cost Falcon 9 rocket of SpaceX.[223] Moreover, following Japan's launch of its first Quasi-Zenith Satellite System (QZSS) satellite in September 2010 to augment the US GPS system over the Pacific region, in April 2013, Melco was contracted to build three additional satellites, estimated to be worth ¥50.3 billion ($539.4 million). NEC Corp. was expected to win a ¥117.3 billion ($1.26 billion) contract to operate the QZSS system under a separate contract.[224]

At the start of 2012, NEC Corp. of Tokyo was contracted to design and build hardware for Japan's Hayabusa-2 asteroid sample-return mission, which JAXA plans to launch in 2014. The probe will be similar in design to the original Hayabusa spacecraft, weighing 600 kilograms when fully fuelled, and will be fitted on a larger satellite platform than its predecessor. The Hayabusa-2 will hold a more powerful sample collection system that will attempt to dig a crater in the asteroid to bring a bigger cache of samples back to Earth. Moreover, the Hayabusa-2 will be equipped with a Ka-band communications subsystem that will be faster than the original Hayabusa's X-band system, and it will carry a sophisticated camera to better capture the shape and the geography of the asteroid. The ¥16 billion ($204 million) spacecraft will be designed to visit 1999 JU3, a 920-meter-diameter carbonaceous asteroid in a similar orbit to Itokawa. Carbonaceous asteroids are plentiful, rocky, and thought to contain water and organic materials, whereas asteroids such as Itokawa are stony, and are thought to lack organic materials.[225]

3.5 China

While the Chinese launcher, Long March 3B had been used to successfully place Eutelsat's W3C Commercial Telecom Satellite into geo-orbit on October 7, 2011, recent changes in US ITAR rules have restricted the EU from launching other 'so-called' ITAR–free spacecraft on Chinese launchers. That is to say that the US has restricted certain satellite components from export to China, directly or through third parties. While W3C had broken the twelve-year gap in satellite launches from

[219] Henry, Caleb. "A Heavyweight Battle: How Sea Launch Plans to Stay Afloat With SpaceX in its Waters." 13 Dec. 2013. ViaSatellite 6 Mar. 2014 <http://www.satellitetoday.com/launch/2013/12/13/a-heavyweight-battle-how-sea-launch-plans-to-stay-afloat-with-spacex-in-its-waters/>.

[220] Raymond, Nate. "Boeing sues Sea Launch partners for $350 million." 4 Feb. 2013. Reuters 30 May 2014 <http://www.reuters.com/article/2013/02/04/boeing-sealaunch-idUSL1N0B31GP20130204>.

[221] De Selding, Peter. "Melco Completes Expansion of Satellte Production Plant." 22 Mar, 2013. Space News 8 Mar. 2014 <http://www.spacenews.com/melco-completes-expansion-of-satellite-production-plant>.

[222] Berger, Brian. "Mitsubishi Electric Reinstated after Reimbursing Government." 13 Feb. 2013. Space News 8 Mar. 2014 <http://www.spacenews.com/article/mitsubishi-electric-reinstated-after-reimbursing-government>.

[223] De Selding, Peter. "Melco: Low Price Tag Will Sell DS-2000 Satellite," 12 Mar. 2012. Space News 8 Mar. 2014 <http://www.spacenews.com/article/melco-low-price-tag-will-sell-ds-2000-satellite>.

[224] De Selding, Peter. "Melco To Build Three QZSS Navigation Satellites." 3 Apr. 2013. Space News 8 Mar. 2014 <http://www.spacenews.com/article/civil-space/34676melco-to-build-three-qzss-navigation-satellites>.

[225] Kallender-Umezu, Paul. "NEC Tapped to Build Second Asteroid-bound Hayabusa Probe." Space News 30 Jan. 2012: 10.

China, following the ITAR rule changes the Thales Alenia-built Turkmen satellite is now barred from being launched on a Chinese launcher in 2014. Instead, it will be launched by an upgraded Falcon 9 rocket in late 2014 or 2015.[226] In fact, while the newly released US government "1248 report" recommends allowing the government to focus its ITAR controls on technologies and capabilities that are only the most sensitive, it still recommends strengthening the US ban on shipping US satellite technology to China for launch on Chinese rockets.[227] Despite the export ban, Thales Alenia Space wanted access to the Chinese market, and thus had developed an "ITAR-free" product line.[228] However, now it will need to make a long-term investment to replace all U.S.-built parts it does use with parts made elsewhere to be able to have a to have a fully ITAR-free product according to the current definition.

AsiaSat of Hong Kong reported an 12.7% increase in revenue and a 20.1% increase in operating profit for 2012, with total revenue reaching HK$1.78 billion ($229.6 million) from HK$1.58 billion ($203.4 million) in 2011, while operating profit was HK$1.22 billion ($157.4 million) from HK$1.05 billion ($135.2 million)in 2011.[229] In 2013, total revenue dropped by 15.8% to HK$1.50 billion ($193.4 million) with operating profit similarly dropping by 26.1% to HK$897.7 million ($115.8 million) for the year.[230] The reduction had been anticipated in 2012, when AsiaSat warned its investors that a major customer had insisted on renewing its transponder lease contract at a lower rate, in addition to ongoing competitive pressures of operating in a crowded Asian field.[231] AsiaSat also sold its subsidiary SpeedCast to TA Associates in late September 2012, with SpeedCast in parallel selling its 50% stake in the money-losing Dish-HD Asia Satellite venture with EchoStar of Englewood, Colorado, USA, to an undisclosed third party. AsiaSat has four satellites in operation, with the latest being AsiaSat 7 which entered into service in February 2012. Work on two more satellites, AsiaSat 6 and AsiaSat 8, is already under way and they should be ready for launch in 2014.[232]

3.6 India

Very high regulatory barriers in India make access to its satellite telecommunications market an unusually difficult pursuit. Nevertheless, SES of Luxemburg is investing heavily there in the hope of capturing 40% of the Indian satellite television market within the next few years. Capacity will increase as part of a major capital spending program, as SES's total in-orbit transponder supply will be increased by 23%, i.e. 293 transponders on 12 satellites will be launched between 2011 and 2014; 85% of that capacity will be directed toward emerging markets, mostly television markets. India is by far the biggest emerging market; its six pay-TV and one free-to-air DTH satellite television providers have a combined total of 32 million subscribers, with that number currently growing at a rate of nearly 1 million per month. With over 300 television channels awaiting regulatory approval, the sheer demand partly explains why India has been forced to allow SES and other non-Indian satellite providers into the market. It is likely that India will remain a growing market for non-Indian providers for the long term, as the regulations will necessarily be relaxed since India will never launch enough bandwidth on its own to meet demand.[233]

Legislators in India have not come to the same conclusion, however. In April 2012 the Indian government proposed a new tax that would impose a 10% royalty fee on foreign satellite communications services that would be retroactive covering the past 36 years. The government is looking for ways to reduce its deficit without regard to the crippling effect this tax will have on broadcast and communications. Such a move would put India in breach of its international tax trea-

[226] De Selding, Peter. "With Chinese Option Blocked, European-built Satellite To Fly Atop Falcon 9." 17 June 2013. SpaceNews 16 May 2014 <http://www.spacenews.com/article/launch-report/35820with-chinese-option-blocked-european-built-satellite-to-fly-atop-falcon-9>.

[227] Leone, Dan. "U.S. Report Supports Sweeping Reform of Satellite Export Rules." 18 Apr. 2012. Space News 23 May 2012 <http://www.spacenews.com/policy/120418-report-backs-reform-sat-export.html>.

[228] De Selding, Peter. "Chinese Rocket Launches Eutelsat's W3C Satellite." Space News 10 Oct. 2011: 4.

[229] AsiaSat Annual Report 2012. AsiaSat 16 May 2014: 54 <http://www.asiasat.com/asiasat/EN/upload/doc/support_reports/ar2012_eng.pdf>.

[230] AsiaSat Annual Report 2013. AsiaSat 16 May 2014: 55 <http://www.asiasat.com/asiasat/EN/upload/doc/support_reports/ir_2013.pdf>.

[231] De Selding, Peter. "AsiaSat's Appetite for Acquisitions Stimulated by a No-growth 2013." 21 Mar. 2014. SpaceNews 16 May 2013 <http://www.spacenews.com/article/financial-report/39931asiasat%E2%80%99s-appetite-for-acquisitions-stimulated-by-a-no-growth-2013>.

[232] De Selding, Peter. "AsiaSat's Appetite for Acquisitions Stimulated by a No-growth 2013." 21 Mar. 2014. SpaceNews 16 May 2013 <http://www.spacenews.com/article/financial-report/39931asiasat%E2%80%99s-appetite-for-acquisitions-stimulated-by-a-no-growth-2013>.

[233] De Selding, Peter. "Despite Barriers, SES Invests Heavily in Indian Satellite Market." Space News 6 June 2011: 6.

ties, as compliance with the royalty tax would amount to double taxation. The matter is now on appeal before the Supreme Court of India. However, if the tax is enforced and foreign satellite providers are unable to obtain a tax credit in their own tax homes, they will be forced to pass on the royalty to their customers in India. The 130-member Cable and Satellite Broadcasting Association of Asia (Casbaa), including many of the world's biggest commercial satellite fleet operators, is also attempting to persuade the Indian government that retroactivity violates basic international rules and principles of fair play.[234] The country is expected to release a new satcom policy in 2014, with satellite operators, equipment vendors and service providers all anticipating revised regulatory restrictions.[235]

3.7 World

The Canadian satellite component manufacturer Com Dev International reported increases in revenue for the years 2012 and 2013. Com Dev reported revenues of C$208.6 million ($208.5 million) in 2012, a 2.7% increase from 2011; and C$215.5 million ($205.9 million) in 2013, another 3.3% increase in revenue.[236] By the year ending 31 October 2013, Com Dev reported a 26% increase in its backlog, stemming mainly from new orders for commercial satellite components, reaching C$164.7 million ($157.4 million) in 2013, from C$139 million ($138.9 million) in the previous fiscal year.[237]

Thaicom of Thailand generated a 20.5% increase in its transponder lease revenue, along with an increase in revenue from its IPStar consumer broadband Ku-band satellite service in 2012, amounting to the company's first profit in five years.[238] Its revenue in 2012 reached 7.27 billion Thai Baht, a 9.7% increase from 6.62 billion Thai Baht in 2011; its revenue in 2013 increased by a further 8.7% to 7.90 billion Thai Baht.[239] Thaicom earned a net profit in 2012, amounting to 173.9 million Thai Baht; that net profit substantially increased by 548.43% to 1.13 billion Thai Baht in 2013. Its satellite services revenue increased by 10.1% to 6.32 billion Thai Baht in 2012 from 5.74 billion Thai Baht in 2011; and satellite services revenue increased by a further 10.4% to 6.96 billion Thai Baht in 2013. Satellite services amounted to 88.2% of the revenue generated in 2013, an increase from the 86.8% share of revenue generated in the previous year. By 2013, Thaicom had presold 40% of its capacity on its Thaicom 6 satellite, while also developing its Thaicom 7 (Asiasat 6) satellite under a partnership with AsiaSat.[240]

[234] De Selding, Peter. "Satellite Fleet Operators Protest Indian Tax Proposal." 5 Apr. 2012. Space News 9 May 2012 <http://www.spacenews.com/policy/120405-sat-operators-protest-indian-tax.html>.

[235] Krishnan, Deepu. "Challenges and Opportunities in the Indian Satcom Market." 17 Feb. 2014. SpaceNews 18 May 2014 <http://www.spacenews.com/article/opinion/39541challenges-and-opportunities-in-the-indian-satcom-market>.

[236] De Selding, Peter. "Com Dev Builds a Backlog Despite Slowdown in U.S. Defense Spending." 10 Jan. 2014. Space News 28 Mar. 2014 <http://www.spacenews.com/article/financial-report/39028com-dev-builds-a-backlog-despite-slowdown-in-us-defense-spending>.

[237] Ibid., De Selding, Peter. "Com Dev Balks at Fixed-price RCM Work." 11 Jan. 2013. Space News 27 Mar. 2014 <http://www.spacenews.com/article/satellite-telecom/33122com-dev-balks-at-fixed-price-rcm-work>.

[238] De Selding, Peter. "Top Fixed Satellite Service Operators | A Breakout Year: Thaicom." 8 Jul. 2013. Space News 27 Mar. 2014 <http://www.spacenews.com/article/features/36180top-fixed-satellite-service-operators-a-breakout-year-thaicom>.

[239] "Thaicom Public Company Limited Annual Report 2013." 13 Feb. 2014. MorningStar 27 Mar. 2014 <http://quicktake.morningstar.com/stocknet/secdocuments.aspx?symbol=thcom&country=tha>.

[240] De Selding, Peter. "Top Fixed Satellite Service Operators | A Breakout Year: Thaicom." 8 Jul. 2013. Space News 27 Mar. 2014 <http://www.spacenews.com/article/features/36180top-fixed-satellite-service-operators-a-breakout-year-thaicom>.

4. European Institutional Market

This chapter analyses institutional space spending in Europe along distinct internal categories. The contributions are explained and contrasted with each other, exhibiting significant ratios and proportions regarding European space activities, and establishing a basis for comparison with space actors outside Europe.

4.1 European Institutional Features

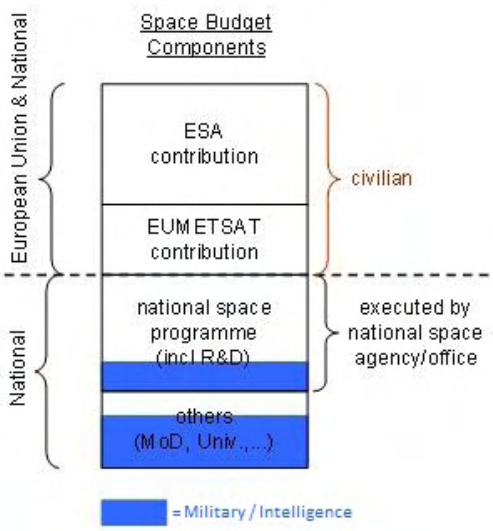

Figure 4.1: General structure of space budgets.

Space programmes in Europe develop simultaneously on three distinct levels, i.e. national, intergovernmental (e.g. ESA, EUMETSAT) and supranational (European Union). Figure 4.1 displays the structure that results from the overlapping complementary budgetary lines.

4.2 Civilian Space Expenditure

As a result of that structure, in regard to utilisation, national space budgets in Europe usually encompass both European and national components. The former normally consist of contributions to European Space Agency (ESA) and EUMETSAT and is regarded as civilian for the purposes of this report, as both organisations are broadly labelled as civilian despite the presence of dual-use products and services. While direct member state contributions to the European Union do not officially have a space related designation, even prior to the Lisbon Treaty revision to the Treaty on the Functioning of the European Union, EU funds have been increasingly used to finance space activities. In this section they are only visible through the ESA budget or are wrapped into the budgets of other actors.

National space budgets usually have three tiers: civilian, military and space related academic research. Countries with national space agencies essentially fund the first and third tiers through the agencies, while funding for the second tier remains under defence ministry control. In countries that prefer less centralised approaches, e.g. the United Kingdom until recently, budgetary lines are dispersed throughout government agencies, making them more difficult to account for.

In addition to vertical delineation, space related budgets are also dispersed horizontally among national, bilateral and multilateral space cooperation agreements. While some European countries are engaged in multinational cooperation through participation in ESA, they may also have bilateral agreements on space activities between them. Through this cooperation, certain security related space projects are funded simultaneously by European institutions (notably the European Commission and the European Defence Agency) and by other sources. The share of funding for military and intelligence gathering activities is represented in the blue area of Figure 4.1. However, academic research and development projects may in a similar way be channelled both through ESA and bilateral scientific cooperation agreements.

Investment in military and intelligence gathering space activities is not obligatory among all European states; additionally, most institutional spending is directed toward civilian activity. The total sum of European institutional spending on space increased by €237.5 million to €7.464 billion in 2012, followed by another increase of €139.5 million to €7.786 billion in 2013. In 2014, ESA and national

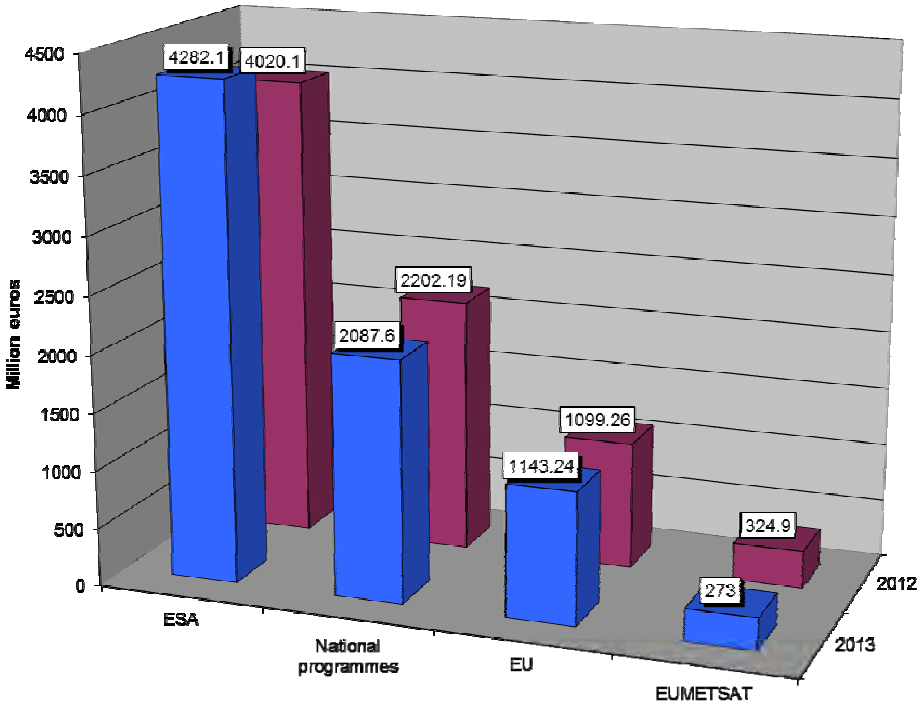

Figure 4.2: Estimated European civil public expenditures in 2013 and 2012.

civil programme expenditures grew by a combined total of €343.9 million to be €4.102 billion and 2.611 billion respectively. While the investment share between civilian and military funding is not readily available, it can be estimated to be around 90% civilian and 10% military. In both 2012 and 2013, the U.S. overshadowed Europe's investment in security-related space activities in both its share-size and amounts invested. However, as the space industry saw a significant decrease in US military spending in 2013 to $21.717 billion (€15.773 billion), it was matched by increased spending among European states which contributed to the $10.216 billion (€7.420 billion) in combined non-US military spending by the rest of world.[241]

4.3 European Space Agency (ESA)

The European Space Agency's budget continued to rise in 2012 and 2013, before decreasing by nearly €200 million in 2014. In 2012, its €4.020 budget reflected changes in allocations due to ESA's involvement in the Galileo and restructuring of basic activities. While Earth observation continued to receive the highest priority, accounting for 21.4% (€861.4 million) of ESA's budget for programmes and mandatory activities, Basic Activities (5.5%) and Navigation (17.9%) saw the most relative growth increasing to €221.5 million and €720.7 million respectively. On the other hand Technology Support, European Cooperating States Agreement, and funding Associated with the General Budget each saw substantial reductions, indicating a refocus on flagship programme priorities within the space agency.[242]

In 2013, ESA`s €4.282 billion budget continued to place more emphasis on Earth observation (22.9%), with €982.5 million of the budget, however Launchers (16%) and Technology Support (2.2%) saw the most growth in funding reaching €684.1 million and €94.6 million; Robotic Exploration (3.2%) also saw increased funding, reaching €138.6 million. On the other hand, funding for Space Situational Awareness (0.24%) dropped substantially from 15.4 million in 2012, to €10.1 million in 2013, as did funding allocated to the European Cooperating States Agreement, likely coinciding with Romania and Poland`s new entry into ESA as full member states.[243]

[241] C.f. The Space Report 2014…: 40.

[242] "ESA 2012 Budget by Domain." Jan. 2012 .ESA 30 May 2014 <http://download.esa.int/docs/corporate/pies_final_final.ppt>.

[243] "ESA Budget by Programme (2013). ESA 21 Mar. 2011 <http://download.esa.int/docs/DG/ESA_2011_Budget_040111_rev2.ppt>.

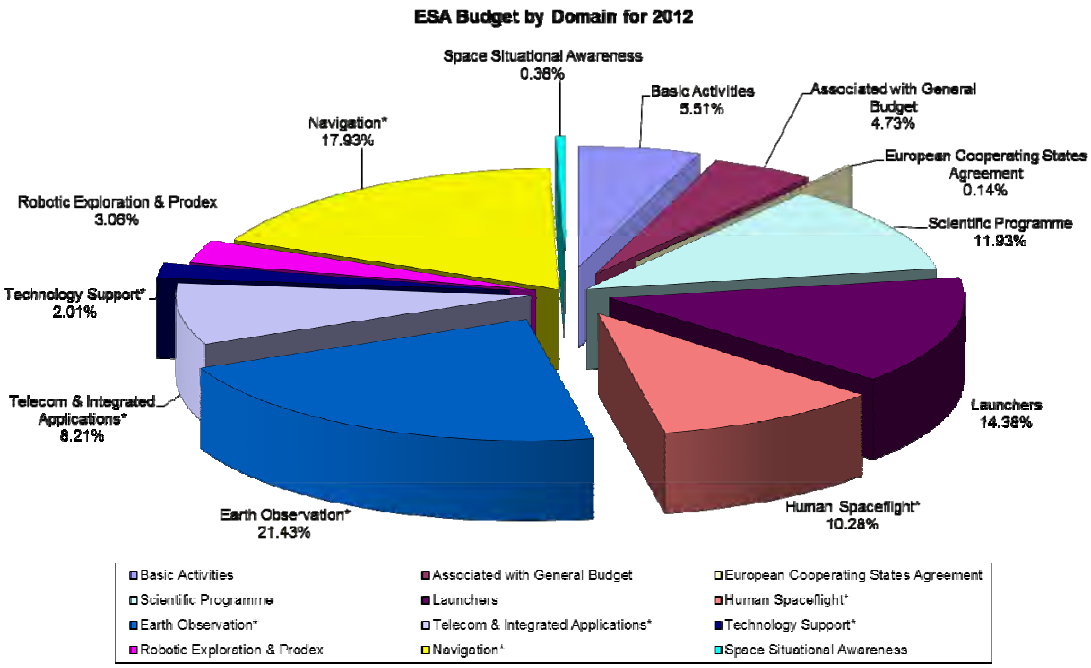

Figure 4.3: ESA Programmatic Budget Allocations for 2012 (Source: ESA)

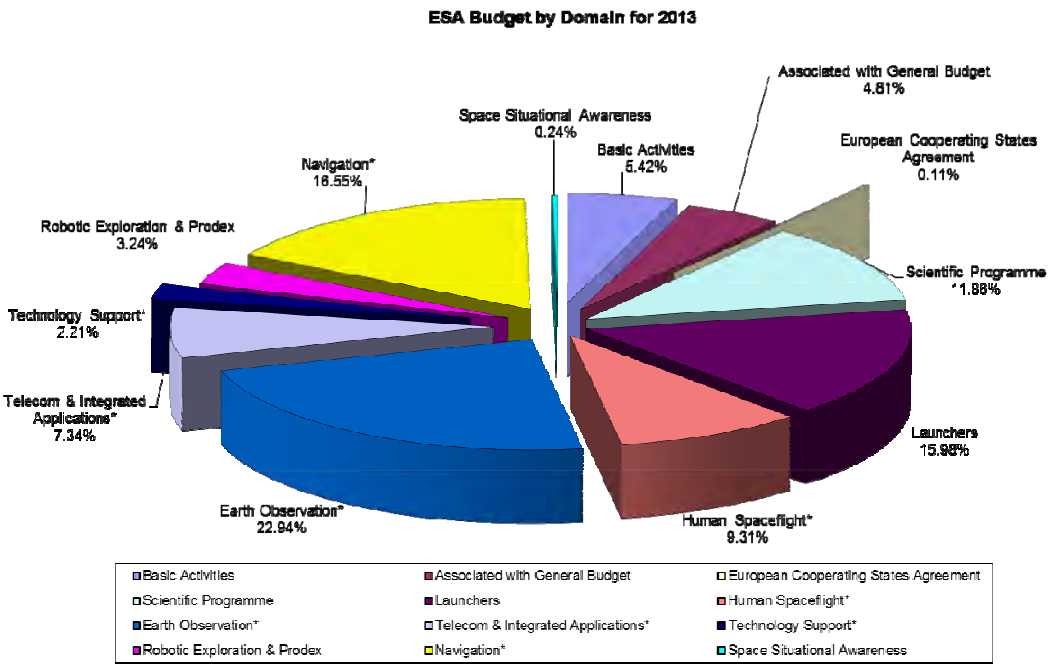

Figure 4.4: ESA Programmatic Budget Allocations for 2013 (Source: ESA)

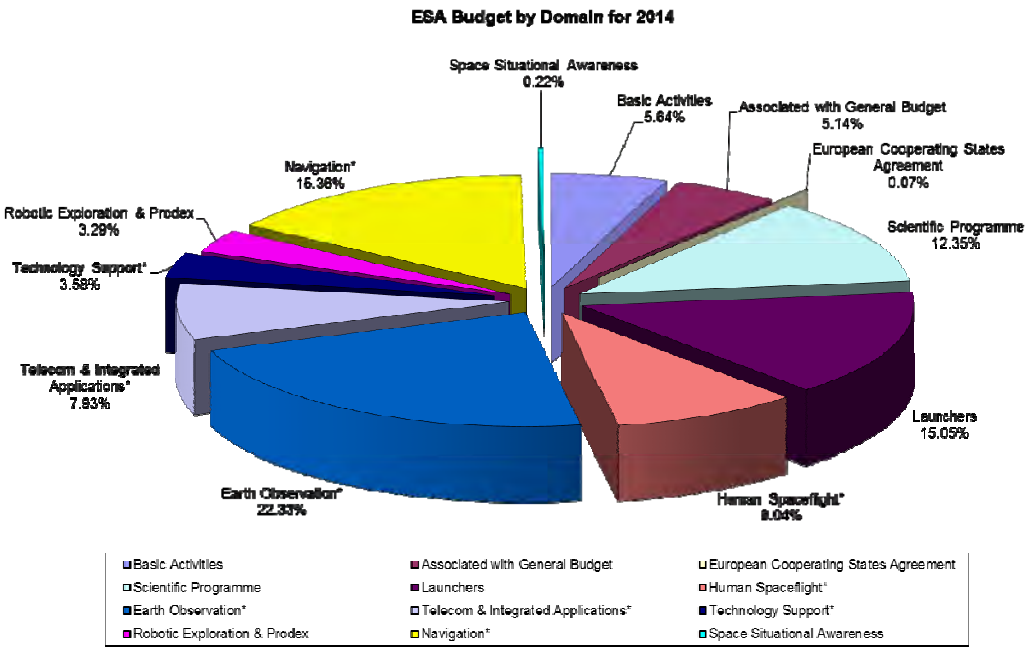

Figure 4.5: ESA Programmatic Budget Allocations for 2014 (Source: ESA)

In 2014, ESA`s budget decreased by 4.2% to €4.102 billion, wherein Technology Support (3.58%) saw the biggest relative increase in funding reaching €146.8 million, while the European Cooperating States Agreement saw the biggest relative decrease in funding, dropping to €2.7 million. Except for funding Associated with the General Budget (5.1%) which saw a slight increase in funding from the previous year, all other programmes saw reductions in funding. This year, Earth Observation received the largest amount of funding accounting for 22.3% (€915.9 million), followed by Navigation at 15.4% (€630.2 million) and Launchers at 15.1% (€617.4 million). The funding for the rest of ESA's programmes is overshadowed by these programmes, with space science receiving 12.4% (€506.5 million), human spaceflight receiving 9.4% (€370.9 million), and telecommunications receiving 7.9% (€325.3 million).[244] The rest of the budget is directed toward activities where the share percentages are between 5.6% and 0.2%.

The utilization of the ISS has been extended to 2020; and by the end of September 2013, Russian, European, Japanese, Canadian and US space agencies were nearing the point where they could declare their respective parts of the ISS fit to fly through 2028 (marking the 30th anniversary of the station's first pressurized space module, Zarya, placed into orbit by Russia in 1998).[245] Before the 2012 ESA Ministerial Council meeting, Germany as Europe's largest contributor to the ISS had a funding commitment share of 41%, while France was committed to a 27.6% share, and Italy's share was 18.9%; however, following the 2012 meeting France planned to cap its contributions to the ISS, following an assessment that its current payments exceeded the station-related contracts received by French industry. For the two-year period 2013-2014, France's ISS contribution was reduced to 20.9% of the total ESA programme.[246] [247]

While the life cycle of the ISS has been extended by another 5 years, ESA is stopping the production of Automated Transfer Vehicles (ATVs). Following the completion of the five ATV missions, ESA will have paid its share of dues for the use of the ISS through 2017. Following the extension, ESA has directed Thales to look for ways to supply a service module for the Multi-Purpose Crew Vehicle (MPCV) that Lockheed Martin started building under the old Constellation program.[248]

[244] "ESA Budget by Programme (2014). ESA 21 Mar. 2011 <http://download.esa.int/docs/DG/ESA_2011_Budget_040111_rev2.ppt>.

[245] "U.S., Russia Close to Completing Technical Assessment of Flying ISS through 2028." 30 Sept. 2013. SpaceNews 30 Apr. 2014 <http://www.spacenews.com/article/civil-space/37460us-russia-close-to-completing-technical-assessment-of-flying-iss-through>.

[246] ""France is Reducing Its Space Station Contributions." 20 Feb. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/33755france-is-reducing-its-space-station-contributions>.

[247] "European Participation – Participating States." ESA – International Space Station 7 May 2012 <http://www.esa.int/esaHS/partstates.html>.

[248] Morring, Jr., Frank. "Spacefaring Nations Regroup For Push Beyond LEO." Aviation Week & Space Technology 10 Oct. 2011: 46.

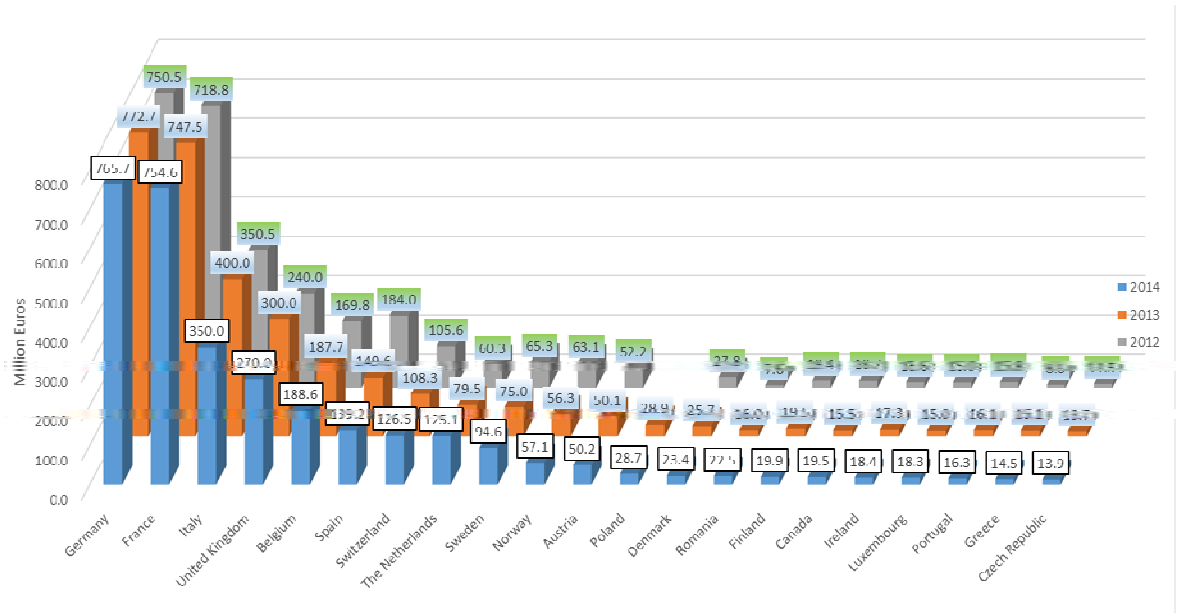

Figure 4.6: Member States' Contributions to ESA's Budget from 2012 to 2014 (Source: ESA)

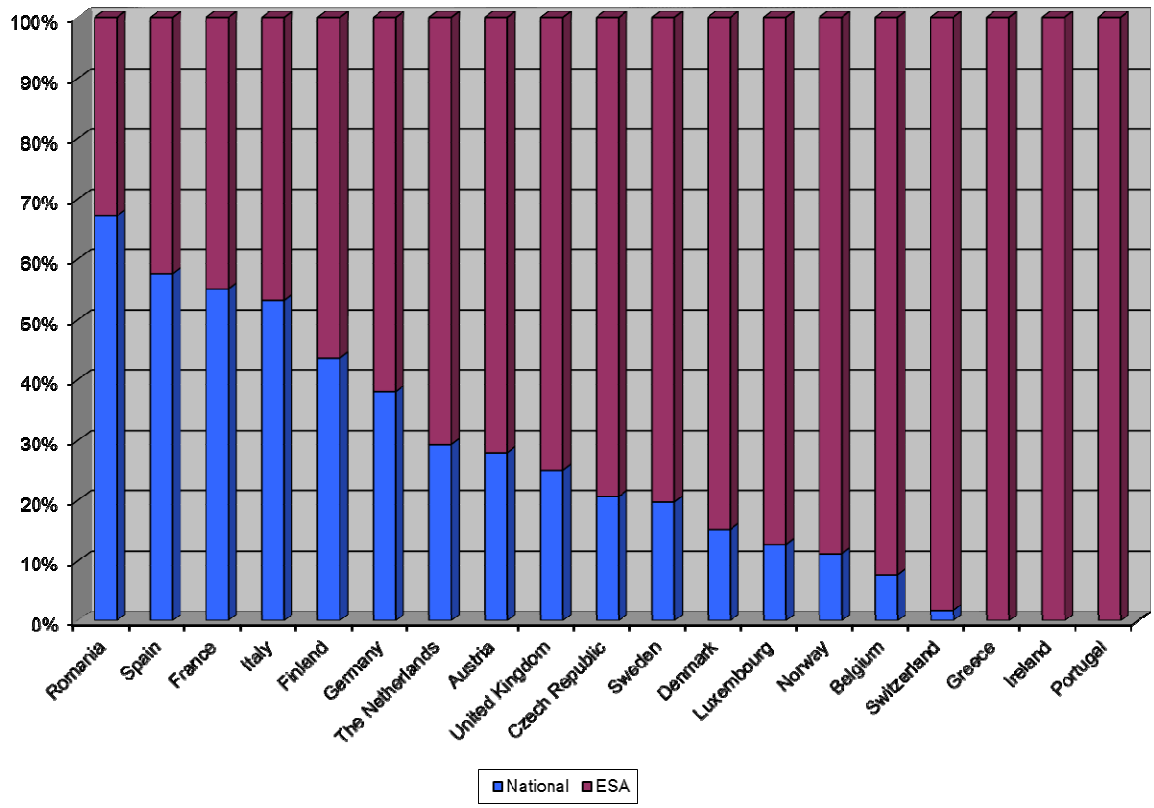

Figure 4.7: Estimated Shares of European National Institutional Investment in Civilian Space of ESA Members in 2012

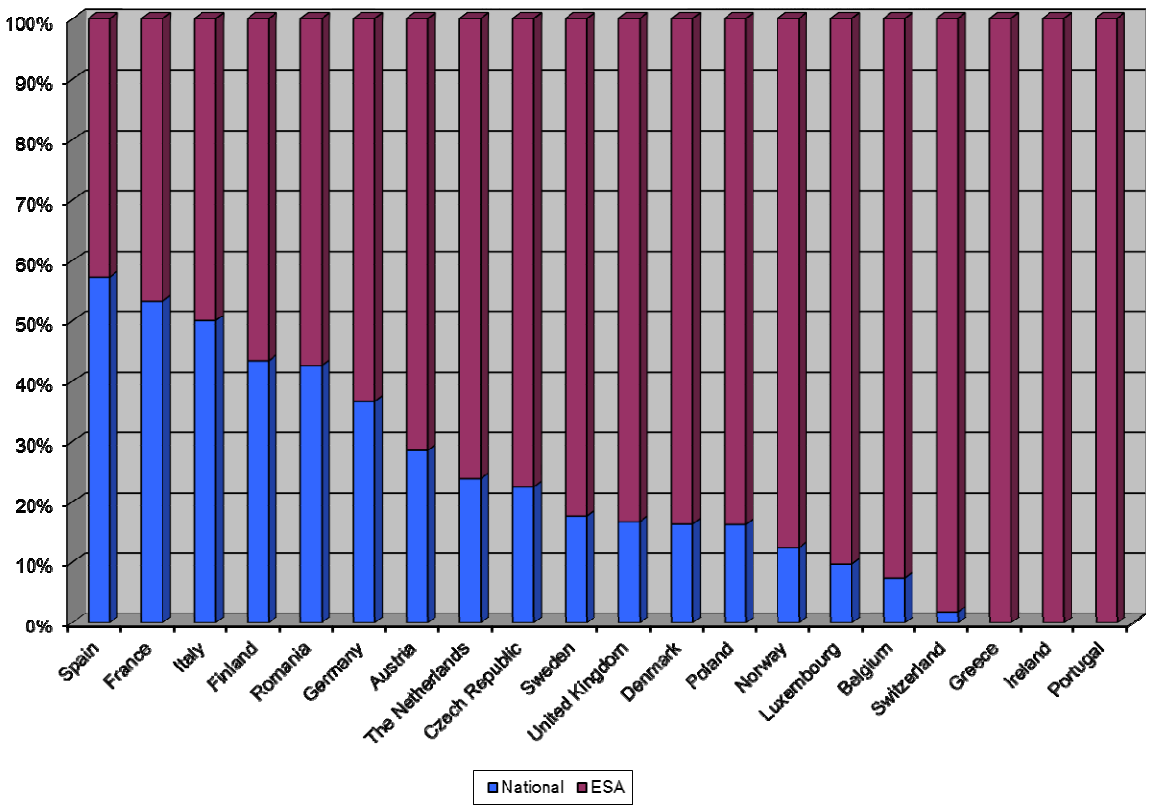

Figure 4.8: Estimated Shares of European National Institutional Investment in Civilian Space of ESA Members in 2013

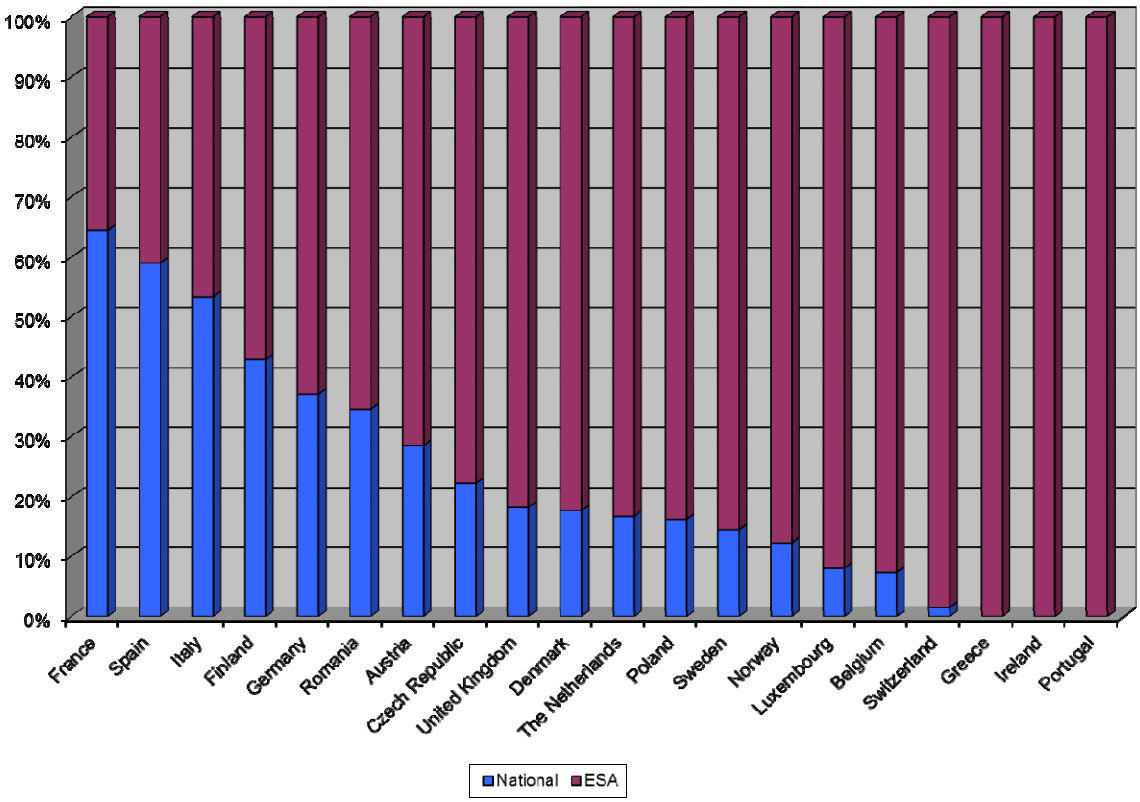

Figure 4.9: Estimated Shares of European National Institutional Investment in Civilian Space of ESA Members in 2014

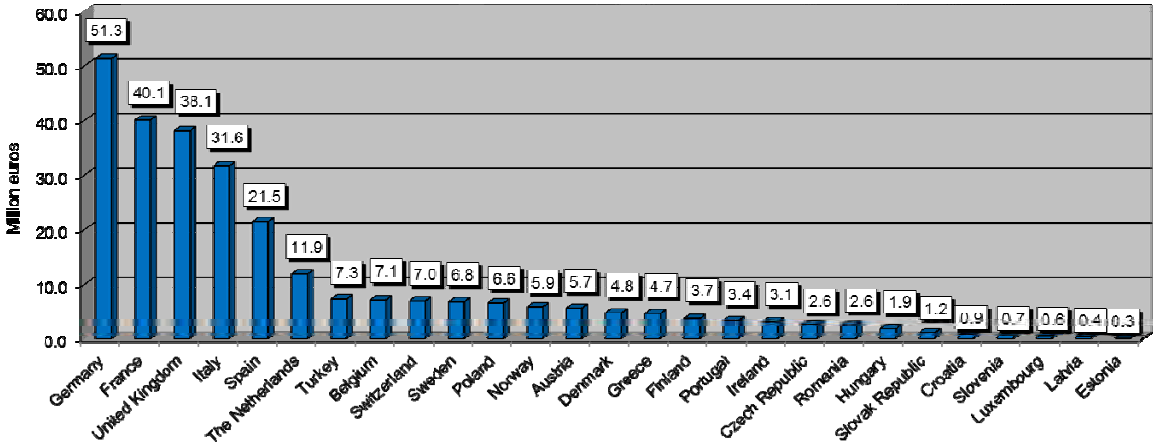

Figure 4.10: Estimates of Member States' contributions to Eumetsat in 2013
(Source: Estimates derived from Euroconsult and amended Eumetsat scale of contributions published in January 2014)

Considering public private partnerships (PPPs) in European space programmes, ESA has initiated notable partnerships on an institutional level, through its participation in satellite communication projects. Through its ARTES 33 Partner programme, ESA provides the satcom industry with an efficient framework to bring innovative products and systems into the marketplace through industry-generated PPPs, implementing such programmes as Amerhis, Alphasat, SmallGEO, Hylas-1 and EDRS.[249] In this context, ESA has also implemented a PPP-type financial arrangement for the development, launch and in-orbit validation of an full electric-propulsion telecommunications satellite in the 3-ton mass range (Electra), offering power consumption and communication capabilities equal to those offered by larger mid-size satellites with a launch mass low enough for small launcher vehicles, or to increase the size of the payload staying at the same launch mass to increase competitiveness and economic benefit.[250] Through the ARTES 33 programme, ESA will help develop innovative satellite communication systems and products in line with ESA's strategic objectives together with a private partner within ESA's Member States and Canada.

4.4 EUMETSAT

On 24 February 2012, ESA entered into a $1.8 billion deal with Thales Alenia Space as prime contractor in partnership with OHB to build 6 satellites for its Meteosat Third Generation (MTG) system, aiming to provide meteorological services for 20 years starting in 2018. ESA is covering 62% of the cost of the 6 satellites while Eumetsat will cover the other 38% of the contract and is also funding more than two-thirds of the entire MTG programme (budgeted at about €2.4 billion).[251] By mid-2014, membership in Eumetsat had grown to 30 member states and one cooperating state (i.e. Serbia).[252] Estonia was welcomed as a member on 26 June 2013[253]; and Lithuania, Bulgaria, and Iceland became full members in 2014.[254] While their contributions are not expected to be substantial, the inclusion of these new members will have symbolic importance for the organization as it moves forward with its flagship programmes.[255]

[249] "ARTES 33 Partner." 27 May 2013. ESA 15 Apr. 2014 <http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=32274&fareaid=64>.
[250] "Electra." 12 Feb. 2013. ESA 23 Apr. 2014 <http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=32275>.

[251] De Selding, Peter. "ESA Signs $1.8B Deal with Thales Alenia for Six Weather Sats." 24 Feb. 2012. Space News 15 May 2012 <http://www.spacenews.com/article/esa-signs-18b-deal-thales-alenia-six-weather-sats>.
[252] See further "EUMETSAT is a user-governed operational organisation, formed in 1986, which serves the needs of its Member States." Eumetsat 30 May 2014 <http://www.eumetsat.int/website/home/AboutUs/WhoWeAre/MemberStates/index.html>.
[253] "Estonia today became EUMETSAT's latest Member State, following the signature of the accession agreement on 14 December 2011 and the recent completion of the ratification process." 26 June 2013. EUMETSAT 29 Apr. 2014 <http://www.eumetsat.int/website/home/News/DAT_2055722.html>.
[254] "EUMETSAT is a user-governed operational organisation, formed in 1986, which serves the needs of its Member States." Eumetsat 30 May 2014 <http://www.eumetsat.int/website/home/AboutUs/WhoWeAre/MemberStates/index.html>.
[255] "Eumetsat Welcoming New Members as Investments Loom." 30 Aug. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/37012eumetsat-welcoming-new-members-as-investments-loom>.

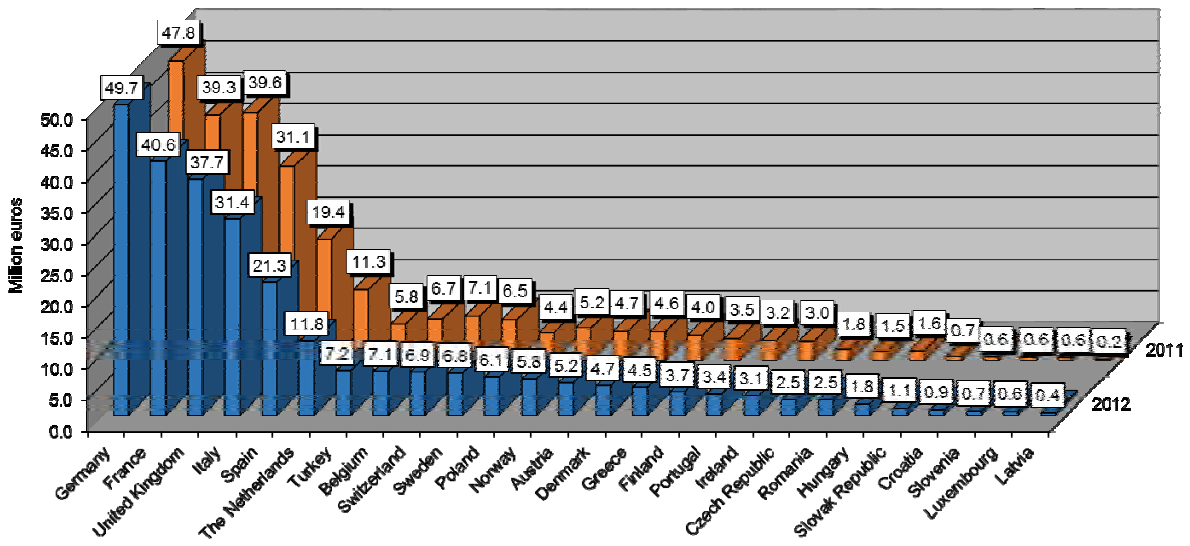

Figure 4.11: Member states' contributions to Eumetsat in 2012 and 2011 (Source: EUMETSAT)

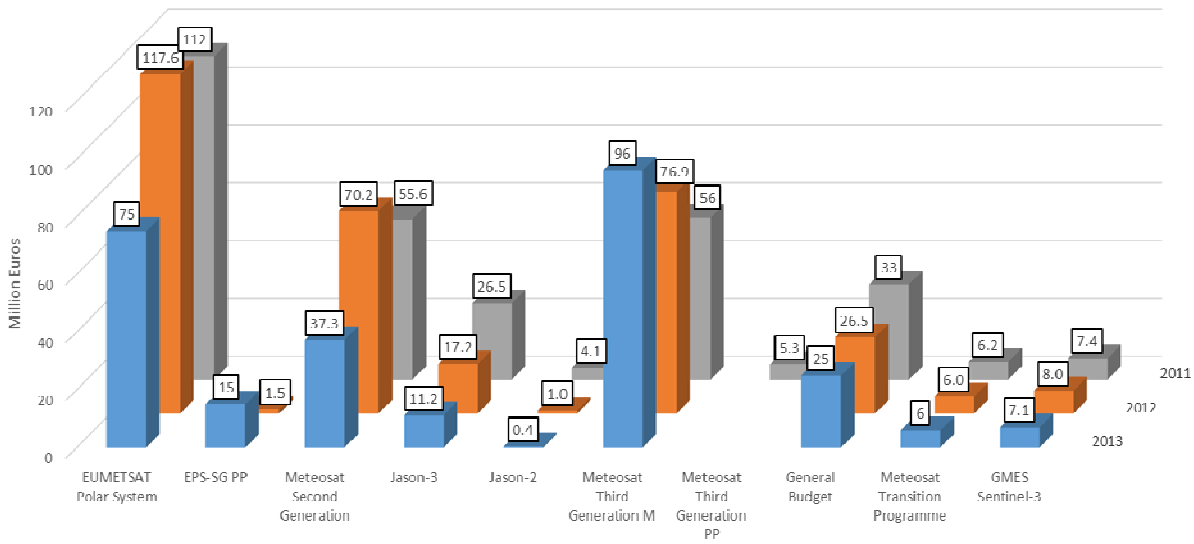

Figure 4.12: Major Programmatic Allocations of Eumetsat 2011-2013

The vast majority of Eumetsat's budget comes from contributions from member states and cooperating states. Member contributions are calculated on the basis of their Gross National Income (GNI), rather than GDP. Over the course of 2012 and 2013, the percentage distribution of contributions remained roughly similar to that of 2011. By 2013, Germany had maintained its position as the largest contributor with a share contribution that is estimated to be about 18.8%, rising from 18.6% in 2012; next, France followed with a diminished 14.7% from 15.2% in 2012. The United Kingdom's share has diminished slightly to 14.0% for 2013, from 14.1% in 2012; likewise, Italy's share decreased to 11.6% in 2013 from 11.8% in 2012. Spain and the Netherlands continued their noteworthy participation at about 7.9% and 4.4% in 2013, respectively. These six states account for 73.44% of the total 2011 allocation (Figures 4.10[256] and 4.11). The contributions from the remaining member states in 2013 are estimated to consist of percentage shares that range from 2.68% to as low as 0.11%, with little variation from the amounts invested in 2012 and 2011.

[256] See Eumetsat Programmes. 1 Jan. 2014. Eumetsat 30 May 2014: 45 <http://www.eumetsat.int/website/home/search/index.html?refineRe-sults%3Asearch=PDF_LEG_PROGRAMMES.pdf&pState=1&subjectKeywords=&sg=UHVibGlj&type1=1&type1=2&searchLanguage=EN>.

The 2012 general budget of Eumetsat increased to €324.9 million to allow a substantial increase for the start of the Meteosat Third Generation Programme, in addition to increased funding towards the Meteosat Second Generation. Whereas contributions to Meteosat Second Generation increased to by 26% to €70.2 million, the successor Meteosat Third Generation jumped by 37% to €76.9 million. Funding for Jason-2 dropped to €1.0 million, while funding for Jason-3 went down to €17.2 million from €4.1 million and €26.5 million respectively. While the Eumetsat Polar System stayed relatively unchanged in funding, its EPS Second Generation Preparatory Programme saw initial funding of €1.5 million. The year's budget allocated more funds to GMES Sentinel 3, evincing also its greater importance in Eumetsat's budget during the coming years. With a budget increase of €18.8 million in 2012, the Eumetsat Polar System was allocated 5% more funding, receiving a considerable amount of €117.6 million. In the geostationary field the investment focus has shifted to Meteosat Third Generation, where funding began to focus on the main programme, rather than its preparatory programme.

The 2013 general budget of Eumetsat is estimated to have decreased by 16% to €273 million corresponding to Eumetsat's programmatic cycles as it begins the development of the MTG programme. While funding for the MTG programme increased by another 24.8% to reach €96 million, funding for MSG, and Jason-3 and -2 both dropped significantly to €37.3 million, and a combined total of around €11 million respectively. Aside from a substantial increase to the ESP-SG PP budget amounting to €15 million, the rest of the programmes saw a decrease in funding with the exception of the Meteosat Transition Programme which saw no change. With a total budget decrease of €51.9 million, the EUMETSAT Polar System saw the greatest share reduction, decreasing from €117.6 million in 2012 to reach €75 million in 2013 (a 36.2% reduction). MSG had also decreased by a significant 46.9% margin, reaching €37.3 million in 2013. These consistent sizable drops in funding demonstrate purely that the Meteosat Second Generation is getting close to the end of infrastructure investment, and that in the future operational costs will dominate in the programme. On the other hand, with the shift to Meteosat Third Generation already underway, Eumetsat is now looking to increase its funding for its Eumetsat Polar System Second Generation, with increased funding toward its Preparatory Programme. It is likely that 2014 will continue the levels of investment in MTG and GMES Sentinel 3, while the other programmes are going to level off or decrease (e.g. METEOSAT Second Generation and EPS).

4.5 National Agencies

Over the course of 2012 to 2014, the hierarchy of European national civilian space programmes (not including contributions to ESA) has remained relatively unchanged between the considered states in Figures 4.13 to 4.15. However, funding amounts have seen relative increases among most states, or at least a consistent flux between years. In each reported year, France, Germany, Italy, Spain, and the UK held the top 5 positions in national space funding; the order remained similar among the Netherlands, Austria, and Sweden as well. In 2012, Romania's national budget had placed it in the middle ranking among European states; ahead of Finland, Belgium and Norway, while Poland's national programme placed it ahead of a number of states as well. In 2013, Belgium and Romania switched places, with Romania's national budget decreasing to €11.9 million to allocate more contributions to ESA; Luxembourg and Switzerland also switched positions due mainly to decreased funding by Luxembourg in 2013. Moreover, France, Germany, Spain and the UK all had significant reductions in funding national space programmes. In 2014, the 2014 European Space Directory 29th Edition listed France's national civilian programme to have increased by 61% to €1.372 billion, whereas other European national civilian space programmes saw relatively minor changes in funding, and the ranking among states remained the same. Authorities conflict as to France's national civilian budget for 2014, with Euroconsult projecting the funding to either decrease or stay on par with the 2013 amount, suggesting the possibility that dual-use spending for military activities was included in the 2014 presented national civilian budget, or otherwise the inclusion of €530 million from French public bonds.[257]

[257] De Selding, Peter. "Sarkozy Reaffirms Commitment to Space Spending." SpaceNews 28 Nov. 2011: 6.

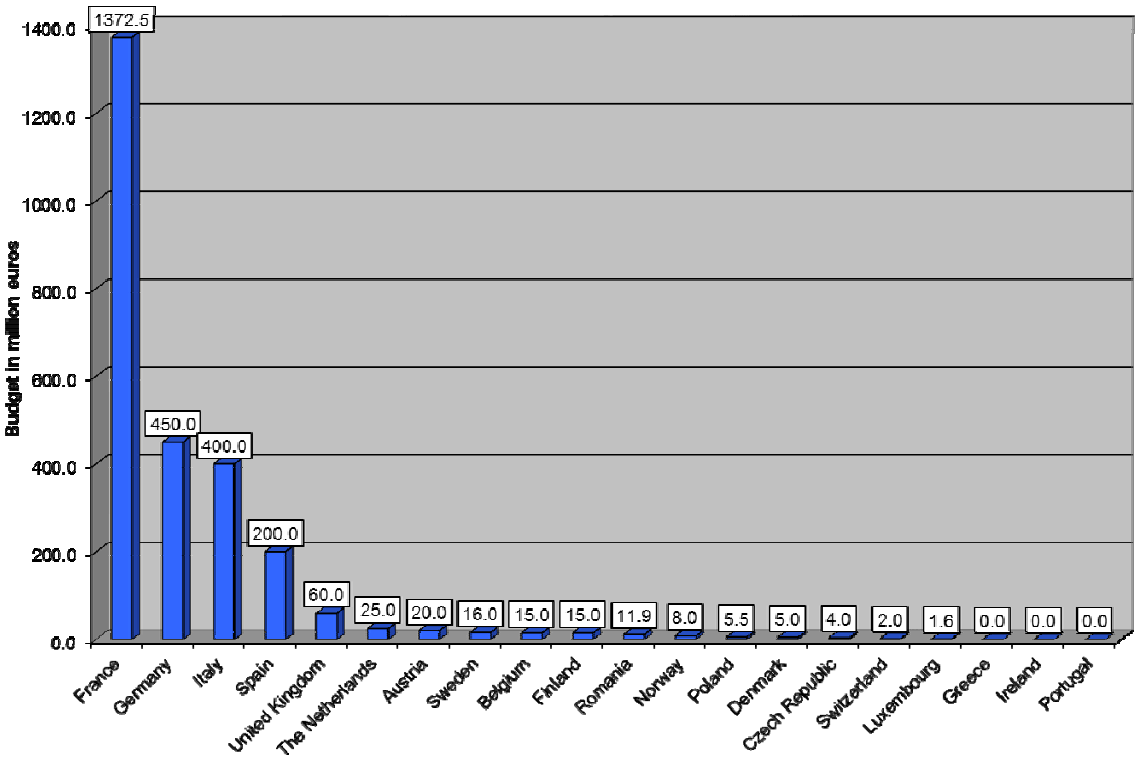

Figure 4.13: National civilian programmes 2014 in million euros

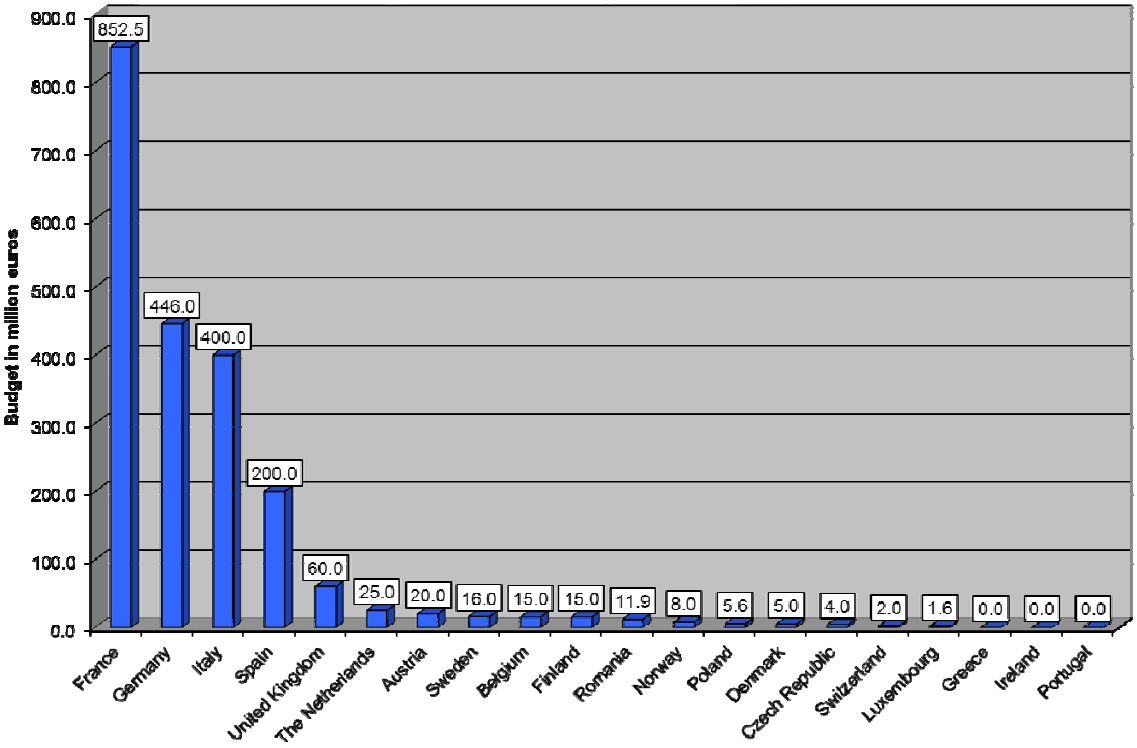

Figure 4.14: National civilian programmes 2013 in million euros

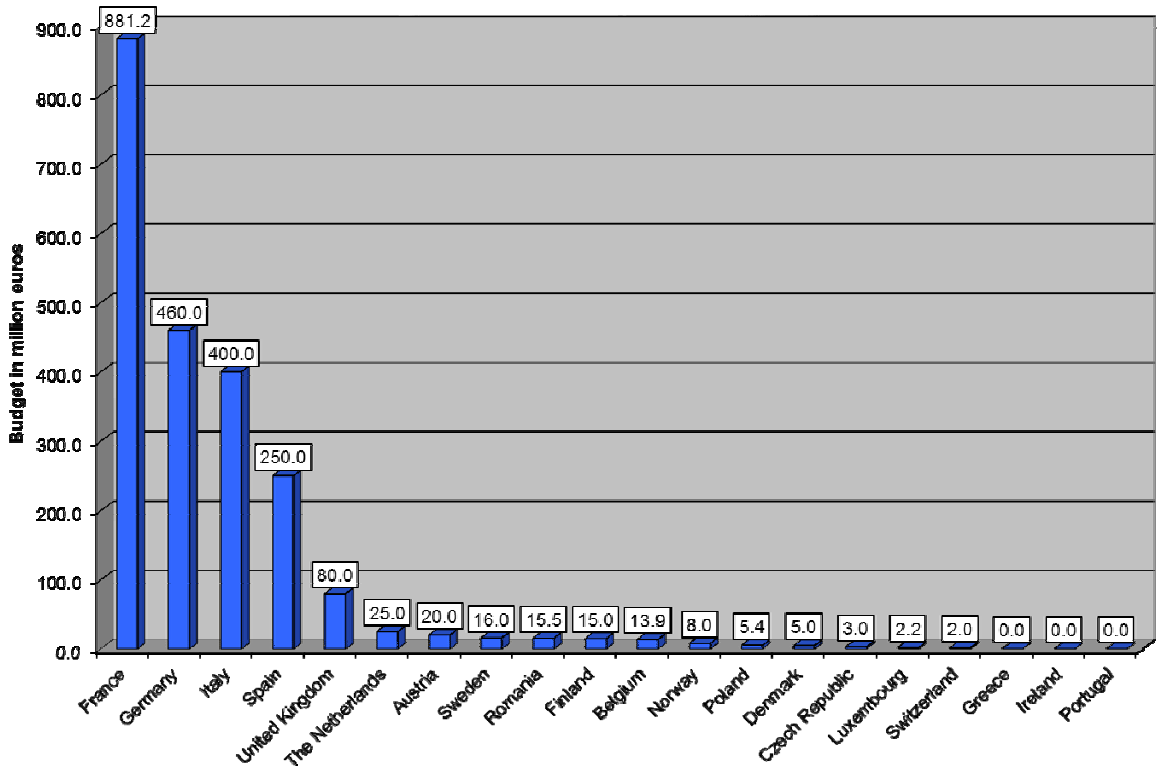

Figure 4.15: National civilian programmes 2012 in million euros

4.5.1 France

France's space budget remained resilient throughout Europe's sovereign-debt crisis, as the French government viewed investment in the space sector to be a necessity.

From 2012 to 2014, France was the second largest contributor to ESA, marginally eclipsed by Germany over this period. Whereas France contributed €718.8 million in 2012, €747.5 million in 2013, and €754.6 million in 2014; Germany had contributed €750.5 million, €772.7 million, and €765.7 million respectively, i.e. within a 1% difference for each year counted. Whereas both France and Germany contributed shares ranging from 24% to 26%; from 2012 to 2014, the other ESA Member States all contributed less than 13% shares of the rest of the budget.

As a result of the 2012 ESA Ministerial Council meeting, France's ISS contribution was capped at €275 million for the two-year period 2013-2014, or 20.86% of the total ESA programme (dropping from 27.1% of the total) with constant annual payments through 2020. Moreover, while the life cycle of the ISS has been extended by another 5 years, with ESA looking for ways to supply a service module for NASA's Orion Multi-Purpose Crew Vehicle (MPCV), CNES' role will be limited to 20% of the ATV-derivative programme, though France intends to review that role at the upcoming 2014 ESA Ministerial Council meeting.[258]

4.5.2 Germany

Following the results of the November 2012 ESA Ministerial Council meeting, with Italy and Spain both reducing their contributions to ISS funding, Germany was left to pick up the slack, contributing 50% of operational funding for the station for the 2 year period leading into the December 2014 ESA Ministerial Council meeting.[259] In preparing for the upcoming meeting, the DLR's Chairman, Johann-Dietrich Woerner, said Germany backs full approval of the extension to 2020 and also wants ESA governments to support NASA's proposed extension of station operations to 2024.[260]

[258] ""France is Reducing Its Space Station Contributions." 20 Feb. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/33755france-is-reducing-its-space-station-contributions>.
[259] De Selding, Peter. "DLR Chief Confident Europe Will Keep Building Orion Prop Modules." 24 Jan. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/33310dlr-chief-confident-europe-will-keep-building-orion-prop-modules>.
[260] De Selding, Peter. "Orion's European Service Module Back on Track." 23 May 2014. SpaceNews 30 May 2014

Europe's work on the service module for NASA's Orion crew-transport vehicle is on track for delivery to NASA in time for its launch planned for late-2017. At the November 2012 ESA Ministerial Council meeting, ESA agreed to spend €455 million on a completed Orion full flight-ready service module, along with parts for a second flight. However, with the debate about allocations of funding for operating the ISS through 2020 continuing between ESA's largest members (Germany, France, and Italy), the governments authorized ESA to spend only €250 million on the Orion work. Orion's inclusion into ESA's space station programme budget was strongly desired by Germany in the last Ministerial meeting as a way to extend ESA's participation in the ISS to 2020, as the fifth ATV launch only covered ESA's barter obligations to NASA to 2017.[261] The upcoming Ministerial Council meeting in December 2014 will determine funding source for the remaining €205 million needed for the Orion service module.[262]

By the end of May 2014, Germany had informed ESA that German spending on launch vehicles will remain flat for the upcoming decade, complicating ESA's push to secure funding and consensus for the future development of the Ariane launcher. Barring an increase of launcher development funding by any other member ESA, Germany's decision means that ESA's annual launcher budget would be limited to around €850 million per year from 2015 to 2024.[263] With Germany's spending cap formally expressed to ESA on 21 May 2014, it is yet another complicating factor leading up to the December 2014 Ministerial meeting.

4.5.3 Italy

In Italy, following the resignation of former ASI president Enrico Saggese on 7 February 2014, the Italian government appointed Aldo Sandulli, a law professor at a Naples university, to oversee ASI's affairs until a new agency management team was in place.[264] On 17 May 2014, ASI's new president Roberto Battiston, a former advanced physics professor at Trento University, began his post expressing Italy's intent to push for upgrades to the Italian-led Vega small-satellite launcher at the upcoming Ministerial Council meeting in December 2014 which will determine future launcher strategy and contributions to the ISS.[265]

Regarding contributions to the ISS, at the last Ministerial Council meeting in 2012, Italy had substantially reduced its contribution to the station due to the dearth of contracts that had been placed with their domestic industry in return for its investment. The result was an "under-return" of €100 million over the past decade which led to Italy recalculating its contribution to be in line with the industrial return it had been receiving.[266] Having dropped its percentage share ISS contribution to 20.8% from 27.1% to better fit Italy's geographic return, its action was met by substantial resistance by Germany which was forced to carry a larger share of station expenses.[267] In addition to its contributions to the ISS, Italy has, however, taken a 20% stake in ESA's contribution to NASA's Orion multipurpose crew-transport vehicle.[268]

Italy is also the largest financial contributor to the ExoMars programme, and likewise had the most to lose following the US withdrawal from the underfunded programme, which threatened to end it from the beginning. Italy contributed about 33% of the €850 million

<http://www.spacenews.com/article/civil-space/40669orion%E2%80%99s-european-service-module-back-on-track>.

[261] De Selding, Peter. "Germany Wins Battle over Ariane, ESA Space Station Role." 21 Nov. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/32467germany-wins-battle-over-ariane-esa-space-station-role>.

[262] De Selding, Peter. "Orion's European Service Module Back on Track." 23 May 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/40669orion%E2%80%99s-european-service-module-back-on-track>.

[263] De Selding, Peter. "Germany's Budget Straightjacket Complicates Europe's Ariane Funding Outlook." 22 May 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/launch-report/40655germany%E2%80%99s-budget-straitjacket-complicates-europes-ariane-funding-outlook>.

[264] De Selding, Peter. "Italy Taps Law Professor To Lead ASI after Saggese Resigns amid Corruption Probe." 14 Feb. 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/39491italy-taps-law-professor-to-lead-asi-after-saggese-resigns-amid-corruption>.

[265] De Selding, Peter. "Italy's New Space Chief Seeks To Close the Chapter on Corruption." 26 May 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/40683italy%E2%80%99s-new-space-chief-seeks-to-close-the-chapter-on-corruption>.

[266] De Selding, Peter. "Luxembourg Replaces Belgium as ESA's Biggest Contributor by GDP." 15 Jan 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/33183luxembourg-replaces-belgium-as-esa%E2%80%99s-biggest-contributor-by-gdp>.

[267] De Selding, Peter. "France is Reducing Its Space Station Contributions." 20 Feb. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/33755france-is-reducing-its-space-station-contributions>.

[268] De Selding, Peter. "Luxembourg Replaces Belgium as ESA's Biggest Contributor by GDP." 15 Jan 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/33183luxembourg-replaces-belgium-as-esa%E2%80%99s-biggest-contributor-by-gdp>.

raised by ESA toward the project. Aside from Italy's 33% share in the programme, the three other top contributors are United Kingdom at 20%, France at 15%, and Germany at 10%.[269]

4.6 European Union (EU)

The lasting effects of the economic crisis likely played a significant part in the developments over the reporting period 2012 and 2013. One example is the developments regarding the Copernicus programme (formerly known as the Global Monitoring for Environment and Security, or GMES) programme. This hindrance first emerged in July 2011, when the European Commission announced that it did not intend to finance Copernicus through its next seven year framework programme, instead proposing that the €5.8 billion amount needed for Copernicus between 2014 and 2020 be provided on an à la carte basis by individual participating states. The proposal of the Commission was to create a funding mechanism outside the Multiannual Financial Framework (MFF), based on voluntary subscription based on GNI contributions from all Member States. While this had initially been an effort on the part of the EC to tighten its research and development budget in view of the ongoing economic crisis, that move put the entire programme at risk. By December 2012, the Commission had reinserted Copernicus into its MFF, yet indicated that it was willing to only spend about €3.786 billion (in 2011 prices) on the programme over the seven-year period, €2 billion less than originally proposed.[270] In July 2013, the 34.4% budget cut was approved by the European Parliament, meaning that replacement satellites likely will not be built in time to take over for the Sentinel satellites, if they are to have seven-year life spans.[271] In coordinating the evolution of the Copernicus Space Component, ESA has prepared a long-term plan for the content and associated funding needs, covering the operation of the Sentinels up to 2020, and the procurement of recurrent Sentinel satellites and instruments and access to data available from contributing missions up to 2028.[272] The first Sentinel-1A was launched on 3 April 2014; with Sentinel-1B to follow in 2016.[273]

In the development of the EU's FP8 programme, later renamed Horizon 2020, other space programmes were also detrimentally affected – albeit not to the same scale as Copernicus. By February 2013, the Galileo flagship GNSS programme faced a 10% reduction in funding, in addition to a scaled-back space research package in Horizon 2020. Where previously, Galileo's system had been allocated €7 billion over the 7-year period, the Commission allocated €6.3 billion to the programme, or €900 million each year.[274] On 22 November 2013, the European Parliament in its plenary approved the Galileo's programme's 7-year €6.3 billion budget at 2011 prices.[275]

Galileo had its first milestone launch for the Galileo GNSS on 21 October 2011, when two Galileo satellites were placed in orbit on the inaugural flight of the European version of the Soyuz rocket, launched from the European spaceport in French Guiana. The successful launch signified the opening of the system's operational deployment phase, with the scheduled launch of fourteen satellites out of a total of thirty required to achieve full operational capability. A further eight spacecraft were ordered on 2 February 2012.[276] Two more Galileo spacecraft were launched on 12 October 2012, meeting the requisite minimum number of 4 Galileo spacecraft in orbit needed to fix a position in three dimensions.

[270] De Selding, Peter. "For Europe's Embattled GMES, Good and Bad News." 7 Dec. 2012. SpaceNews 25 Apr. 2014 <http://spacenews.com/article/civil-space/32717for-europe%E2%80%99s-embattled-gmes-good-and-bad-news>.

[271] Cf. De Selding, Peter. "Copernicus Backers Worry EU Cuts Will Discourage Investment." 8 Feb. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/33564copernicus-backers-worry-eu-cuts-will-discourage-investment>.

[272] "Green Light for GMES Copernicus." 4 July 2013. ESA 28 Apr. 2014 <http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Green_light_for_GMES_Copernicus>.

[273] "What is Sentinel – 1?." ESA 30 May 2014 <https://earth.esa.int/web/guest/missions/esa-future-missions/sentinel-1>.

[274] De Selding, Peter. "Space Programs Facing Cuts in Seven-year EU Budget." 1 Feb. 2013. SpaceNews 25 Apr. 2014 <http://spacenews.com/article/space-programs-facing-cuts-in-seven-year-eu-budget>.

[275] Pepper, George. "Galileo Funding: A 'Small' Difference of €700 Million." 22 Nov. 2013. The European Sting 25 Apr. 2014 <http://europeansting.com/2013/11/22/galileo-funding-a-small-difference-of-e700-million/>.

[276] De Selding, Peter "Galileo on Firmer Ground with New Satellite, Launch Deals." 2 Feb. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/galileo-firmer-ground-new-satellite-launch-deals>.

5. The Defence Perspective

This chapter considers key developments regarding the field of military space activities. These developments include military space government programmes and related spending, the industrial achievements in military space technologies and the evolution of space security doctrines of all the major space-faring nations. Given the confidential nature of military space spending, calculating the exact volume and nature these activities is difficult as the analysis is based only on open sources. Consequently, the facts and figures presented must be considered as incomplete in assessing the full range of military space programmes and should be treated accordingly. For these reasons, the following figures are conservative estimates and it is very likely that actual military space budgets far exceed the amounts that are reported. This is particularly the case with Russian and Chinese programmes that are often classified. With these factors in mind, readers can take from this chapter a relative assessment of global military space activities as per key space faring states, along with an overall estimate of the general trends in this field.

5.1 Trends in Military Expenditure

Space-related military spending saw an increase in most countries (not including the US), with total military spending estimated to have grown from $27.85 billion in 2011, to $36.2 billion in 2012, however, reduced spending by the US decreased overall amounts to $31.9 billion in 2013.[277] Euroconsult reported a similar outcome, estimating world government expenditures for defence space programs growing from $31.57 billion in 2011 to $31.69 billion in 2012, although that total decreased to $28.43 in 2013. Due to the nature of dual-use technology in space activity, there is a risk that certain military activity has been already included in larger budgets, which can result in double counting. Moreover, while missions, often listed as civil programmes, may also serve dual-purpose military objectives, their expenditure is not included in this section. The Space Report lists United States military spending in 2012 to have been $27.47 billion, a slight increase from the previous year, with changes in military space spending prioritizing the development of new capabilities. As anticipated, space spending in the US decreased significantly in 2013, with military spending reaching $21.72 billion.[278] This figure takes into account the space portion of the US Department of Defence budget (which includes the budgets of the National Reconnaissance Office (NRO), and the National Geospatial-Intelligence Agency (NGA)). However, Euroconsult noted significant expenditure reductions in US defence space programmes for the whole period 2011-2013, from $24.13 billion in 2011 to $23.06 billion in 2012, and $18.93 billion in 2013.[279] While there is a significant discrepancy between the two authorities, it is likely due to the availability of information at their times of publication as well as the different programmes considered. However, no matter how one looks at it there is clearly a trend towards decreasing military space spending in the US.

The Space Report 2014 estimated the US to account for about 68% of global military space spending in 2013, less than the 75.9% it estimated for 2012, and much less than the 95% estimate of global military space spending in 2011. In contrast, non-US global military spending grew to 24.1% in 2012, and 32% in 2013.[280] However, the Euroconsult report is more conservative in this area, estimating US defence expenditure to be $23.06 billion, i.e. 72.8% of the world total in 2012, and $18.93 billion, i.e. an even further diminished 66.6% in 2013.[281] Russia, China, and Japan were next in line in military space spending, with 2012 defence spending estimates of $3.99 billion, $1.41 billion, and $1.15 billion respectively, while 2013 esti-

[277] See: The Space Report 2013. Colorado Springs: The Space Foundation, 2013: 40, and The Space Report 2014. Colorado Springs: The Space Foundation, 2014: 40.

[278] The Space Report 2014. Colorado Springs: The Space Foundation, 2014: 40.

[279] Euroconsult 2014. Profiles of Government Space Programs: 12.

[280] The Space Report 2014. Colorado Springs: The Space Foundation, 2014: 40, The Space Report 2013. Colorado Springs: The Space Foundation, 2013: 40, and The Space Report 2012, 58.

[281] Euroconsult 2014. Profiles of Government Space Programs: 14.

mates increased to $4.58 billion, $1.67 billion, and $1.31 billion.[282] However, due to fluctuating exchange rates, variations in purchasing power, and different employment costs, a direct comparison of the budgets of these countries in fixed dollar values does not present a clear picture of their relative space defence efforts.

5.2 Europe

EU Member States continue to set the level of spending on military space programmes. Military space programmes are undertaken by all major European space faring nations, with an even larger number of European countries participating on the basis of bilateral or multilateral agreements and arrangements. While total European space defence spending dipped in 2012 to $1.04 billion from $1.21 billion in 2011, it returned to its 2011 level in 2013 with $1.21 billion in funding. This fluctuation came from a change in funding from the region's largest space defence players. Since 2011, France has sharply reduced its budget from $743 million to $558 million in 2012, followed by another reduction to $492 million in 2013; on the other hand, Germany's budget is estimated to have shifted from $69 million in 2011, to $63 million in 2012, and to $219 million in 2013. And while Italy's budget grew from $90 million in 2011, to $100 million in 2012, and $190 million in 2013, the UK's budget advanced from $235 million in 2011 to remain at $239 million in the next two years. The other military space budgets in Europe remained relatively unchanged from the previously recorded military space budgets.[283] This indicates that states may be increasing their cooperation to reduce redundant expenditure on military security. Outsourcing services and reducing public budget costs through PPPs have been established as an efficient alternative to individual government spending on Earth observation and dedicated military satcom services. Through cooperation and innovative funding schemes, European governments will be able to maintain current levels of security at less expense to tax payers.

In an effort to reduce expenditure, on 19 June 2013 the European Defence Agency (EDA) said it was in favour of replacing current separate British, French, German, Italian and Spanish military telecommunications satellites with a consolidated network owned by multiple nations. Britain, France, Italy, Spain and Germany have developed five individual military satellite communications networks, at a cost of between €6-€8 billion ($7.77 and $10.36 billion), although these governments could significantly benefit from the shared use of a single next-generation military satellite communication system, enabling cost savings of more than €1 billion ($1.3 billion) while still retaining much of their autonomy.[284] Sovereignty issues and national industrial policy interests are the initial hurdles to overcome in this endeavour. In April 2013, the EDA approved an effort called Secure Telecom by Satellite (SecTelSat), which invites EDA and other EU members to list their requirements for next-generation satellite systems. Under SecTelSat, a core group of nations would be contracted to develop the satellites and then lease portions of their capacity to other EU member states.[285] By the end of 2013, many EU members had stated their disapproval of the idea of pooling Europe's separate military satellite communications systems into a single constellation. Instead, on 19 and 25 November 2013, EU ministers adopted a set of recommendations from the EDA that left core command-and-control functions to individual governments buying their own hardened and encrypted satellite systems, while less-strategic satellite requirements would be merged into a pan-European system.[286]

On 2 July 2013, Germany's OHB AG announced its €816 million ($1.1 billion) contract with the German defence procurement agency, BAAINBw, to develop the three-satellite SARah radar reconnaissance system; the system is expected to be operational in late 2019. SARah's ground segment will be operational in 2016, allowing the currently operating SAR-Lupe satellites to make use of the ground services prior to transitioning to SARah. OHB's SAR-Lupe satellites, operating since 2008, are under contract with the German military to run until November 2017.[287]

[282] Ibid.
[283] Ibid.

[284] De Selding, Peter. "Five European Nations Agree to Pool Resources for Satellite Bandwidth Buys." Space News 5 Dec. 2011: 5.
[285] De Selding, Peter. "Military Satellite Communications | Europe Faces Obstacles in Pooling Military Satellite Telecom Resources." 19 June 2013. SpaceNews 5 May 2014 <http://spacenews.com/article/military-space/35877military-satellite-communications-europe-faces-obstacles-in-pooling>.
[286] De Selding, Peter. "EU Backing Away from Combining Milcom Constellations." 26 Nov. 2013. SpaceNews 5 May 2014 <http://spacenews.com/article/military-space/38368eu-backing-away-from-combining-milcom-constellations>.
[287] De Selding, Peter. "OHB Signs Contract for Germany's Next-gen Radar Satellites." 2 July 2013. SpaceNews 6 May 2014 <http://spacenews.com/article/military-space/36091ohb-signs-contract-for-germany%E2%80%99s-next-gen-radar-satellites>.

France also had plans to enhance its military capabilities, issuing its seven-year military program proposal on 2 August 2013, which emphasized a three-satellite 'Ceres' constellation, that would fly in formation conducting operational electronic intelligence as a top priority. The system, expected to be operational in 2020, would replace France's current French-Italian Syracuse military telecommunications satellite system. Even with the success of Syracuse, to France military satellite telecommunications is preferably a "sovereign" undertaking, hence cooperation with Italy and Britain on a common milsatcom effort is a slow process, as could be expected. Even so, France had made some progress with Italy by mid-summer 2013.[288] The Defence Ministries of both France and Italy will have separate telecommunications payloads on the Sicral 2 satellite, being constructed by Thales Alenia Space, which is scheduled for launch in 2014. Both countries' military and civil space authorities also share the cost of the upcoming Athena-Fidus broadband satellite, which is expected to carry an extremely high frequency/Ka-band payload for Italy and a Ka-band payload; also to be launched in 2014.[289]

5.3 The United States

While exceeding the combined military space budgets of the world by a large, yet receding margin, the US defence-related space budget dropped by 13.6% in 2013 due to budgetary pressures on spending. Whereas the US spent an estimated $26.46 billion in 2011, its budget increased to $27.47 billion in 2012 but then dropped substantially in 2013 to $21.72 billion.[290] In this subsection the focus will be on US DoD programmes as listed by the Space Report 2014, allowing readers to distinguish purely DoD expenditures with greater clarity than can be gleaned from other space faring nations.

The US military space budget increased by $1.01 billion in 2012, followed by a steep reduction of $5.76 billion in 2013. While the US military space budget more than doubles any other country's budget, a difference of 20.9% (not including adjustments for inflation) is likely to have a substantial effect on US military programmes. The US Air Force (USAF) terminated the Defense Weather Satellite System (DWSS) on 16 April 2012[291], while plans for a second Space-Based Space Surveillance satellite, designed to detect debris, spacecraft or distant space objects without interference related to weather, atmosphere or the time of day were absent from budget requests.[292] The budget for the US Missile Defense Agency (MDA) was expected to decrease by 8% between 2012 and 2013, from $8.42 billion to $7.75 billion.[293] Moreover, in April 2013 the MDA's Precision Tracking Space System (PTSS), a satellite constellation capable of tracking ballistic missiles during the midcourse portion of flight, was officially cancelled in the 2014 budget request.[294]

The USAF has shown great interest in placing military payloads aboard commercial satellites as a low-cost way of fielding new capabilities. However, it has held back in committing to their use until Congress starts to fully integrate hosted payloads into its future planning. Indeed, following 27 months in orbit, on 6 December 2013, the USAF announced it would decommission its experimental Commercially Hosted Infrared Payload (CHIRP) mission hosted by SES's SES-2 commercial satellite, due to reductions in US federal budget spending. Yet it should be noted that the mission had already been extended three times to include additional wide field-of-view staring demonstrations, and had originally been planned to complete its one-year mission in July 2012.[295] Moreover, the USAF has requested proposals for the Hosted Payload Solutions (HoPS) contracting vehicle which is designed to standardize the proc-

[288] De Selding, Peter. "Ceres Satellites are a High Priority in French Defense Ministry's 7-year Plan." 2 Aug. 2013. SpaceNews 6 May 2014 <http://spacenews.com/article/military-space/36597ceres-satellites-are-a-high-priority-in-french-defense-ministrys-7-year>.

[289] De Selding, Peter. "Italian Military Buys $100M Spy Satellite from Israel in Exchange Deal." 6 July 2012. SpaceNews 6 May 2014 <http://spacenews.com/article/italian-military-buys-100m-spy-satellite-israel-exchange-deal>.

[290] Cf. The Space Report 2012…:44 & The Space Report 2011, 43.

[291] "Defense Weather Satellite System Termination." 26 Apr. 2012. SpaceRef 22 May 2014 <http://www.spaceref.com/news/viewpr.html?pid=36846>.

[292] Ledbetter III, Titus. "U.S. Military Space Spending To Decline 22 Percent in 2013." 13 Feb. 2012. Space News 12 May 2012 <http://www.spacenews.com/military/120213-mil-space-spending-decline.html>.

[293] Ledbetter III, Titus. "Missile Defense Agency Seeks Big Increase in Space Spending." 14 Feb. 2012. Space News 12 May 2012 <http://www.spacenews.com/military/120214-mda-seeks-increase-spending.html>.

[294] SpaceNews Staff. "PTSS Canceled Before Analysis Of Alternatives, Report Says." 29 July 2013. SpaceNews 7 May 2014 <http://spacenews.com/article/military-space/36503ptss-canceled-before-analysis-of-alternatives-report-says>.

[295] Gruss, Mike. "U.S. Air Force Decision To End CHIRP Mission Was Budget Driven." 12 Dec. 2013. SpaceNews 7 May 2014 <http://spacenews.com/article/military-space/38628us-air-force-decision-to-end-chirp-mission-was-budget-driven>.

esses for placing dedicated military capabilities aboard commercial satellites. Experts on the topic highlight the potential in using hosted payload solutions for applications such as missile warning or weather monitoring.[296]

By the end of May 2014, the USAF was close to awarding a contract for its next-generation space-object tracking system to either Lockheed Martin Corp. or Raytheon Corp.[297] This 'space fence' is a system of ground-based radars with enhanced ability to track greater numbers of smaller objects than the currently operating Air Force Space Surveillance System. The current system was slated to be shut down in September 2013, to save $14 million annually, while not compromising overall space surveillance capabilities; it being one component of the overall US Space Surveillance Network, which includes other ground and space based sensor assets. The new multibillion-dollar project had been delayed due to a Pentagon review of its major acquisition programs.[298]

Back in 2009, the Obama Administration cancelled plans to deploy a missile defence system in Europe in favour of a European Phased Adaptive Approach (EPAA) built around the Aegis Ballistic Missile Defence system. This system is being developed in stages, with the first phase having involved the deployment of Naval Aegis ships, carrying SM-3 Block 2A interceptors, in European waters beginning operation in 2011.[299] The second phase, having passed its critical design review in mid-October 2013, will place a land-based variant of the Aegis system and SM-3 Block 2A interceptors in Romania by 2015, with full capability expected by 2018.[300] The third phase, located in Poland, will replace the current interceptor with the next-generation Aegis SM-3 Block 2B interceptor beginning in 2018, and should be capable of targeting larger intercontinental ballistic threats.[301] Raytheon Missile Systems is under contract to build 22 Block 2A interceptors for developmental testing.[302]

On 27 November 2012, the US DoD authorized the USAF to purchase up to 50 rocket cores during the next five years under its Evolved Expendable Launch Vehicle (EELV) programme. While 14 cores will be procured competitively, with the first of these competitive awards expected in 2015 for a mission launching in 2017, the other 36 will be procured from the DoD's traditional prime contractor United Launch Alliance (ULA) on a sole-source basis. The ULA is a joint venture between Boeing and Lockheed Martin, utilizing their respective Delta 4 and Atlas 5 rockets to launch both defence and scientific payloads for the US.[303] In 2012, the DoD had 9 launches, 4 carrying classified National Reconnaissance Office payloads while the other 5 carried DoD or DoD-sponsored payloads including the launch of the X-37B[304]; in 2013, the DoD had 8 launches, carrying 2 classified NRO payloads, in addition to 6 DoD-sponsored payloads.[305]

5.4 Russia

Russia has a long tradition of military space activity; however, its current activity must be assessed in its current day context. Maintaining a reputation in the military space field may be in Russia's interest in a geopolitical sense, yet it should be borne in mind that Russia's reported military space budget makes up only a part of the total $8-10 billion spent by all countries in the world, excluding the US, while the US alone spent

[296] Gruss, Mike. "Industry Officials Call for Dedicated U.S. Air Force Funding for Hosted Payloads." 14 Oct. 2013. SpaceNews 7 May 2014 <http://spacenews.com/article/military-space/37704industry-officials-call-for-dedicated-us-air-force-funding-for-hosted>.

[297] "U.S. Air Force sees Space Fence choice soon: Lockheed or Raytheon." 21 May 2014. WN.com 30 May 2014 <http://article.wn.com/view/2014/05/21/US_Air_Force_sees_Space_Fence_choice_soon_Lockheed_or_Raythe/>.

[298] Gruss, Mike. "U.S. Air Force Sets March 2014 Target for Space Fence Award." 21 Aug. 2013. SpaceNews 7 May 2014 <http://spacenews.com/article/military-space/36887us-air-force-sets-march-2014-target-for-space-fence-award>.

[299] Ferster, Warren. "Military Space Quarterly | GAO Says European Missile Shield Faces Operational, Budgeting Issues." 28 Apr. 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/military-space/40373military-space-quarterly-gao-says-european-missile-shield-faces>.

[300] SpaceNews Staff. "GAO Dings Pentagon for Missile Defense Report." 31 Mar. 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/military-space/40049gao-dings-pentagon-for-missile-defense-report>.

[301] Ferster, Warren. "Military Space Quarterly | GAO Says European Missile Shield Faces Operational, Budgeting Issues." 28 Apr. 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/military-space/40373military-space-quarterly-gao-says-european-missile-shield-faces>.

[302] Gruss, Mike. "Military Quarterly | SM-3 Block 2A Passes Critical Design Review, Set for Flight Testing in 2015." 31 Oct. 2013. SpaceNews 7 May 2014 <http://spacenews.com/article/military-space/37944military-quarterly-sm-3-block-2a-passes-critical-design-review-set-for>.

[303] Leone, Dan. "Pentagon Approves EELV Block Buy, with Competitive Twist." 4 Dec. 2012. SpaceNews 15 May 2014 http://www.spacenews.com/article/military-space/32657pentagon-approves-eelv-block-buy-with-competitive-twist.

[304] Commercial Space Transportation: 2012 Year in Review, 11.

[305] Commercial Space Transportation: 2013 Year in Review, 7.

$21-27 billion. The Euroconsult Report 2014 is unclear as to the total amount Russia puts towards its military program, but reports that it should have been at least $3.99 billion in 2012, and $4.58 billion in 2013 (including dual-use programmes).[306] In 2012, Russia launched one optical reconnaissance satellite meant for intelligence, the Cosmos 2480, and launched its Cosmos Persona intelligence gathering satellite in 2013.

On 30 March 2012, Russia launched its last Oko-series missile early warning satellite, labelled Cosmos 2479.[307] The satellite is designed to detect missile launches using an infrared telescope that senses infra-red radiation emitted by the exhaust of the rocket engines; it is part of an 8-satellite constellation – the first of the series was launched in 1991.[308] Russia reportedly operates between 60 to 70 military satellites, and plans to launch at least 100 additional military satellites in the next decade.[309] These satellites are meant to boost the country's reconnaissance and ballistic missile detection capabilities, the influx also benefitting the military's navigation and imaging capability.

In April 2013, Russia's military ordered 5 high-resolution optical-electronic surveillance satellites worth almost 70 billion roubles ($2.2 billion). Russia's Lavochkin aerospace company won the contract to design and build the satellites, but the electronic payload will be initially acquired either from Airbus Defence & Space, Thales Alenia Space, or Israel Aerospace Industries. The company intends to gradually increase the share of domestically produced electronic equipment in the payload, with the goal of eventually building several of the series on its own.[310]

Russia plans to launch additional military spacecraft in March 2014, following several years of delay due to technical reasons. In addition to the reform being conducted in Russia's launch and satellite sectors, it plans to qualitatively increase its space military forces to improve its strategic nuclear missiles and for capacity building for precision-guided conventional arms. In addition to improving its satellite technology, Russian will begin construction of terrestrial infrastructures to support these systems, with preliminary cost estimates reaching several trillion roubles up to 2020.[311]

Near the end of 2013, Russia's interest in placing Glonass navigation satellite ground stations in the US again came to light. The proposal was met with strong opposition from conservative lawmakers in the US, with some congressional Republicans proposing a legislative ban on any foreign satellite navigation facilities on US soil. Their concerns were based on the potential for the ground stations to be used for spying and improving the accuracy of Russian missiles.[312] On 26 December 2013, President Obama signed into law the US defense budget bill which contains a measure that effectively bars Russia from building about a half-dozen ground stations on US soil. With the new law, unless waived altogether on national security grounds, Congress would need certification from both the Secretary of Defense and the Director of National Intelligence that the ground stations would not be used to spy on the United States or improve the effectiveness of Russian weaponry; without that, Russian ground stations are barred.[313]

5.5 Japan

The Euroconsult report lists Japan's space defence budget at $1.15 billion in 2012 and $1.31 billion in 2013 (including dual-use systems), with 18% of the 2013 budget directed toward satcom, about 47% toward Earth observation, and about 30% toward space security (i.e. mostly missile defence).[314] As a leading space faring country with broadly developed space capabilities, Japan has begun to refocus its efforts from its traditional multilateral "peaceful-use-only" position in space activities to the space security and

[306] Cf. Euroconsult Report 2014, 5.
[307] Clark, Stephan. "Russian early warning satellite orbited by Proton." 30 Mar. 2012. Spaceflight Now 12 May 2012 <http://www.spaceflightnow.com/news/n1203/30proton/>.
[308] Graham, William. "Russian Proton-K completes 45 years of service with US-KMO satellite launch." 29 Mar. 2012. NASA Spaceflight.com 12 May 2012 <http://www.nasaspaceflight.com/2012/03/russian-proton-k-rocket-launch-us-kmo/>.
[309] "Russian Military Orders Missile Early Warning Satellites." 25 Apr. 2012. Defence Talk 12 May 2012 <http://www.defencetalk.com/russian-military-orders-missile-early-warning-satellites-41939/>.
[310] "Russian Military Orders Five High-Res Spy Satellites – Media." 10 Apr. 2013. RIA NOVOSTI 14 May 2014 http://en.ria.ru/military_news/20130410/180548366/Russian-Military-Orders-Five-High-Res-Spy-Satellites--Media.html.
[311] Kislyakov, Andrei. "Russia's Military Looks to Outer Space." 6 Dec. 2013. Russia Beyond the Headlines 14 May 2014 <http://rbth.com/science_and_tech/2013/12/06/russias_military_looks_to_outer_space_32341.html>.
[312] Gruss, Mike. "Lawmakers Flag Proposal for U.S.-based Glonass Ground Stations." 25 Nov. 2013. SpaceNews 14 May 2014 <http://spacenews.com/article/military-space/38340lawmakers-flag-proposal-for-us-based-glonass-ground-stations>.
[313] Schmitt, Eric. "New Law All but Bars Russian GPS Sites in U.S." 28 Dec. 2013. The New York Times 14 May 2014 <http://www.nytimes.com/2013/12/29/world/europe/new-law-all-but-bars-russian-gps-sites-in-us.html>.
[314] Cf. Profiles of Government Space Programs. Paris: Euroconsult, 2014: 46-3.

defence areas. In the wake of several significant regional and international security events in recent years, Japan's space priorities have adapted to a more active role in the field of national security through the use of space technologies. A leader in multilateral diplomacy, it has increased even more its cooperation with multilateral organizations, as well as with its allies in building common space capabilities. Since 2011, Japan has become acutely sensitive to the challenges stemming from its region both in geopolitical terms and in terms of natural disasters. Hence, Japan has increased its focus on security; the results of which are new agreements, budget reshuffling and accelerated project completion times.

In 2008, Japan changed its basic law to allow active involvement in military space, whilst still respecting that this must be for peaceful purposes. Japan's 2009 5 year Basic Space Plan should also be mentioned in this context, as it calls for strengthening security through the utilisation of space. The plan recommended ¥2.5 trillion ($26 billion) in financing for civil and military space development activities between 2010 and 2014. In October 2011, Japan's Ministry of Defence requested an additional ¥260 billion in funding for military-purpose space programs in 2012. The 2011 space budget of the Ministry of Defence was reduced by 32.2% amounting to ¥41.3 billion, from ¥60.933 billion in 2010.[315]

In December 2010, Japan released a 10-year strategy document called the National Defence Program Guideline.[316] It calls for the strengthening of development efforts and the use of outer space in the field of information gathering, communications, disaster management and arms proliferation control. One of the main reasons why Japan decided to strengthen its position in space defence and security is constant security uncertainties from the Korean peninsula and East Asia military and space ambitions. On 12 December 2011, it successfully launched its next instalment of the much-delayed Information Gathering Satellite (IGS) system, consisting of two satellites with optical sensors and radar monitoring.[317] A long time in development (IGS was initiated following an August 1998 North Korean missile test that overflew Japan), with the launch of the IGS-Radar 4 spacecraft on 27 January 2013, Japan now has two functional radar satellites and an experimental optical satellite in orbit for disaster monitoring and national security purposes.[318] The IGS-Radar 4 carries a SAR that enables the satellite to peer through clouds and observe targets at night. Japan plans to replenish its surveillance constellation, with the launch of an optical satellite and a radar satellite in 2014, another optical satellite and a radar satellite in 2016 and a radar satellite in 2017.[319]

In October 2013, the governments of the US and Japan pledged to build on previous arrangements for the sharing of space situational awareness (SSA) information. In the following months, the countries had bilateral exchanges to discuss the topic, which resulted in the 3 October 2013 US-Japan SSA Sharing Agreement, calling on the two governments to deliver SSA data to one another expeditiously.[320]

5.6 China

China's space defence budget is estimated to have increased by 17.6% from $1.20 billion in 2011 to $1.41 billion in 2012, followed by another increase of 18.6% to $1.67 billion in 2013.[321]

The manner in which China develops its technical capabilities and the depth of its military interest in the space program merits analysis. It seems to be clear that Chinese space efforts are intimately connected to the Chinese army, principally because many space activities are under the direct control of the People's Liberation Army (PLA); moreover, all Chinese space operation facilities are entirely manned and operated by the PLA. In the case of manned space activities, all development and plans are directly under the control of the Chinese military and political bureau.

[315] Cf. The Space Report 2012, 55 & The Space Report 2011, 52.
[316] "National Defense Program Guidelines for FY 2011 and Beyond." Japan Ministry of Defense 11 May 2012 <http://www.mod.go.jp/e/d_act/d_policy/pdf/guidelinesFY2011.pdf>.
[317] Kallender-Umezu, Paul. "Japan Launches IGS Radar Reconnaissance Satellite". 13 Dec. 2011. Space News 8 May 2012 <http://www.spacenews.com/launch/121311-japanlaunches-latest-radar-reconnaissance-satellite.html>.
[318] Kallender-Umezu, Paul. "Japan Stays the Course on IGS under Latest Five-year Plan." 18 Feb. 2013. SpaceNews 30 Apr. 2014 <http://www.spacenews.com/article/japan-stays-the-course-on-igs-under-latest-five-year-plan>.
[319] Kallendar-Umezu, Paul. "With Launch, Japan Begins Rebuilding IGS Spy Satellite Network." 29 Jan. 2013. SpaceNews 8 May 2014 <http://spacenews.com/article/military-space/33391with-launch-japan-begins-rebuilding-igs-spy-satellite-network>.
[320] De Selding, Peter. "U.S., Japan Pledge Closer Cooperation on Space Surveillance." 4 Oct. 2013. SpaceNews 8 May 2014 <http://spacenews.com/article/military-space/37551us-japan-pledge-closer-cooperation-on-space-surveillance>.
[321] Profiles of Government Space Programs. Paris: Euroconsult, 2014: 14.

Analysis of China's space defence prospective is very difficult due to a dearth of unclassified sources. In May 2013, the US DoD presented its Annual Report to Congress on 'Military and Security Developments Involving the People's Republic of China 2013', confirming that China's growing space prowess shows no signs of slowing down. The report highlights China's interest in improving its capabilities "to limit or prevent the use of space-based assets by adversaries during times of crisis or conflict".[322] Having conducted a total of 19 space launches in 2012, and 15 in 2013, the country has expanded its space-based intelligence, surveillance, reconnaissance, navigation, meteorological, and communications satellite constellations. It should be noted that among other developments and trends mentioned, the report says some PLA writings emphasize the necessity of' using anti-satellite weapons to 'blind and deafen the enemy'.

However, the same report sparked protest from China's Defence Ministry, which had been strongly dissatisfied about the manner in which China's space programme had been cast. To respond to the report's statements over China's moves to assert its sovereignty in the neighbourhood and the questioning of the direction of China's defence policies, a spokesman for China's Defence Ministry said that "China's military build-up, meeting the country's needs of upholding sovereignty, security and territorial integrity, is part of the country's justified rights and does not target any specific country".[323] Also highlighted was the United States' heavy investment in developing state-of-the-art weapons and building up cyber-attack troops in recent years.

Within weeks of China's protest of the US DoD's 'Report', some news outlets reported that China had conducted a land-based mid-course missile interception test on 27 January 2013. While unconfirmed by Chinese authorities, if substantiated, this would be the second time that China conducted such a test; the country had successfully attempted a similar anti-missile test back in January 2007. These reports have led some US authorities to infer that Chinese policy makers are pursuing significant ballistic missile defence (BMD) capabilities. However, it should be noted that China's test was conducted just hours after the US had tested its own missile interceptor.[324] While Chinese authorities said that they had conducted a test of a sounding rocket, US authorities viewed it as a disguised missile test, pointing to similarities to the January 2007 ASAT test.[325]

According to China's 11th Five Year Plan, space activities are considered as one of China's major military advances. It suggests that development of certain technological areas, including space related capabilities, will play an important role in the army's modernisation efforts.[326]

Regarding space debris mitigation, following the 20 July 2013 launch of Chuangxin-3, Shiyan-7, and Shijian-15 on its Long March 4C launcher, the three spacecraft were observed conducting worrying manoeuvres, such as changing orbits and closing in on a separate satellite, the Shijian-7 (in orbit since 2005). While the mission was announced to be meant for "space debris observation", "mechanical arm operations" and the testing of "space maintenance technologies", its dual-use potential had the US alarmed that it could also be used for anti-satellite purposes.[327]

5.7 India

India is developing its own space military programme; however, the majority of the activities of the Indian Space Research Organization (ISRO) still focus on civil applications. Following China's ASAT test, defence scientists in India began focusing on "space security" to protect India's $12 billion (Rs 60,000 crore) space infrastructure from electronic or physical destruction.

On 30 August 2013, India launched its first solely military communications satellite, GSAT-7 aboard the Ariane 5 launcher from the Kourou spaceport in French Guiana. The

[322] David, Leonard. "China Space Program Ramping Up Capabilities, Pentagon Says." 21 May 2013. Space.com 13 May 2013 <http://www.space.com/21251-china-space-capabilities-pentagon-report.html>.

[323] "China Protests Against US Report on its Military." 8 May 2013. The Economic Times 13 May 2014 <http://articles.economictimes.indiatimes.com/2013-05-08/news/39116773_1_pentagon-report-geng-yansheng-china>.

[324] Kazianis, Harry. "China Conducts Anti-Missile Test." 29 Jan. 2013. The Diplomat 13 May 2014 <http://thediplomat.com/2013/01/china-conducts-anti-missile-test/>.

[325] Gertz, Bill. "China Conducts Test of New Anti-Satellite Missile." 14 May 2013. The Washington Free Beacon 21 May 2014 <http://freebeacon.com/national-security/china-conducts-test-of-new-anti-satellite-missile/>.

[326] Cheng, Dean. "China's Space Program in the National Security Context." 18 Jan. 2012. The Heritage foundation 10 May 2012 <http://www.heritage.org/research/reports/2012/01/us-needs-to-meet-chinas-space-challenge-of-the-next-5-years>.

[327] David, Leonard. "Mysterious actions of satellites have experts guessing China's intentions." 10 Sept. 2013. NBCnews 21 May 2014 <http://www.nbcnews.com/science/space/mysterious-actions-satellites-have-experts-guessing-chinas-intentions-f8C11122565>.

satellite is unique for India, due to its strategic character in providing a dedicated system for use by the Indian navy. In fact, the GSAT-7 had been ready for launch since 2010, but ISRO lacked a fully reliable GSLV platform to launch the spacecraft. To avoid further delay, India turned to Arianespace to carry the GSAT-7 along with Eutelsat's 'Eutelsat 25B' commercial telecommunications satellite, to GEO orbit. The GSAT-7 will be used by India's navy to monitor activities over both the Arabian Sea and the Bay of Bengal region, with an approximately 3,500- to 4,000-kilometer footprint over the Indian Ocean region.[328]

By 30 November 2013, India's Defence Research Development Organization (DRDO) began planning the first test of its newly developed interceptor missile from a defence base off the Odisha coast early in 2014. India's Prithvi Defence Vehicle (PDV), part of India's Ballistic Missile Defense (BMD) programme, has the potential to destroy incoming missiles with a strike range of around 2,500 km, operating at an altitude beyond 150 km.[329] The BMD programme has also developed a long-range radar system that is able to detect incoming missiles and launch its own counter-projectile.[330]

India's PDV can also be seen as a further step toward developing its own anti-satellite capabilities. In this pursuit, the DRDO is looking at the feasibility of developing such an anti-satellite vehicle by integrating its Angi-3 missile with its PDV. If it succeeds, the anti-satellite missile would have an effective range of about 1400-1500 km, and would advance India's missile capabilities to be on a par with US and China.[331]

Currently, India's DRDO is working on mini-satellites for battlefield use to protect India's main satellites. This planned network of mini-satellites is expected to be capable of seeing a moving target on the ground or at sea anywhere in the world, expanding India's military's intelligence, surveillance and reconnaissance capabilities.[332]

5.8 Iran

In 2009, Iran became the 11th country with space launch capabilities. Its inaugural launch put the Omid satellite (meaning "Hope") into orbit using the Iranian-developed launch vehicle, Safir-2.[333] Since that launch, the state has invested an estimated $100 million per year in its civil space budget; increasing that amount to $120 million from 2011 to 2013.[334] Iran has begun acting on its desires to be a Middle-East space power by 2020.[335] By February 2012, Iran had launched a small Earth-observing satellite into orbit, its third successful launch out of four attempts. This new Iranian satellite has a mass of 50 kg and was built by students at the Sharif University of Technology. Its applications can be used for meteorology, management of natural disasters and measuring the temperature and humidity of air.[336] Iran plans to launch three more indigenously designed and manufactured satellites into orbit by the end of the current Iranian calendar year (20 March 2014).[337]Contrary to international suspicions, the Islamic Republic of Iran maintains that it has no military ambitions for its space program.

However, many Western countries, especially the United States and Israel remain concerned that Iran may be seeking to strengthen its military power.[338] Some experts expect Iran to use dual-use technology

[328] Lele, Ajey. "GSAT-7: India's Strategic Satellite." 9 Sept. 2013. SpaceNews 9 May 2014 <http://www.spacenews.com/article/opinion/37142gsat-7-india%E2%80%99s-strategic-satellite>.

[329] Rout, Hemant Kumar. "DRDO Planning to Test-fire High-altitude 'Killer' Missile in January." 30 Nov. 2013. The New Indian Express 12 May 2014 <http://www.newindianexpress.com/nation/DRDO-Planning-to-Test-fire-High-altitude-Killer-Missile-in-January/2013/11/29/article1917837.ece>.

[330] "India Takes on China." 01 May 2012. Military & Aerospace Electronics 09 May 2012 <http://www.militaryaerospace.com/news/2012/05/01/india-takes-on-china.html>.

[331] "India Contemplates Anti-Satellite Vehicle Integration with Agni-III Ballistic Missile." 15 Oct. 2013. Missile Threat 12 May 2014 <http://missilethreat.com/india-contemplates-anti-satellite-vehicle-integration-with-agni-iii-ballistic-missile/>.

[332] Raghuvanshi, Vivek. "India's Tech Roadmap Points to Small Sats, Space Weapons." 10 Sept. 2013. Defense-News 12 May 2014 <http://www.defensenews.com/article/20130910/DEFREG03/309100007/India-s-Tech-Roadmap-Points-Small-Sats-Space-Weapons>.

[333] "Iran sends first home-built satellite into orbit." 03 Feb. 2009. AFP 10 May 2012 <http://www.spacedaily.com/reports/Iran_sends_first_home-built_satellite_into_orbit_999.html>.

[334] Cf. Euroconsult Report 2014, 8.

[335] Derakhshi, Reza. "Iran unveils missiles and satellites as warning to foes" 07 Feb. 2011. Reuters 10 May 2012 <http://www.reuters.com/article/2011/02/07/us-iran-military-missiles-idUSTRE7162F520110207>.

[336] "Satellite 'Promise of Science, Industry' put on orbit successfully: Defense Min." 03 Feb. 2012. IRNA10 May 2012 <http://irna.ir/News/Politic/Satellite-%E2%80%98Promise-of-Science,-Industry%E2%80%99-put-on-orbit-successfully,-Defense-Min/30795827>.

[337] "Iran to Put 3 satellites into Orbit in 6 Months." 10 Oct. 2013. PressTV 8 May 2014 <http://www.presstv.com/detail/2013/10/10/328683/iran-to-launch-3-satellites-into-space/>.

[338] Brinton, Turner. "Iran's Satellite Launch a Signal of Missile Progress, Analysts Say." 12 Feb. 2012. SPACE.com 10 May 2012 <http://www.space.com/5624-iran-satellite-launch-signal-missile-progress-analysts.html>.

for military build-up purposes, while remaining under the guise of non-military purposes.[339] Iran states it wants to put its own satellites into orbit for civil protection purposes, monitoring natural disasters in the earthquake-prone nation, in addition to improving its telecommunication infrastructure. Iranian officials were quick to point out the United States use of satellites to monitor Afghanistan and Iraq, and said they needed similar capabilities for Iran's security.[340]

Unlike other Islamic countries that operate civilian-purpose satellites, the Iranian Defence Ministry plays a key role with potential contributions from the Islamic Revolution Guards Corps (IRGC). This military element also manages the Shahab ballistic missile program, which is capable of being modified into a space launch vehicle. The enhancement of the Shahab, with satellite-guided navigation, is a big concern for the US and Israel, because this would allow Iran to strike objects with increased precision.[341] Western countries are concerned that long-range ballistic technology used to propel Iranian satellites into orbit might one day be used to launch atomic warheads.

Analysts claim Iran's space goals are probably both scientific and military in purpose, with the added objective of increasing national pride - important to legitimize the current regime's policies and actions.[342]

5.9 North Korea

North Korea returned to the space scene in 2012, with 2 launches of its Unha-3 long-range rocket. Its first launch of the year, occurring on 12 April 2012, was unsuccessful, with the missile disintegrating prior to escaping Earth's atmosphere; both US and Japanese sources said it had fallen into the sea. Prior to the launch, North Korea's Foreign Ministry ignored the UN Security Council's condemnation of the launch of a long-range rocket and reasserted the nation's right to develop its own autonomous civilian space program. Paek Chang Ho, chief of the North Korean command centre, said the launch was for peaceful purposes.[343] He said the Kwangmyongsong-3 satellite, on board the failed launcher was designed to send back images and data that will be used for meteorological and Earth observation purposes.[344] At the time, Western experts assessed that the launch's apparent failure "shows the weakness of the North Korea missile program" and suggested that the threat from North Korea had been "exaggerated." On the other hand, the UN and diplomats warned that Pyongyang would face further isolation if it went ahead. For example, the White House Press Secretary described the failed launch as a threat to regional security, a violation of international law and a breach of its own recent commitments.[345] Shortly after the launch, South Korea convened an emergency security meeting and said that Seoul would continue to closely monitor its neighbour's actions.[346]

At the end of 2012, North Korea had its first successful launch of its Unha rocket lifting North Korea's first payload the Kwangmyongsong-3 Unit-2 satellite into a 498 by 582-Kilometer Sun-Synchronous Orbit on 12 December 2012. The launch again drew condemnation from the US, South Korea and other nations, which viewed such launches to be thinly disguised missile tests. This time, the US White House called the launch a "highly provocative act that threatens regional security," while the UN Secretary-General declared it to be a "clear violation" of a UN resolution sanctioning North Korea.[347] Within hours of the launch, South Korea's navy retrieved of a portion of the Unha-3

[339] Hsu, Jeremy. "Iran's Space Program: Lots of Talk, but a Chance to Shine." 09 Nov. 2011. SPACE.com 10 May 2012 <http://www.space.com/9499-iran-space-program-lots-talk-chance-shine.html>.

[340] "Iran Launches Rocket Capable of Carrying Satellite." 17 Aug. 2008. The Telegraph 10 May 2012 <http://www.telegraph.co.uk/news/worldnews/middleeast/iran/2575063/Iran-launches-rocket-capable-of-carrying-satellite.html>.

[341] Kahn, Gabe. "The Iranian Space Monkey Cometh." 17 June 2011. Israel National News 10 May 2012 <http://www.israelnationalnews.com/News/News.aspx/144990#.T6o56egx_zA>.

[342] Moskowitz, Clara. "Iran Says It Launched New Rocket and Capsule Into Orbit." 17 Mar. 2011. SPACE.com 10 May 2012 <http://www.space.com/11153-iran-launches-rocket-space-capsule.html>.

[343] "North Korea Threatens Retaliation for U.S. Aid Clawback." 17 Apr. 2012. CBCNEWS 10 May 2012 <http://www.cbc.ca/news/world/story/2012/04/17/north-korea-rocket-reaction.html>.

[344] "Japan on Full Alert Ahead of North Korean Launch." 12 Apr. 2012. AdelaideNow 10 May 2012 <http://www.adelaidenow.com.au/news/world/japan-on-full-alert-ahead-of-north-korean-launch/story-e6frea8l-1226324759731>.

[345] Schwarz, Tim. "North Korea Rocket Breaks Up in Flight." 17 Apr. 2012. CNN 10 May 2012 <http://edition.cnn.com/2012/04/12/world/asia/north-korea-launch/index.html>.

[346] McCurry, Justin. "North Korea's Failed Rocket Launch Triggers Indifference in Seoul" 13 Apr. 2012. The Guardian 10 May 2012 <http://www.guardian.co.uk/world/2012/apr/13/north-korea-failed-rocket-launch-reaction>; Young-jin, Kim. "DUP Head Urges NK Against Nuke Test." 05 July 2012. The Korea Times 10 May 2012 <http://www.koreatimes.co.kr/www/news/nation/2012/05/116_110488.html>.

[347] SpaceNews Staff. "Reports: North Korea Successfully Launches Satellite." 12 Dec. 2012. SpaceNews 7 May 2014 <http://spacenews.com/article/reports-north-korea-successfully-launches-satellite>.

rocket's first stage, which will allow South Korea to gain some insight into the North's rocket/missile technology.[348]

In response to the December 2012 launch, on 22 January 2013, the UN Security Council unanimously agreed to tighten sanctions against North Korea by issuing travel bans and asset freezes on Korean individuals and companies involved in the space launch work; making it difficult for North Korea's senior aerospace officials to leave the country, and specifically to attend professional conferences such as the 2013 International Astronautical Congress which took place in September 2013 in Beijing, China. The Security Council froze assets and issued a ban on travel for 4 individuals said to be key to North Korea's rocket launch program; moreover, 6 organizations with alleged ties to the launcher/missile technology had their assets frozen.[349]

On 26 November 2013, US intelligence sources said Iranian missile technicians had secretly visited North Korea over the course of several months as part of joint development of a new rocket booster for long-range missiles or space launchers. US authorities believe the booster is intended for a new long-range missile or space launch vehicle that could be used to carry nuclear warheads, and could be exported to Iran in the future. Moreover, its recent assessments expect both North Korea and Iran to have missiles capable of hitting the United States with a nuclear warhead in the next two years, while presenting these activities as part of space launcher development to avoid international sanctions.[350] On the other hand, other sources say that North Korea is planning six more satellite launch vehicles in the near future, with the Unha 4 and 5 intended to launch Earth observation satellites, 6, 7, and 8 (presumably to launch communications satellites), and the Unha 9 aiming to carry a lunar orbiter.[351] Be it for peaceful for belligerent purposes, the international community may have to accept that North Korea will soon have the technical capability to reach orbit and must consider the consequences of such a development.

[348] "South Korea Retrieves North Korean Unha-3 Rocket Debris." 15 Dec. 2012. Spaceflight 101 8 May 2014 <http://www.spaceflight101.com/unha-3-launch-updates-kwangmyongsong-3-2.html>.

[349] De Selding, Peter. "U.N Security Council Hits North Korea for Satellite Launch." 23 Jan. 2013. SpaceNews 7 May 2014 <http://spacenews.com/article/un-security-council-hits-north-korea-for-satellite-launch>.

[350] Gertz, Bill. "Iran, North Korea Secretly Developing New Long-Range Rocket Booster for ICBMs." 26 Nov. 2013. The Washington Free Beacon 15 May 2014 <http://freebeacon.com/national-security/iran-north-korea-secretly-developing-new-long-range-rocket-booster-for-icbms/>.

[351] Herman, Steve. "More N. Korean Long-Range Rocket Launches Expected 'Soon'." 31 July 2013. Voice of America 24 Apr. 2014 <http://www.voanews.com/content/nkorea-claim-of-more-long-range-rocket-lauches-seen-as-credible/1713495.html>.

6. Space Policies and Strategies around the World

The following chapter presents an overview and analysis of the space policies of all major space-faring countries. Attention is particularly given to high-level policy developments and general trends that reveal the different actor's strategic rationales. Military space and defence related policies were considered in more detail in chapter five.

6.1 European Union

In 2012 and 2013, the European Union continued its efforts to position itself as a leading global actor in space activities. Yet significant challenges remained regarding the future of the European space policy and programmes heralded in the Lisbon treaty, especially from a budgetary point of view. The lasting effects of the economic crisis discussed earlier may have played a significant part in this state of affairs. In general, developments during the reporting periods 2012 and 2013 present a mixed picture and included considerable breakthroughs, despite some funding setbacks.

In February 2013, funding for Horizon 2020, the EU's Research and Innovation programme which includes a large variety of space research efforts, was estimated to be at €1.4 billion over the 7-year period, i.e. €200 million per year.[352] However, as expected by European government and industry officials, by 10 December 2013 the actual amount allocated to space research under Horizon 2020 had fallen short of that estimate for at least 2014 and 2015. Under the Horizon 2020 Work Programme 2014-2015, the 2014 space research budget was €165.75 million, while the 2015 indicative budget was slightly higher at €181.9 million.[353]

Following the mandate in Article 189 of the Treaty on the Functioning of the European Union (TFEU) to establish any appropriate relations with ESA, on 4 April 2011, the European Commission presented a Communication to the Council, and European Parliament entitled 'Towards a Space Strategy for the European Union that Benefits its Citizens' wherein the Commission put forward initial ideas regarding the evolution of relations between EU and ESA.[354] On 14 November 2012, the Commission built on its previous Communication, issuing another one to the Council and the European Parliament on 'Establishing Appropriate Relations between the EU and the European Space Agency'.[355] Therein, it assessed the structural obstacles in current EU/ESA relations, highlighting the mismatch of financial rules, such as the conflict between geographic return in ESA financial procedures and EU Financial Regulation rules that embody the strict principle of 'best value'. It also noted membership asymmetry between the members of the EU and ESA, along with differing voting systems that might give non-EU members disproportionate leverage over matters that may affect the EU. Asymmetry also exists in terms of security and defence matters, due to the ESA membership including states that are not within the EU. Moreover, regarding international issues, there is no formal mechanism at policy level to ensure that initiatives taken within ESA are consistent with EU policies. And finally, it highlights an asymmetry regarding political accountability. Within the Communication, the Commission considered that a clear target date needed to be set between 2020-to-2025, on the evolution of ESA, wherein potential options for consideration might be: improved cooperation under the "status quo"; bringing ESA under the authority of the European Union (similar to

[352] De Selding, Peter. "Space Programs Facing Cuts in Seven-year EU Budget." 1 Feb. 2013. SpaceNews 25 Apr. 2014 <http://spacenews.com/article/space-programs-facing-cuts-in-seven-year-eu-budget>.

[353] Commission of the European Communities. Horizon 2020 – Work Programme 2014-2015. Annex 8. European Commission Decision C(2013)XXX of 10 December 2013. Brussels: European Union <http://ec.europa.eu/enterprise/policies/space/files/research/horizon-2020/h2020-leit-space-work-programme-2014-2015_en.pdf>.

[354] Commission of the European Communities. Towards a Space Strategy for the European Union that Benefits its Citizens. COM(2011) 152 final of 4 April 2011. Brussels: European Union <http://ec.europa.eu/enterprise/policies/space/files/policy/comm_pdf_com_2011_0152_f_communication_en.pdf>.

[355] Commission of the European Communities. Establishing Appropriate Relations between the EU and the European Space Agency. COM(2012) 671 final of 14 November 2012. Brussels: European Union <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0671:FIN:EN:PDF>.

the model of the European Defence Agency); or transforming ESA into an EU agency (following the model of existing regulatory agencies).[356] On 19 February 2013, the EU Competitiveness Council adopted a lighter version of the Commission's proposal, omitting references to security concerns with ESA's non-EU member states, and lightly touching on differences in contract award procedures.[357] On 6 February 2014, the European Commission adopted a progress report on establishing appropriate relations between the European Union and the European Space Agency (ESA)[358]; it was followed by an exchange of views by the Competitiveness Council on 20-21 February 2014.[359] By 26 May 2014, the EU Competitiveness Council decided to delay any decision on future EU relations with ESA until more studies could be provided on their effect on Europe's space industrial base.[360]

6.2 European Space Agency

Throughout 2012 and 2013, the European Space Agency continued its course of transition. With the Ministerial Council meeting successfully completed in Naples, Italy on 20-21 November 2012, the focus shifted to assessing the role of ESA in sustaining competitiveness and growth, in addition to securing the needed level of resources for ESA's mandatory activities between 2013-2017 covering science programmes and basic activities, renewal of ESA Member States contributions to the running costs of the Guiana Space Centre, in French Guiana, and initiating the process for the further evolution of ESA, with the aim of capitalising on ESA's competences and achievements, while taking full benefit of EU policies to ensure the continued success of ESA as the research and development space agency for Europe, Member States and the EU. With Ministers having approved funding for the next budgetary cycle, and having confirmed Europe's commitment to the exploitation of the ISS, the question left for the 2014 Ministerial Council will be the future of Europe's launcher system. In the two years that have followed the 2012 Ministerial Council, detailed definition studies have been underway for the development of a new launcher Ariane 6 and the continuation of the development of Ariane 5 ME, with the goal of developing as many commonalities as possible between the two launchers.

The period of review also witnessed the emergence of trends in ESA policies as a response to the rapidly changing geopolitical and economic conditions of our time. These included strong emphasis on international cooperation, as well as on the use of more flexible and purpose-specific funding mechanisms, capable of maximising investment returns on both the operational and industrial levels.

An example of this trend has been ESA's contribution to the development of public private partnerships (PPPs) in European space programmes. In 2012 and 2013, this mutually beneficial interaction between the public and private sectors continued its expansion on a European, as well as national level. In fact, on a national level, all major space faring countries are continuing to explore this sort of advantage, with the United Kingdom, Germany and France taking the lead. Especially in the United Kingdom, almost two thirds of all European PPPs are anchored.[361] Moreover, ESA has initiated the most important such partnerships on an institutional level, especially through its participation in satellite communications projects. Through its ARTES 33 Partner programme, ESA has provided the satcom industry with an efficient framework to bring innovative products and systems into the marketplace through industry-generated public–private partnerships, having already implemented several PPPs such as Amerhis, Alphasat, SmallGEO, Hylas-1 and EDRS.[362] In this context, ESA has also implemented a PPP-type financial arrangement for the development, launch and in-orbit validation of an electric-propulsion telecommunications satellite in the 3-ton mass range (Electra), offering power consumption and communication capabilities equal to those offered by larger mid-size satellites

[356] Ibid.
[357] De Selding, Peter. "Resolution Underscores Complications in ESA-EU Partnership." 19 Feb. 2013. SpaceNews 25 Apr. 2014 <http://spacenews.com/article/resolution-underscores-complications-in-esa-eu-partnership>.
[358] Commission of the European Communities. Report From The Commission – Progress report on establishing appropriate relations between the EU and the European Space Agency (ESA). COM(2014) 56 final of 6 February 2014. Brussels: European Union <http://ec.europa.eu/DocsRoom/documents/4232/attachments/1/translations/en/renditions/native>.
[359] Council of the European Union. Press Release, 3295th Council meeting, Competitiveness (Internal Market, Industry, Research and Space). 6653/14 of 20-21 February 2014. Brussels: European Union <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/intm/141115.pdf>.
[360] De Selding, Peter. "European Union Delays Decision on ESA Changes." 26 May 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/40685european-union-delays-decision-on-esa-changes>.
[361] De Selding, Peter. "Europe Knocked for Balking at Public-Private Satellite Venture." Space News, 20 June 2011: 7.
[362] "ARTES 33 Partner." 27 May 2013. ESA 15 Apr. 2014 <http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=32274&fareaid=64>.

with a launch mass low enough for small launch vehicles, or increasing the size of the payload staying at the same launch mass to increase competitiveness and economic benefit.[363] With SES acting as Electra's prime contractor for the design phase, and OHB as SES's subcontractor, the first Electra flight is scheduled for 2018.[364]

Contrary to the uncertainty regarding the future of the Ariane launcher, the start of 2012 witnessed the successful development conclusion and inaugural launch of the European Soyuz and Vega rockets. The former is the European version of the Russian launcher, modified for operations from French Guiana. Having undergone improvements in safety, telemetry and tracking systems to qualify the rocket for launch from the European spaceport, in addition to naturally enhancing the launcher's lift capacity due to the spaceport's equatorial geographic location, the launcher's October 2011 inaugural flight carried Europe's first two Galileo satellites to orbit.[365] Prior to its inaugural launch, the rocket's development had met with a three year delay and a 36% budget increase, mainly related to the completion of ground launch infrastructure.[366] Since its inaugural launch, the Europeanised Soyuz conducted a total of 6 launches by year-end 2013.[367] Arianespace's launcher family was completed by the accompaniment of the Italian-made Vega small-satellite launcher, whose maiden flight occurred on 13 February 2012. Its first launch under the Vega Research and Technology Accompaniment (VERTA) programme which aimed to demonstrate the flexibility of the Vega launch system took place on 7 May 2013.[368] By November 2013, 10 more Vega launchers were commissioned, on top of the 5 VERTA demonstration launches ordered in 2010.[369]

On the issue of future international cooperation, especially in the fields of space transportation and exploration, the retirement of the space shuttle in 2011 increased the potential for cooperation between Europe and the United States in terms of access to space vehicles. At the same time, it indirectly increased the value and relevance of ESA's Automated Transfer Vehicle (ATV). The combined use of the ATV and other similar spacecraft from the US (Dragon and Cygnus COTS missions), Japan (HTV) and Russia (Progress M) to serve ISS supply needs could create opportunities in the long term for the creation of common transportation policies among all participating space actors. Due to their technological proximity and operationally complementary nature, these spacecraft could also pave the way for future cooperation on a technology development level.[370] Indeed, on 16 January 2013, ESA agreed to supply NASA with an ATV-derived service module to provide the Orion spacecraft with propulsion, power and thermal control, in addition to water and gas for the astronauts in the Orion module.[371] ESA's provision of ATV-technology for the Orion module is meant to pay for the space agency's 8.3% share of the ISS's annual operating costs for the period 2018-to-2020; estimated at a total cost of €455 million. The use of ESA's 5 ATV cargo supply vehicles has released ESA from paying further dues for the operation of the ISS until 2017.[372]

Another example of the European Space Agency's efforts to position itself at the centre of international cooperation appeared in ESA's collaboration with Russia in the ExoMars space exploration mission. In October 2011, the Russian space agency Roscosmos was invited to participate as a full partner in the US-European endeavour, and to contribute a third of its budget. ESA's decision was partially dictated by a previous NASA budgetary tightening that prohibited it

[363] "Electra." 12 Feb. 2013. ESA 23 Apr. 2014 <http://telecom.esa.int/telecom/www/object/index.cfm?fobjectid=32275>.
[364] De Selding, Peter. "SES Partners with European Space Agency, OHB To Build All-electric Satellite." 15 Oct. 2013. Space News 23 Apr. 2014 <http://www.spacenews.com/article/satellite-telecom/37714ses-partners-with-european-space-agency-ohb-to-build-all-electric>.
[365] De Selding, Peter. "European Soyuz Must Pass Final Exam Before October Debut." Space News 4 July 2011: 5; De Selding, Peter. "Insiders Hard-pressed to Say Why European Soyuz Was Delayed." Space News 4 July 2011: 5.
[366] De Selding, Peter. "European Soyuz Must Pass Final Exam Before October Debut." Space News 4 July 2011: 5; *see also* De Selding, Peter. "Insiders Hard-pressed to Say Why European Soyuz Was Delayed." Space News 4 July 2011: 5.
[367] "Milestones." ESA 24 Apr. 2014 <http://www.arianespace.com/launch-services-soyuz/milestones.asp>.
[368] "VERTA Programme." 20 Nov. 2013. ESA 24 Apr. 2014 <http://www.esa.int/Our_Activities/Launchers/Launch_vehicles/Vega3/VERTA_programme>.
[369] "Stepping Up Vega Launcher Production." 20 Nov. 2013. ESA 24 Apr. 2014 <http://www.esa.int/Our_Activities/Launchers/Stepping_up_Vega_launcher_production>.
[370] Svitak, Amy. "U.S. And Europe Explore Common Space Transportation Needs." Aviation Week & Space Technology 27 June 2011: 41.
[371] "ESA Workhorse to Power NASA's Orion Spacecraft." 16 Jan. 2013. ESA 8 Apr. 2014 <http://www.esa.int/Our_Activities/Human_Spaceflight/Research/ESA_workhorse_to_power_NASA_s_Orion_spacecraft>.
[372] De Selding, Peter. "France is Reducing Its Space Station Contributions." 20 Feb. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/33755france-is-reducing-its-space-station-contributions>.

from committing to the originally set 2016 launch timeframe. Then by mid-2012, ESA's ExoMars project underwent a significant reorganization of support, with Russia's Roscosmos replacing NASA as ESA's main partner in launching the telecommunications orbiter, two landers and a rover to Mars in 2016 and 2018. Subsequently, in March 2013, ESA and Roscomos signed a formal agreement to work in partnership on the ExoMars programme with launches of the two missions planned for January 2016 and May 2018.[373] The ExoMars programme is expected to cost ESA around €1.2 billion; however, ESA has only managed to raise about €850 million – enough to secure funding for the 2016 mission. To secure the rest of the funding needed for the 2018 mission, ESA may need to channel the costs saved in launching its JUICE satellite to Jupiter on a Russian Proton rocket to the ExoMars mission.[374] On 17 October 2013, ESA's Council approved the request to transfer entry fees from ESA's new members, Romania and Poland, to go to ExoMars.[375] Before this decision, the ExoMars Programme had been funded by 14 ESA Member States (Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the UK and Canada), of which Italy is the largest contributor and the UK the second largest.[376] Additional sources of funding that are being considered include: delaying construction on ESA's new headquarters building; soliciting funds from Europe's space science decision-making body; and trying to gain additional funds from ExoMars' current sponsors.[377]

US budgetary tightening took a toll on other cooperation already initiated between ESA and NASA on space science and exploration missions. Following the announcement of the US Planetary Science Decadal Survey, and changes in NASA's budget in 2011, NASA withdrew from the JUICE mission, and would no longer provide the Jupiter Europa Orbiter (JEO) expected to perform flybys by four Jupiter moons prior to orbiting Europa.[378] On the upside, however, budgetary constraints across the Atlantic could further increase the incentive for ESA to engage in international cooperation with various partners in this mission area. At the time of JUICE's selection by ESA's Space Programme Committee (SPC) in May 2012, an agreement had already been established with NASA as a minor payload contributor, and negotiations on an agreement with Russia concerning payload provision for the JUICE spacecraft and the Russian Ganymede lander were in progress.[379] In addition to the JUICE programme, ESA and Roscosmos are exploring an opportunity for European participation in Russia's planned Luna-25 (Luna-Glob lander in 2016), 26 (Luna-Resurs orbiter in 2018) and 27 (Luna-Resurs lander in 2019) missions to the Moon.[380]

Collaboration on the NASA/ESA/CSA James Webb Space Telescope (JWST) remained ongoing, with NASA responsible for the overall management and operations of the JWST mission. NASA will build the spacecraft, the telescope and the platform that will host the instruments, while ESA will provide the launch with an Ariane 5 ECA rocket, and the Near-Infrared spectrograph (NIRSpec) on board instrument.[381] In September 2013, the NIRSpec was completed, taking the JWST a step further to completion, and its scheduled 2018 launch.[382]

China and ESA are also looking to cooperate in developing the expansion of China's manned Tiangong-1 space station, which could host European astronauts in addition to astronauts from China. In exchange for Euro-

[373] "ExoMars 2016 Set to Complete Construction." 17 June 2013. ESA 28 Mar. 2014 <http://exploration.esa.int/mars/51931-exomars-2016-set-to-complete-construction/>.
[374] De Selding, Peter. "ESA, Roscosmos Fromalize ExoMars Pact." 14 Mar. 2013. SpaceNews 27 Apr. 2014 <http://www.spacenews.com/article/civil-space/34153esa-roscosmos-formalize-exomars-pact>.
[375] De Selding, Peter. "Entry Fees for New ESA Members Go to ExoMars." 18 Oct. 2013. SpaceNews 27 Apr. 2014 <http://www.spacenews.com/article/civil-space/37747entry-fees-for-new-esa-members-go-to-exomars>.
[376] "ExoMars: ESA and Roscosmos for Mars Missions." 14 Mar. 2013. ESA 28 Mar. 2014 <http://exploration.esa.int/mars/51495-exomars-esa-and-roscosmos-set-for-mars-missions/>.
[377] De Selding, Peter. "ExoMars Wins One-month Reprieve." SpaceNews 21 May 2012: 8.
[378] "L1 Mission Reformulation: JUICE – JUpiter ICy moon Explorer | Technical & Programmatic Review Report." 18 Dec. 2012. ESA 24 Apr. 2014 <http://sci2.esa.int/cosmic-vision/JUICE_technical_and_programmatic_review_report.pdf>.
[379] "Forthcoming Announcement of Opportunity for Scientific Instrumentation Onboard the JUICE Spacecraft." 30 May 2012. ESA 27 Mar. 2014 <http://sci.esa.int/juice/50400-forthcoming-announcement-of-opportunity-for-juice-scientific-instrumentation/>.
[380] "European-Russian Luna Mission Speed Dating." 3 Dec. 2013. Spaceports 25 Apr. 2014 <http://spaceports.blogspot.co.at/2013/12/european-russian-luna-mission-speed.html>.
[381] "ESA and NASA Sign Agreement on James Webb Space Telescope and LISA Pathfinder." 18 June 2007. ESA 25 Apr. 2014 <http://www.esa.int/Our_Activities/Space_Science/ESA_and_NASA_sign_agreement_on_James_Webb_Space_Telescope_and_LISA_Pathfinder>.
[382] Staff Writers. "ESA Completes Second Instrument for James Webb Space Telescope." 10 Sept. 2013. Space Daily 25 Apr. 2014 <http://www.spacedaily.com/reports/ESA_completes_second_instrument_for_James_Webb_Space_Telescope_999.html>.

pean astronauts aboard the station, ESA might build technologies for the station similar to ESA's International Berthing and Docking Mechanism (IBDM), which could overcome a problem China has experienced in using the current Russian system. ESA's IBDM system allows different countries' spacecraft to berth and dock, being compatible with the different designs. ESA has been cooperating with China on Earth observation since the 1990s and, since 2004, under the ongoing Dragon programs (joint ESA-China Earth observation programmes).[383] ESA's Estrack network also provided critical support to China's Chang'e 3 mission throughout its journey to the Moon, recording radio signals as the spacecraft touched down, to aid China in pinpointing the lander's location with remarkable accuracy.[384]

Apart from cooperating on an international level in 2012 and 2013, ESA continued its efforts to strengthen its relations with other European institutional space stakeholders. For example, building on its shared objective with the European Defence Agency (EDA) in developing European dual use technologies and operational concepts, the two organizations agreed to pursue cooperation on such key policy topics relating to space and security as governmental satellite communications, navigation, or Intelligence, Surveillance and Reconnaissance (ISR). The first such project was a demonstration mission for the control of Unmanned Aerial Systems (UAS) by satellite under the DeSIRE programme, where satellite communications were used to pilot a UAV in general air traffic.[385]

And finally, as regards ESA's rapprochement with the EU, decisions on the direction of ESA's evolution (i.e. improved cooperation under the "status quo"; bringing ESA as an intergovernmental organisation under the authority of the European Union (following, to a certain extent, the model of the European Defence Agency); or transforming ESA into an EU agency (following the model of existing regulatory agencies); etc.) are expected to made at the next ESA Council at Ministerial level held in autumn 2014.

[383] Coppinger, Rob. "Europe May Work With China on Space Station." 26 Feb. 2013. Space.com 24 Apr. 2014 <http://www.space.com/19960-china-space-station-europe-cooperation.html>.
[384] "ESA Teams Ready for Moon Landing." 13 Dec. 2013. ESA 24 Apr. 2014 <http://www.esa.int/Our_Activities/Operations/ESA_teams_ready_for_Moon_landing>.
[385] "EDA-ESA bilateral at ESA's European Space Research and Technology Centre." 17 July 2013. EDA 24 Apr. 2014 <http://www.eda.europa.eu/info-hub/news/2013/07/17/eda-esa-bilateral-at-esa-s-european-space-research-and-technology-centre>.

6.3 EUMETSAT

One of the key developments regarding the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) programmes was the progress made in the development of the organisation's next generation geo-stationary weather satellites. While the meteorological satellite organization had also been hindered by the sovereign-debt crisis in its pursuit to gain support for its second-generation European Polar System (EPS-SG), by July 2012 it has been fortunate enough to have 95% of the funding needed to begin its preparatory programme. On 16 November 2012, Eumetsat successfully concluded the approval process for the EPS-SG Preparatory Programme with all 26 Member States having firmly committed themselves.[386] The EPS-SG sets of satellites will succeed the current Metop three-satellite programme, and are expected to begin launching around 2020.

The MetOp Second Generation (MetOp-SG) is the space segment of EUMETSAT's EPS. In terms of funding for the MetOp-SG, ESA will spend about €800 million on the design and construction of the first MetOp-SG models, while Eumetsat has budgeted the program at €3.4 billion over more than 20 years, including operations of each successive pair of satellites. With nearly all of the funding for the MetOp-SG secured, the prime contractor for the spacecraft will be selected early in 2014.[387] Unlike its MetOp predecessor, which operated in a 3-satellite relay in SSO, MetOp-SG will feature 6 satellites, operating in 3 pairs, each carrying a different but complementary suite of instruments, and all being part of an overall cooperative effort with NOAA of the US.[388] The launch of the first spacecraft is planned for 2020, with the programme lifetime expected to last 21 years.

Eumetsat's current METOP program consists of three identical satellites launched at six-year intervals between 2006 and 2018, with operations running until 2023. The second polar-orbiting meteorological satellite, Metop-

[386] "EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites, held its 77th Council meeting in Darmstadt, Germany, on 15 November." 16 Nov. 2012. EUMETSAT 29 Apr. 2014 <http://www.eumetsat.int/website/home/News/DAT_2041274.html>.
[387] De Selding, Peter. "Addition of Debris-mitigation Measure Delays MetOp-SG Award." 18 Oct. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/37749addition-of-debris-mitigation-measure-delays-metop-sg-award>.
[388] "MetOp-SG (MetOp-Second Generation Program)." eoPortal Directory 29 Apr. 2014 <https://directory.eoportal.org/web/eoportal/satellite-missions/m/metop-sg>.

B, was successfully placed into orbit on 17 September 2012, where it began operating in tandem with Metop-A, which had launched in October 2006. The third identical Metop satellite, Metop-C, is expected to launch sometime between late 2016 and late 2018. The entire cost of the Metop program (including development of the three satellites, their launches and the related ground infrastructure) reached €3.2 billion (at 2011 prices), with Eumetsat covering 75% of the cost, and ESA covering the rest of the amount.[389]

On 24 February 2012, ESA entered into a $1.8 billion deal with Thales Alenia Space as prime contractor in partnership with OHB to build 6 satellites for its METEOSAT Third Generation (MTG) system, aimed at providing geostationary meteorological services for 20 years starting in 2018.[390] On 7 February 2013, a milestone in the programme's development was achieved with the signing of a contract for the development of four new lightning imagers for the spacecraft, providing the first fully operational lightning detection capability from GEO, with real-time data on lightning events across Earth, both day and night, and with a spatial resolution of better than 10 km.[391] And by 4 December 2013, contracts were signed again with Thales Alenia Space for the development of the ground segment for the MTG programme, giving Thales Alenia the reigns in ensuring that optimal MTG performance is achieved.[392]

The existing Meteosat programme consists of two generations of active satellites, i.e. the Meteosat First Generation (MFG) and the Meteosat Second Generation (MSG) operating in geostationary orbit over Europe and Africa. While only one satellite, Meteosat-7, remains under the MFG programme operating until 2016; the MSG programme has three satellites in operation, Meteosat -8 to -10, which are expected to end service in 2019, 2021, and 2022 respectively. The primary role of the Meteosat satellites is to help detect and forecast rapidly developing high impact weather, including thunderstorms, volcanic ash, and fog, up to six hours ahead through continuous monitoring.[393]

On the international level, on 27 August 2013, Eumetsat and the US National Oceanic and Atmospheric Administration (NOAA) formally extended their longstanding cooperation, reconfirming 3 decades of willingness to collaborate on space-based weather, ocean and climate monitoring.[394] Additionally, Eumetsat will cooperate with China's National Satellite Ocean Application Service (NSOAS), to provide NSOAS with data from its Metop satellites and from the US-European Jason-2 and Jason-3 ocean-monitoring satellites in exchange for similar scatterometer and altimetry data from the Chinese HY-1 and HY-2 ocean-colour satellites.[395]

6.4 National Governments

6.4.1 France

Several different issues emerged regarding France and its space activities during the reporting period. However the main discussion continued to relate mostly to launch issues, with France as a leading country in European space cooperation activities and one of the two biggest contributors to the ESA budget remaining vocal on its opinion following the ESA Ministerial Council meeting in November 2012. Further issues focused on the future of the ISS, and the development of relations between ESA and the EU.

On 4 September 2013, the French government created a joint government-industry grouping, 'Cospace' in the hope of facilitating a consensus opinion between the French space industry and CNES on the future of Europe's launcher development. Following the previous Ministerial Council meeting in Italy in November 2012, differing opinions on the

[389] De Selding, Peter. "European Weather Satellite Launched after 4-Month Delay." 27 Sept. 2012. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/european-weather-satellite-launched-after-4-month-delay>.

[390] De Selding, Peter. "ESA Signs $1.8B Deal with Thales Alenia for Six Weather Sats." 24 Feb. 2012. Space News 15 May 2012 <http://www.spacenews.com/article/esa-signs-18b-deal-thales-alenia-six-weather-sats>.

[391] "Contract Signed for METEOSAT Third Generation Lightning Instruments." 7 Feb. 2013. ESA 28 Apr. 2014 <http://www.esa.int/Our_Activities/Observing_the_Earth/The_Living_Planet_Programme/Meteorological_missions/Contract_signed_for_Meteosat_Third_Generation_lightning_instruments>.

[392] "Thales Alenia Wins Contract for METEOSAT Third Generation (MTG) Ground Segment." 4 Dec. 2013. Thales Group 28 Apr. 2014 <https://www.thalesgroup.com/en/worldwide/space/press-release/thales-alenia-space-wins-contract-meteosat-third-generation-mtg-ground>.

[393] "There are two generations of active Meteosat satellites, Meteosat First Generation (MFG) and Meteosat Second Generation (MSG), providing images of the full Earth disc, and data for weather...." Eumetsat 30 May 2014 <http://www.eumetsat.int/website/home/Satellites/CurrentSatellites/Meteosat/index.html>.

[394] Gruss, Mike. "NOAA, Eumetsat Extend Cooperation Accord." 28 Aug. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/36985noaa-eumetsat-extend-cooperation-accord>.

[395] De Selding, Peter. "Europe and China To Share Ocean-monitoring Sat Data." 25 Sept. 2012. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/europe-and-china-share-ocean-monitoring-sat-data>.

direction of launcher development, i.e. Ariane 6 or Ariane 5 ME, had pitted French industry and CNES on opposite sides, in addition to the debate between France and Germany. French industry, particularly Airbus Defence & Space with production facilities in both France and Germany, saw the Ariane 5 ME as a job producer, while CNES sees the value of Ariane 5 diminishing with European governments turning to the European Soyuz to launch spacecraft. And Germany has the opinion that although Ariane 6 might do well in the international market of commercial telecommunications satellite operators, the billions of euros invested in launcher development are primarily for government missions allowing for the launch of heavy exploration payloads out of the reach of Ariane 6. With Cospace, France hopes to attend the autumn 2014 Ministerial Council with a united view on the full development of either the Ariane 6 or the Ariane 5 ME, or both launchers.[396]

In September 2013, France also planned to increase its spending in ESA. Its 2014 spending in ESA was expected to grow by 7.8% to €854.4 million to meet its commitments for the next generation launcher. Its spending will be offset by a decrease in France's non-ESA-related space activities. Thus overall spending at CNES was expected to increase by only 1.3% to €1.43 billion for 2014.[397]

In the same vein, France is also reducing its contributions to the ISS, following an assessment that its current payments are much higher than the station-related contracts received by French industry.

6.4.2 Germany

In 2012 and 2013 Germany continued advancing its position as a European space technology leader by taking the lead in key European space technology development projects, both in the framework of the EU and ESA. At the same time, it increased the visibility and public impact of its technological capabilities, both through its strong support for the International Space Station (ISS) and by initiating its own national programmes. The German space programme focuses on the following priorities: the completion of the Galileo and Copernicus (GMES) constellations; the full exploitation of ISS for as long as possible; the development of new or improved launch vehicles; and the realization of space exploration missions.[398]

While France has pushed for the development of a new Ariane 6 launcher as the way to go for Europe's step, Germany was not convinced. The German DLR's chairman, Johann-Dietrich Woerner went as far as to say "Any hope that Europe one day would be launching its own astronauts would evaporate with Ariane 6". [399]

In international initiatives, the DLR and OHB System AG signed an agreement on 13 November 2013, where the DLR agreed to direct funding from its budget to finance a study to explore possible uses of the US spacecraft Dream Chaser being developed by the US Sierra Nevada Corporation (SNC). The project, known as Dream Chaser for European Utilization (DC4EU), will explore ways in which the spacecraft can be used to cover German and European requirements for the transportation of payloads and astronauts to the ISS and for deployment as a manned or unmanned space vehicle allowing German and European scientists to conduct research under weightless conditions over extended periods of time. The study will also determine the extent to which Dream Chaser is able to launch satellites or remove decommissioned satellites from their orbits. This project will complement work conducted by SNC under NASA's Commercial Crew Program.[400]

6.4.3 Italy

Cooperative PPPs in developing space capabilities were highly relevant for Italy for civilian and defence purposes. In November 2012, Italy's Defence Ministry expressed its support for a proposal by the Italian Space Agency and the Italian space industry to launch two Ka-band communications satellites for civil and military use under a government-commercial partnership called the Sigma project. A portion of the construction

[396] De Selding, Peter. "France Moves To Get Industry, Government on Same Page with Creation of Cospace Group." 5 Sept. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/37072france-moves-to-get-industry-government-on-same-page-with-creation-of>.

[397] De Selding, Peter. "France Favors CNES with Better-than-inflation Budget Bump." 26 Sept. 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/civil-space/37395france-favors-cnes-with-better-than-inflation-budget-bump>.

[398] De Selding, Peter. "Germany Reaffirms Commitment to $2B Ariane 5 Upgrade." Space News 31 Oct. 2011: 6.

[399] De Selding, Peter. "DLR's Woerner Remains Unconvinced Just-unveiled Ariane 6 Design Is Right Way To Go." 12 July 2013. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/launch-report/36225dlr%E2%80%99s-woerner-remains-unconvinced-just-unveiled-ariane-6-design-is-right>.

[400] "OHB System Launching Bilateral Partnership for the Commercial Provision of Supplies for ISS." 13 Nov. 2013. OHB System 28 Apr. 2014 <https://www.ohb-system.de/press-releases-details/items/contract-signed-with-dlr-for-the-study-phase-for-the-utilization-of-us-company-sierra-nevada-corporations-dream-chaser-spacecraf.html>.

of the military communication satellites Sicral 1B and Sicral 2 (under construction) will be financed by Italy's Telespazio in return for ownership of a portion of their capacity for resale. With Italy still overcoming the effects of the financial crisis, co-investing in Sigma for additional Ka-band capacity is an example of the government's interest in finding creative solutions beyond merely sharing expenses with ASI. UHF capacity on the open market (i.e. spot purchases by military forces needing short-term leases on bandwidth) can fetch as much as $3 million per year for a 25-kilohertz channel.[401] This project could also fulfil Italy's obligation to NATO should the 28-nation alliance decide to use its capacity post-2020; Italy along with Britain and France already provide satellite capacity to NATO under a contract that expires in 2019.

Another example of Italy's cooperation with the private sector is its stake in the Athena-Fidus Ka-band broadband satellite, launched on 6 February 2014. France and Italy are constructing the satellite, with ownership stakes held by CNES and ASI, and the two nations' military forces. Athena-Fidus has separate French and Italian Ka-band payloads, and an extremely high frequency Ka-band payload for Italian national coverage to be used by government emergency response forces. France will have operational control of Athena-Fidus.[402]

6.4.4 United Kingdom

In 2012 and 2013, the United Kingdom (UK) continued to successfully develop its space activities and cooperation with other partners, related in part to its recently established UK Space Agency. On 9 November 2012, just days prior to the 2012 ESA Ministerial Council meeting, the United Kingdom pledged to increase its annual investment in ESA by 25% for the next five years, 2013-2017. While the news was unanticipated, given the fact that the UK was dialling back spending in many other areas due to the crisis, increased investment in space is expected to have a multiplier effect on the nation's economy in addition to boosting the UK's international competitiveness. Thus, the UK's annual investment in ESA was increased to €301 million ($383 million) per year through 2017, placing the UK fourth behind Germany, France, and Italy as ESA's biggest contributors. Within that same period, ESA moved part of its telecommunications directorate from the European Space Research and Technology Centre in Noordwijk, Netherlands, to ESA's newest facility in Harwell, UK.[403] The European Centre for Space Applications and Telecommunications (ECSAT)[404] located in Harwell, UK, was officially unveiled on 14 May 2013, and will be active in telecommunications, climate change, technology, science and integrated applications.[405]

In November 2013, the UK space sector published the UK Space Innovation & Growth Strategy 2014-2030: Space Growth Action Plan report, a follow-on to the Space Innovation and Growth Strategy (IGS) report, published in February 2010. The Action Plan report aims to deliver new jobs and growth for the sector, with the goal of increasing the UK share of the global space market to 8% by 2020. In addition to proposing measures designed to enhance the UK's supportive business environment, including the development of a vibrant regional SME community spread across the UK, the report calls for stronger support for exports and an improved regulatory framework for space activity.[406] Its recommendations include: 1) Develop the high-value priority markets identified to deliver £30 billion per annum of new space applications by promoting the benefits of space to business and Government and engaging service providers; 2) Make the UK the best place to grow existing and new space businesses and attract inward investment by providing a regulatory environment that promotes enterprise and investment in the UK; 3) Increase the UK's returns from Europe by continuing to increase the UK's contributions to European Space Agency (ESA) programmes and securing greater influence in large European-funded programmes; 4) Support the growth of UK space exports from £2 billion to reach £25 billion per annum by 2030 by launching a National Space Growth Programme and defining an international policy that will improve collaboration with nations across the world, enhance the UK's competitive edge in export markets and en-

[401] De Selding, Peter. "Italian Defense Ministry Backs Sigma Ka-band Satellite Partnership." 29 Nov. 2012. SpaceNews 28 Apr. 2014 <http://spacenews.com/article/italian-defense-ministry-backs-sigma-ka-band-satellite-partnership>.
[402] Ibid.

[403] SpaceNews Editor. "Editorial | Britain Steps Up in Space." 19 Nov. 2012. SpaceNews 28 Apr. 2014 http://spacenews.com/article/editorial-britain-steps-up-in-space.
[404] "ECSAT." ESA 30 May 2014 <http://www.esa.int/About_Us/Welcome_to_ESA/ECSAT>.
[405] Press Releases. "N° 14–2013: ESA opens its doors in UK." 14 May 2013. ESA 30 May 2014 <http://www.esa.int/For_Media/Press_Releases/ESA_opens_its_doors_in_UK>.
[406] Staff Writers. "Space Sector Calls for Action to Keep Britain Ahead in the Global Race." 18 Nov. 2013. Space Daily 28 Apr. 2014 <http://www.spacedaily.com/reports/Space_sector_calls_for_action_to_keep_Britain_ahead_in_the_global_race_999.html>.

able targeted and market-led investments in leading edge technology; and 5) Stimulate a vibrant regional space SME sector by improving the supply of finance, business support, information, skills and industry support.[407]

On 5 December 2013, the UK Space Agency announced the beginning of its five-year Global Collaborative Space Programme (GCSP), which will allow the space agency to increase its international portfolio by fostering projects of mutual interest with other countries, with £80 million ($131.3 million) in funding focused on using space to assist in social and economic development. On 10 December 2013, the UK Space Agency completed its first Memorandum of Understanding with the China National Space Administration (CNSA), beginning the process of identifying collaborative opportunities that have the potential to deliver real economic growth and social benefit for both the UK and China. International collaboration between UK industry and Russia, Brazil and Kazakhstan has also begun. Through this programme, the UK hopes these partnerships will play an important role in helping the UK space economy to be worth £40 billion per year by 2030. The GCSP will also address a key recommendation of the ambitious Space Innovation and Growth Strategy Action Plan, designed to enable the UK to develop an even more supportive business environment for space companies to deliver growth and other benefits to the national economy.[408]

6.5 United States of America

From a policy perspective, 2012 and 2013 saw significant changes in US space initiatives. Funding for space programmes continued to be a major hurdle, resulting in the restructuring of priorities. During this time, concrete actions were undertaken to implement the new strategic orientations, amid political controversy over their declared objectives and how best to accomplish them. Nevertheless, concerns remained on such topics as changes to US regulations on EO satellites, hosted payloads, export reform, and the development of suborbital and in-orbit satellite service industries.

On 2 January 2013, President Obama signed into law the National Defense Authorization Act (NDAA) for Fiscal Year 2013 which repealed the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 that had placed satellites and related items on the United States Munitions List (USML). In response to allegations that China was improving its rocket capabilities through launches of US satellites, in 1998 the US Congress had put in place stricter export controls that were applied to all space-related hardware and services, transferring all items from the US Commerce Control List (CCL) regardless of sophistication or availability. Over the following decade, US satellite and component makers were placed at a competitive disadvantage due to export control laws; a 2012 Aerospace Industries Association report showed the US share of the global satellite manufacturing market having dropped from 65% to as low as 30% since 1999, in addition to $21 billion in lost revenues between 1999 and 2009, and a loss of 9,000 jobs annually. The new law gives the US President the discretion (with appropriate national security reviews) to place satellites and related items on the CCL, which contains dual-use items whose exports are regulated by the US Department of Commerce. Moreover, the new NDAA maintains a de facto ban on transferring US satellite hardware to China or North Korea, or countries deemed to be state sponsors of terrorism; i.e. should the US President seek a waiver to permit the launch of US satellite hardware aboard a Chinese or North Korean rocket, Congress is directed to meet that request with a presumption of denial. However, if companies want to launch US-built satellites on Russian or European rockets, they still need a State Department license (i.e. a Technical Assistance Agreement, or TAA) to hold the discussions necessary to mate the two vehicles. Moreover, with the exception of launches of US hardware operated by close US allies, monitors from the US DoD are required to be present.[409]

With the NDAA signed, the next step was for the US government to draft implementing regulations for publication in the US Federal Register, to include categories of space technology proposed for transfer to the CCL. On 24 May 2013, the Obama administration published in the Federal Register its proposed new USML Category 15, including a list of those items that would move to the CCL. This

[407] UK Space Innovation & Growth Strategy 2014-2030: Space Growth Action Plan. 14 Nov. 2013. Innovateuk.org 13 May 2014 <https://connect.innovateuk.org/web/space/space-igs-2014-30>.

[408] "Going Global: UK Space Agency to Build International Partnerships Using UK Expertise." 12 Dec. 2013. UK Space Agency 28 Apr. 2014 <http://www.bis.gov.uk/ukspaceagency/news-and-events/2013/Dec/going-global>.

[409] "New Export Law Seen as Boon to U.S. Satellite, Component Makers." 4 Jan. 2013. SpaceNews 29 Apr. 2014 <http://www.spacenews.com/article/civil-space/33047new-export-law-seen-as-boon-to-us-satellite-component-makers>.

proposed Category 15 list closely followed what had appeared in the April 2012 Section 1248 report.[410] Under the "1248 report" (invoked by Section 1248 of the National Defense Authorization Act for 2010), items recommended for transfer to the CCL include communications satellites that do not contain classified components, and some low-performing remote sensing satellites and components that may be treated as non-military technology for export purposes, without affecting national security. Items likely to remain on the USML include dedicated military payloads hosted aboard commercial satellites, most of which are owned by international companies and launched on foreign rockets, on the grounds that hosted military payloads may contain sensitive encryption and radiation-hardening technologies and thus sensitive from a security perspective. That is, there is no material change to restrictions imposed on spacecraft carrying DoD-funded secondary or hosted payloads, and specially designed parts and components.[411]

On 21 November 2013, President Obama signed the 2013 National Space Transportation Policy, meant to update and replace the 2004 US Space Transportation Policy, with the purpose of providing comprehensive guidance to all Federal Departments and Agencies on US priorities and on roles and responsibilities with respect to space transportation issues and programs.[412] More specifically, the new Space Transport Policy seeks to: 1) promote and maintain a dynamic, healthy, and efficient domestic space transportation industrial base; 2) encourage and facilitate the US commercial space transportation industry to increase industry robustness and cost effectiveness, foster innovation-driven entrepreneurship and international competitiveness, and benefit the US economy; 3) conduct and promote technology research and development activities to improve the affordability, reliability, performance, safety, and responsiveness of US space transportation capabilities, while increasing collaboration and coordination among departments and agencies; 4) enable the capabilities to support human space transportation activities to and beyond low Earth orbit, including services to and from the International Space Station and the development of a deep-space-capable transportation system; and 5) foster the development of US commercial spaceflight capabilities serving the emerging nongovernmental human spaceflight market.[413] To implement this policy, a set of sector guidelines is laid out in the document, ranging from civil and national security space guidelines to commercial space guidelines. Moreover, cross-sector guidelines are listed in the fields of: space launch ranges; space transportation technology development, US space transportation industrial base; non-proliferation and excess intercontinental ballistic missile assets; and international collaboration.

Some of the differences from the previous 2004 US Space Transportation Policy relate to its emphasis on allowing new entrants to launch US government payloads, with the need to have available alternative US space transportation families. It also does not use the term 'operationally responsive space', and deemphasizes operationally responsive access to and use of space to support national security requirements, in favour of directing the Secretary of Defence to work with other agencies on "launch concepts, techniques, and technologies needed for augmentation or rapid restoration of national security space capabilities" without a specific goal or deadline. The policy clarifies the launch of US government hosted payloads on commercial spacecraft, and includes a provision to encourage increased technological innovation and entrepreneurship in the US commercial space transportation sector through the use of incentives such as non-traditional acquisition arrangements, competition, and prizes.[414]

6.5.1 National Aeronautics and Space Administration (NASA)

NASA has experienced difficulty in generating public interest in its human spaceflight programme while developing hardware with no deep-space mission anywhere in the agency's five-year budget horizon. Lacking the impetus drawn from Cold War-era Moon expeditions, or the roar of the now-retired space

[410] "The ITAR Shift." 1 July 2013. SpaceNews 29 Apr. 2014 <http://spacenews.com/article/civil-space/36055the-itar-shift>.
[411] "Proposed ITAR Changes a Mixed Bag for U.S. Satellite Industry." 14 June 2013. SpaceNews 29 Apr. 2014 <http://spacenews.com/article/satellite-telecom/35794proposed-itar-changes-a-mixed-bag-for-us-satellite-industry>.
[412] "Fact Sheet: 2013 National Space Transportation Policy." 21 Nov. 2013. Whitehouse.gov 19 May 2014 <http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_space_transportation_policy_fact_sheet_11212013.pdf>.
[413] National Space Transportation Policy. 21 Nov. 2013. NASA 20 May 2014 <http://www.nasa.gov/sites/default/files/files/national_space_transportation_policy_11212013.pdf>
[414] Foust, Jeff. "New national space transportation policy makes modest, not major, changes." 22 Nov. 2013. Space Politics 20 May 2014 <http://www.spacepolitics.com/2013/11/22/new-national-space-transportation-policy-makes-modest-not-major-changes/>.

shuttle launch, public dialogue on exploration, science, and technology seems to be stagnant. On 21 October 2013, NASA Administrator Charles Bolden - before a National Research Council panel evaluating NASA's human spaceflight goals - defended the agency's plan to build deep-space hardware before settling on a destination as being "the only realistic way to set the stage for a manned Mars mission given the current budget climate". By the end of May 2014, the National Research Council was days away from receiving a report published by the Space Studies Board's Committee on Pathways to Exploration. This ad hoc committee was established in response to the NASA Authorization Act of 2010, which saw the Constellation Moon exploration programme cancelled by President Obama for being too costly given NASA's then expected budget. President Obama's 2014 budget request includes $17.7 billion for NASA, and proposes using the future Space Launch System to launch a crewed Orion to rendezvous with a small asteroid relocated near the Moon by a robotic tug sometime between 2021 and 2023. While NASA has not formally committed to this Asteroid Redirect Mission (ARM) – especially following the lukewarm response from Congress - should the mission proceed, it would use a solar-powered robotic spacecraft to push a 10-meter asteroid into a deep retrograde orbit around the Moon. While no formal cost estimate for ARM has been determined, estimates put the mission cost at approximately $2.6 billion. To be successful, it will need to fit within overall financial considerations, in addition to satisfying political interests.[415]

Moreover, the US Government shutdown had put at risk many NASA activities. Beginning on 1 October 2013 when the US Senate and House could not agree on an emergency spending bill to keep the government funded, the 16-day shutdown forced huge numbers of federal employees home, including 97% of NASA's 18,000-member workforce. During that time, a skeleton crew of 549 employees remained at their posts to protect the lives of the astronauts aboard the ISS and monitor currently operating scientific spacecraft to ensure their safety.[416] A further 1,566 employees were on call in the event of an emergency. While most of NASA had shut down, some projects were exempted, such as those in the middle of delicate tests or working in limited time windows. The main instrument for the $8.8 billion James Webb Space Telescope (expected to launch in 2018), had been undergoing cryogenic vacuum testing when the shutdown took effect, but was allowed to continue in part due to the long-term implications that would arise otherwise; i.e. the instrument was kept cool, and in suspend-mode with a crew to monitor it so that the mission schedule could remain on track.

However, NASA suspended the Mars Atmosphere and Volatile Evolution (MAVEN) mission launch preparations on 1 October, sparking an outcry from Mars exploration advocates, due to the 26 month delay and millions of dollars of additional expense that would result if the 4-week launch window was missed. On 3 October, the orbiter was granted an emergency exemption on the grounds that the orbiter must launch this year to protect the rovers NASA already has at Mars by replacing Mars Odyssey (launched in 2001) and the Mars Reconnaissance Orbiter (launched in 2005) as a communications relay in order to be assured of continued communications with the Curiosity and Opportunity rovers. Missing that launch window, and launching in 2016 would have required MAVEN to use more fuel to reach the red planet, and would have limited the duration of MAVEN's core science mission of measuring the interaction of solar particles with the upper Martian atmosphere.[417] On 16 October, the Senate and House passed the Continuing Appropriations Act (CAA), which kept the government funded at its FY2013 levels until 15 January 2014; President Obama signed the bill into law early the next day.[418] The MAVEN mission launched on 18 November 2013.

In NASA's FY2014 budget request, the ARM proposal was seen to be its most controversial aspect, being the stepping-stone toward President Obama's 15 April 2010 directive setting an asteroid as the next destination for the US human spaceflight programme. The earlier directive had similarly received little support in Congress and the broad space community, where it envisioned astronauts travelling for several months to visit an asteroid and study human adaptation to deep space missions as a step towards even longer missions to Mars. As a precursor to this mis-

[415] Leone, Dan. "Bolden: Capabilities-based Approach Is All NASA Can Afford." 22 Oct. 2013. SpaceNews 29 Apr. 2014 <http://www.spacenews.com/article/civil-space/37808bolden-capabilities-based-approach-is-all-nasa-can-afford>.

[416] "NASA Assessing Impacts of Government Shutdown." 18 Oct. 2013. Space.com 29 Apr. 2014 <http://www.space.com/23253-nasa-government-shutdown-impacts.html>.

[417] "U.S. Government Shutdown | Most of NASA Idled but Mars Orbiter Gets Reprieve." 4 Oct. 2013. SpaceNews 29 Apr. 2014 <http://spacenews.com/article/civil-space/37561us-government-shutdown-most-of-nasa-idled-but-mars-orbiter-gets-reprieve>.

[418] "NASA's FY2014 Budget Request." 17 Oct. 2013. Space Policy Online 29 Apr. 2014 <http://www.spacepolicyonline.com/pages/images/stories/NASA FY2014 Budget Request Oct 17.pdf>.

sion, the Keck Institute for Space Studies (KISS) published a report in 2012 recommending that an asteroid be captured by a robotic spacecraft and tugged into lunar orbit for easier accessibility by astronauts who could return a large sample to Earth for study. While the White House adopted a variation of this plan in its FY2014 budget request, as a way to send humans to an asteroid more quickly and cost effectively, NASA faces opposition from the House Science, Space and Technology Committee while also struggling to define a mission concept.[419]

In the private sector, following the permanent grounding of the NASA space shuttle fleet, NASA began the third phase of its Commercial Crew Development (CCDev) programme, called the Commercial Crew integrated Capability (CCiCap) initiative. In August 2012, following solicitations for proposals from US space industry participants to mature the design and development of an integrated crew transportation system (CTS) (which included spacecraft, launch vehicle, ground and mission systems), NASA awarded Boeing, SpaceX, and Sierra Nevada Corporation (SNC) funding to develop their vehicles to the next stage of providing domestic access to the ISS for US astronauts. Boeing was awarded $460 million, while SpaceX received $440million, and SNC $212.5 million.[420] As of December 2013, the CCiCap award winners had the following milestone completion status: Boeing (14 of 20), SpaceX (11 of 17), and SNC (6 of 12).[421] Moreover, NASA's Orion Multi-Purpose Crew Vehicle (MPCV) is expected to conduct its first mission, Exploration Flight Test-1 (EFT-1), in 2014, where it will test whether Orion's heat shield can withstand the forces of atmospheric re-entry at about 32,000 km per hour, with temperatures reaching up to 2,200 degrees Celsius.[422]

[419] "NASA's FY2014 Budget Request." 17 Oct. 2013. Space Policy Online 29 Apr. 2014 <http://www.spacepolicyonline.com/pages/images/stories/NASA%20FY2014%20Budget%20Request%20Oct%2017.pdf>.
[420] "NASA CCiCAP Funding for SpaceX, Boeing and SNC's Crew Vehicles." 3 Aug. 2012. NASA Spaceflight 15 Apr. 2014 <http://www.nasaspaceflight.com/2012/08/nasa-ccicap-funding-spacex-boeing-sncs-crew-vehicles/>.
[421] "NASA's Return on Investment Report." 20 Dec. 2013. NASA 15 Apr. 2014 <http://www.nasa.gov/sites/default/files/files/NASAROIReport_Dec2013_TAGGED.pdf>.
[422] Leone, Dan. "NASA Proposes Orion Test Flight in 2014." 8 Nov. 2011. SpaceNews 12 Mar. 2013 <http://www.spacenews.com/article/nasa-proposes-orion-test-flight-2014>.

6.5.2 National Oceanic and Atmospheric Administration (NOAA)

In the reporting period, the main issues related to the US National Oceanic and Atmospheric Administration (NOAA) were in its total budget, and its financial capacity to procure civil weather satellites on its own or with NASA as its broker.

Following the cancellation of the Pentagon's Defense Weather Satellite System (DWSS) in 2012, NOAA's life-cycle cost estimate of its Joint Polar Satellite System (JPSS) needed revision to cover an additional 4 years of operations, and the development of a Total Solar Irradiance Sensor that was meant to launch on the DWSS. While the JPSS planned to lift the Total Solar Irradiance Sensor and two other payloads, including search-and-rescue transponders compatible with the international Cospas-Sarsat system, and the Advanced Data Collection System which monitors instrumented ocean buoys on a Free Flyer-1 satellite, Congress did not provide the funds needed in NOAA's 2014 budget request for the Free Flyer satellite. In regard to NOAA's 2015 budget request, on 8 May 2014 the US House Appropriations Committee approved a funding bill that also lacked the $15 million requested for launching the three instruments. NOAA is considering launching the Total Solar Irradiance Sensor as a host payload.[423]

Whereas NOAA had asked Congress for $916.4 million for the JPSS program for 2013 to ensure that JPSS-1 is ready to launch by early 2018, its revised polar-orbiting weather satellite programme budget cost estimate increased by around $1 billion, to $12.9 billion through 2028.[424] Additionally, the request asked Congress for $802 million for NOAA's next generation of Geostationary Operational Environmental Satellites (GOES-R). In total, NOAA's National Environmental Satellite, Data and Information Service (NESDIS) programme needed $2.04 billion of NOAA's $5.06 billion total funding request for 2013.[425]

[423] Leone, Dan. "House Appropriators Meet NOAA Request for Satellites, Block Climate Sensor Plans." 9 May 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/40523house-appropriators-meet-noaa-request-for-satellites-block-climate-sensor>.
[424] Berger, Brian. "JPSS Cost Estimate Rises To $12.9B through 2028." 24 Feb. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/jpss-cost-estimate-rises-129b-through-2028>.
[425] Werner, Debra. "U.S. Lawmakers Question NOAA's Satellite Spending Plans." 8 Mar. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/us-lawmakers-question-noaas-satellite-spending-plans>.

On 17 April 2012, the US Senate Appropriations Committee proposed to eliminate the role that NOAA had played in purchasing civilian weather satellites, instead moving that responsibility to NASA. By removing the procurement of weather satellite funding from the budget, NOAA's new budget was expected to be $41.5 million below the 2012 budget.[426] On the other hand, the US House Appropriations commerce, justice, science subcommittee proposed that NOAA retain responsibility for acquiring new weather satellites; allocating to NOAA the full amount requested for its JPSS system for 2013.[427] It should be noted that NOAA has already for years let NASA act as its procurement agent for its fleet of civilian weather satellites.[428] In September 2012, the US Congress vowed to pass a continuing resolution, i.e. a stopgap spending measure, to keep the federal government running through late March 2013 also giving NOAA budgetary leeway to keep its JPSS and GOES satellites on track for launch.[429]

Following the continuing resolution taking effect on 1 October 2012, the head of NOAA announced plans to retire at the end of February 2013.[430] In that time, concerns by the US Government Accountability Office (GAO) listed the task of mitigating anticipated gaps in weather satellite data as one of the top priorities requiring the attention of Congress and the executive branch. The addition of that risk to the GAO's High Risk Series biennial report was due to the potential gaps in weather satellite data which had the potential to begin as early as 2014 and last up to 53 months if NOAA's already orbiting Sunomi NPP satellite failed prematurely and JPSS-1 launched a year behind schedule.[431] Congress, while receptive to the concerns about protecting weather satellites at risk from the budget-cutting sequester that began on 1 March 2013, approved another continuing resolution to provide 2012 level funding for federal activities until October 2013.[432] In the following months, Congress continued to be politically divided on spending for NOAA and other space program budgets.[433]

On 16 October 2013, following the end of the US government shutdown, Congress passed another continuing resolution which kept NOAA (and other federal programmes) funded at the 2013 level to its programmes on track until the agency received its 2014 appropriation. NOAA had requested $954 million for work on the next-generation GOES-R satellites in 2014, intended for launch readiness in early 2016. NOAA also requested $824 million for the JPSS-1 satellite in 2014, to be launched in late 2017 or early 2018.[434]

6.6 Canada

In 2012, the Canadian Space Agency (CSA) appeared in need of clearly defined future space plans to keep Canadian aerospace from falling behind China, Russia and other countries, according to recommendations in a report by a Canadian aerospace review panel led by David Emerson (i.e. the Emerson Report) presented on 29 November 2012. A notable improvement would be the use of yearly, minister-level reviews of its activities as well as some high-level advisory boards that could advise Canadian officials on space activities. Moreover, the panel said that the agency should hand off contracting responsibility to the Public Works department to better focus the work of the CSA; saying further that competition for contracts should be more open to foreign companies who pledge to include Canadian content. The recommendations were made in a revenue-neutral way, in

[426] Werner, Debra. "U.S. Senate Panel Votes to Transfer NOAA Satellite Programs to NASA." 17 Apr. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/us-senate-panel-votes-transfer-noaa-satellite-programs-nasa>.
[427] Werner, Debra. "House Appropriators Poised To Vote on $17.6B NASA Budget." 18 Apr. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/house-appropriators-poised-vote-176b-nasa-budget>.
[428] Berger, Brian. "Senate Spending Bill Less Generous to NASA than House Version."
[429] Leone, Dan. "Stopgap Spending Bill Gives NOAA a Measure of Flexibility on Key Satellite Programs." 17 Sept. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/stopgap-spending-bill-gives-noaa-measure-flexibility-key-satellite-programs>.
[430] Leone, Dan. "NOAA Administrator Lubchenco Stepping Down." 13 Dec. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/noaa-administrator-lubchenco-stepping-down>.
[431] Werner, Debra. "GAO Report Urges Action On Weather Satellite Gap." 15 Feb. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/33705gao-report-urges-action-on-weather-satellite-gap>.
[432] Gruss, Mike. "Lawmakers Move To Protect Weather Satellites." 5 Mar. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/34010lawmakers-move-to-protect-weather-satellites>; "Stop-gap spending measure funds MEADS missile defense." 25 Mar. 2013. Reuters 30 May 2014 <http://www.reuters.com/article/2013/03/25/us-lockheed-missiles-idUSBRE92O02F20130325>.
[433] Leone, Dan. "Senate, House NASA Bills Far Apart on Funding, Close on Some Priorities." 18 July 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/36339senate-house-nasa-bills-far-apart-on-funding-close-on-some-priorities>.
[434] Gruss, Mike. "Continuing Resolution Provides Funding Flexibility for Weather Satellites." 18 Oct. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/37752continuing-resolution-provides-funding-flexibility-for-weather-satellites>.

an effort to remain in line with the government's goal of cutting back spending to try to balance the budget. Hence, if the CSA is to increase its activities, it will need to become more streamlined in order to do so, or look to other federal departments with an interest in space (e.g. defence or environment). The panel also emphasized that the CSA should rent out research space at its facilities, or form PPPs, to leverage additional funding from the private sector. To increase commercial space activity, the panel also proposed the use of regulatory changes to increase the opportunities to companies interested in suborbital and orbital launches, high-altitude tests and human spaceflight.[435]

On 2 December 2013, Canada's Industry Minister James Moore announced that Canada's new space plan would be made public early in 2014. Moore said that the Canadian government will examine all opportunities to work with the private sector and Canada's international partners to encourage innovation in the country's space activities. Moreover, a background paper said the plan will outline the government's strategic goals for its space activities, which include jobs and growth, sovereignty, security and the advancement of knowledge. As an additional result of the Emerson Report, the current support for the CSA's space technologies development program is expected to double to $20 million annually in the 2015-2016 period.[436]

By November 2013, the Canadian government had reduced its fees and coverage restrictions for satellite licensees, following requests by satellite operators and users. The government will also be more active in seeking orbital slots outside Canada's orbital arc to enhance the competitiveness of Canada's satellite sector. Whereas previously, Industry Canada had accepted incomplete or defective applications, and permitted a licensee to maintain their place in queue while the filing was corrected, now defective applications will be accorded first-come, first-served preference for assistance but will also be sent to the back of the queue. Also, a new fee structure imposed on licensees will permit Industry Canada to recoup its processing costs, and to reduce the number of spurious applications. In line with similar rules imposed by the US FCC, licensees will be required to meet development milestones to keep their licenses (i.e. demonstrate a signed satellite construction contract within two years, and operation within five years of license approval). The new policy reduces the public service obligation of satellite license holders from spending 2% down to 0.5% of their adjusted gross income toward research and development. Also, while 50% of the satellite capacity is still expected to be reserved for Canadian users, it is now only for the first 6-months of the satellite's operational life, unless a Canadian market exists. And the Canadian government has agreed to act as licensing authority for satellites to be operated outside the Canadian orbital arc of between 70 degrees west and 130 degrees west longitude in GEO.[437]

By deciding to proceed with the Radarsat Constellation Mission, Canada will help boost MDA Corp.'s position in providing the international market with satellite data and attracting new customers because of the system's ability to conduct rapid revisits of specific locations. On 9 January 2013, the CSA and MDA Corp. signed a C$706 million contract to continue the development of the Radarsat Constellation Mission (RCM) of three satellites to be launched in 2018. With initial work beginning in 2005, Canada has already paid MDA Corp. C$269 million for its previous work on the programme, with this announcement raising the total contribution to C$975 million. The programme, led by the CSA, will be supported by its principal users, which are Canadian federal government departments, including the Department of National Defence, Fisheries and Oceans Canada, Agriculture and Agri-Food Canada, Environment Canada, Natural Resources Canada and Public Safety Canada. The programme will employ around 200 employees over a 6-to-7 year period.[438] The three satellites of the RCM mission will be launched on a single SpaceX Falcon 9 rocket in 2018.[439]

Lastly, the status of Canada's Polar Communications and Weather (PCW) mission remained uncertain near the end of 2013. While the CSA hopes to start work on the

[435] Howell, Elizabeth. "Canadian Space Agency Needs a Plan, Experts Say." 30 Nov. 2012. Space.com 29 Apr. 2014 <http://www.space.com/18715-canadian-space-agency-future-plans.html>.

[436] "Canada's New Space Plan Coming 2014." 2 Dec. 2013. CBC News 29 Apr. 2014 <http://www.cbc.ca/news/politics/canada-s-new-space-plan-coming-2014-1.2448154>.

[437] De Selding, Peter. "Canada Revamps Satellite Regulations To Make Industry More Competitive." 7 Nov. 2013. SpaceNews 29 Apr. 2014 <http://spacenews.com/article/satellite-telecom/38046canada-revamps-satellite-regulations-to-make-industry-more>.

[438] Pugliese, David. "Canada Recommits To Building Radarsat Constellation Mission." 9 Jan. 2013. SpaceNews 29 Apr. 2014 <http://www.spacenews.com/article/civil-space/33100canada-recommits-to-building-radarsat-constellation-mission>.

[439] Ferster, Warren. "SpaceX Wins Contract to Launch Canadian Radar Satellites." 30 July 2013. Space.com 29 Apr. 2014 <http://www.space.com/22178-spacex-launch-contract-canadian-satellites.html>.

new polar-orbiting communications and weather satellite system as soon as November 2016; following a feasibility study on the project in 2008, in February 2013 the agency was looking for partners, including other Canadian government agencies and other nations, to help finance the system (expected to cost about C$600 million). The PCW would benefit Canada because GEO communications satellites face limitations for mobile services at far northern latitudes.[440]

6.7 Russia

Russia plans to spend an estimated 2.1 trillion roubles (around $63 billion, or $7.9 billion per year at 2013 exchange rates) including extrabudgetary sources, for the development of its national space activities in 2013-2020. In addition to enabling effective participation in forward-looking projects, such as the ISS, the study of the Moon, Mars and other celestial bodies in the solar system, the programme is designed to maintain Russia's leading position as a global space power, while also supporting its defence capability, and boosting economic and social development.[441] The government's decision to increase Russia's space budget will enable Russia to surpass China and reach spending parity with Europe. With only one-fifth of its domestic demand for geospatial imagery currently able to be met by Russia's own satellites and with Russian meteorological satellites being below international standards, this funding could help Russia to redress its past underinvestment in Earth observation and meteorology satellites.[442] In July 2013, an Audit Chamber released a statement finding Russia's Federal Space Program for 2006-2015 to be ineffective, due largely to the poor management of space activities and the budgeted funds allocated for space projects; in particular, it lacked a comprehensive management system in regard to space programs, projects, contracts and expenses, despite the increase in budget spending for space exploration by 2.5 times in the past three years. The Federal Space Program met only 40% of its set goals in 2010, 66.7% in 2011, and 73.3% in 2012; and launched only 47.1% of its planned number of satellites into orbit in 2010-2012.[443] The Audit Chamber attributed Roscosmos' lack of adherence to regulatory requirements and best practices in state procurement orders to be a cause of that state of affairs.

By the end of September 2013, engineers in Russia determined that the Zarya cargo module on the ISS can last in orbit until about 2028 (twice its design service life) despite micro-cracks occurring in the aluminium hull during pressure and loads cycling of a test article on the ground. Some of the recertification work was based on the Komplast space-exposure experiment removed from Zarya's hull and returned to Earth after 12 years in space, which validated predictions of aging effects.[444]

Recently, Russian space policies have focused on improvement of the country's self-sufficiency, on technological and operational levels, with a drive to increase Russia's global market shares in the space sector. This was particularly true regarding the development of access to space systems, where over the course of 2012 and 2013, Russian authorities made a number of key government decisions on the development of the long-term space program. On 16 August 2012, the Russian government ordered the formation of the Directorate for the Vostochny Cosmodrome, currently under construction in the Russian Far East.[445]

Another characteristic of Russian space policies during the review period was its increased involvement in international cooperation, especially regarding the present and future of ISS operations. In April 2013, NASA signed a deal with Roscosmos to continue sending American astronauts to the ISS aboard Soyuz space capsules until June 2017. As in the previous contract, covering flights for American astronauts through 2015, this agreement continues Russia's ferrying services for the United States through 2016 and into 2017. However the cost has increased by 12.8 % for the 6 American seats on the Soyuz, from $62.7 million per seat to $70.7 million per seat on a $424 million contract.

[440] Gruss, Mike. "Weather, Communications Project Inches Ahead at CSA." 1 Nov. 2013. SpaceNews 29 Apr. 2014 <http://www.spacenews.com/article/civil-space/37963weather-communications-project-inches-ahead-at-csa>.
[441] "Russia Launches $70 Bln Space Program for 2013-2020." 27 Dec. 2012. RIA NOVOSTI 30 Apr. 2014 <http://en.ria.ru/science/20121227/178432916/russia_launches.html>.
[442] De Selding, Peter. "Russia Boosting Space Budget To Surpass China, Equal Europe." 5 June 2013. SpaceNews 30 Apr. 2014 <http://www.spacenews.com/article/civil-space/35638russia-boosting-space-budget-to-surpass-china-equal-europe>.
[443] "Russia's Space Program Is Ineffective – Audit Chamber." 4 July 2013. RIA NOVOSTI 30 Apr. 2014 <http://en.ria.ru/russia/20130704/182063035.html>.
[444] Morring, Jr., Frank. "Oldest ISS Element Cleared Until 2028." 24 Sept. 2013. Aviation Week 30 Apr. 2014 <http://aviationweek.com/space/oldest-iss-element-cleared-until-2028>.
[445] "Center to build of the Vostochny cosmodrome." TsENKI 20 May 2014 <http://www.tsenki.com/en/about/leading_enterprise/division/build_spaceport/>.

With the retirement of its space shuttle fleet in July 2011, NASA is dependent on the Soyuz for launching its astronauts until its CCP programme has matured fully; now expected to be sometime in 2017.[446]

6.8 Japan

On 20 June 2012, Japan passed legislation implementing a 2008 law that profoundly changes the organization of Japanese space activities, enabling the Prime Minister's Cabinet Office to take control of the planning and budgeting of Japan's government space program, and providing JAXA with the ability to pursue military space programs. Previously, JAXA had been wholly controlled by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and was overseen by a MEXT committee called the Space Activities Commission (SAC). MEXT no longer controls the direction of JAXA, and its SAC has now been abolished. In its place, the Prime Minister's Cabinet Office will set up a Space Strategy Office, which will be supported by a consultative Space Policy Commission of five to seven academics and independent observers. The next step of the Space Strategy Office will be to draft new laws and policies to shift Japan's space focus away from purely research and development programs to a more national, security-orientated approach, which is also expected to encourage the industrialization and commercialization of Japan's space industry.[447]

On 25 January 2013, Japan's Space Strategy Headquarters released the latest version of its Basic Plan that lays out the priorities for most of Japan's space development for the five years that started in April 2013. The Basic Plan has three main targets: national security and disaster management, development of industries, and space science.[448] Similar to the previous strategy, this 46-page document puts emphasis on continuing to fund the development and launch of the increasingly capable Information Gathering Satellites (IGS) system with the aim of maintaining a constellation of two optical and two radar imaging satellites. A long time in development (IGS was initiated following an August 1998 North Korean missile test that overflew Japan), with the launch of the IGS-Radar 4 spacecraft on 27 January 2013, Japan now has two functional radar satellites and an experimental optical satellite in orbit for disaster monitoring and national security purposes. In other respects, the new Basic Plan does not specify budgets for particular programs and essentially leaves the current structure intact.[449] In the new space plan, the human space activity programme is listed beneath the space science and space exploration programme as a priority area, marking a change in Japan's interests since Japan's earthquake in March 2011.[450]

On 3 April 2013, Japan announced that Mitsubishi Electric Co. (Melco) would be tasked to complete Japan's Quasi-Zenith Satellite System (QZSS) meant to enhance the precision of the US GPS positioning, navigation and timing satellites over the Pacific Ocean region. The contract, valued at $539.4 million, will have Melco build one geostationary satellite and two spacecraft to be operated in highly elliptical orbit to complete the QZSS space architecture by 2017. Whereas GPS-only signals are available with precision only 90% of the time in Japan, with the QZSS overlay in place, the signals will increase that percentage to 99.8% of the time, and will carry six civil signals. That is, while the GPS-only L1S signal has a 10-meter horizontal accuracy in Japan, the addition of the QZSS will refine that accuracy down to 2-meters, in addition to being able to send short disaster-warning messages to mobile phone users.[451]

Japan's Epsilon 3-stage launcher, meant to be a lower-cost replacement for its M-5 solid-propellant rocket, has been in development since 2011.[452] The launcher cost around ¥20.5 billion to develop, launch costs are projected to be ¥3.8 billion ($44.5 million) per vehicle, resulting in a cost about half as

[446] Wall, Mike. "NASA to Pay $70 Million a Seat to Fly Astronauts on Russian Spacecraft." 30 Apr. 2013. Space.com 30 Apr. 2014 <http://www.space.com/20897-nasa-russia-astronaut-launches-2017.html>.
[447] Kallenar-Umezu, Paul. "Japan Passes Overhaul of Space Management Structure." 2 July 2012. SpaceNews 30 Apr. 2014 <http://spacenews.com/article/japan-passes-overhaul-space-management-structure>.
[448] "Profile | Naoki Okumura, President, Japan Aerospace Exploration Agency." 9 Dec. 2013. SpaceNews 30 Apr. 2014 < http://spacenews.com/article/features/38565profile-naoki-okumura-president-japan-aerospace-exploration-agency>.
[449] Kallendar-Umezu, Paul. "Japan Stays the Course on IGS under Latest Five-year Plan." 18 Feb. 2013. SpaceNews 30 Apr. 2014 <http://www.spacenews.com/article/japan-stays-the-course-on-igs-under-latest-five-year-plan>.
[450] Basic Plan on Space Policy. 25 Jan. 2013. Government of Japan 20 May 2014: 6 <http://www8.cao.go.jp/space/plan/plan-eng.pdf>.
[451] De Selding, Peter. "Melco To Build Three QZSS Navigation Satellites." 3 Apr. 2013. SpaceNews 30 Apr. 2014 <http://spacenews.com/article/civil-space/34676melco-to-build-three-qzss-navigation-satellites>.
[452] Kallendar-Umezu, Paul. "Japan To Take Incremental Approach for New Epsilon Launcher." 11 Apr. 2011. SpaceNews 30 May 2014 <http://www.spacenews.com/article/japan-take-incremental-approach-new-epsilon-launcher>.

much as the M-5 per launch.[453] The tradeoff for the lower price is one-third less capability than the previous M-5 rocket.[454] While the Epsilon 1 was scheduled to debut on 27 August 2013, poor synchronization between flight and ground-based computers caused an anomaly reading on a sensor aboard the launcher which forced JAXA to abort the launch 19 seconds prior to liftoff.[455] The launch was postponed until 14 September 2013, when the rocket successfully lifted the Hisaki (SPRINT-A) satellite into elliptical orbit from the Uchinoura Space Center in Japan.[456]

Japan also plans to develop a lower-cost, commercially viable successor to its H-2A rocket. On 17 May 2013, Japan's Space Transportation Systems Subcommittee of its Cabinet-level Office of National Space Policy (ONSP) presented a draft midterm report recommending an H-3 successor launcher.[457] By 24 December 2013, the Japanese government approved initial funding of $70 million for 2014 for the development of the launcher, estimated to need a $1.9 billion for full development. The two-stage H-3 is tentatively scheduled to have its first launch in 2020, and is projected to lift up to 6.5 metric ton payloads to GTO at a cost ranging between $50 million and $70 million per launch.[458] Mitsubishi Heavy Industries Corp. was selected by JAXA as the prime contractor, with the launcher expected to feature a liquid hydrogen/liquid oxygen core stage with up to six solid-fuel strap-on boosters to offer a wide range of payload-to-orbit capabilities.[459]

6.9 China

Chinese space policy revolves around the country's five-year economic development plan. The country's space programme is therefore meant to support its overall development objectives, while maintaining a comprehensive set of objectives for space activities. The main challenge for the Chinese programme is to achieve the right mix of national space capabilities and participation in international space cooperation. In December 2011, the Chinese government announced its latest five year plan for 2011-2016, in the form of a government White Paper entitled "China's Space Activities in 2011".[460] This document updates and extends the country's strategic and operational objectives in space, depicting the progress made since 2006 and laying down its short term plans, divided into four main activity areas: space transportation, satellite development, space applications and space science. In addition to this, it presents China's ambitions to play a pivotal role on the international scene and underpins the contribution of space activities to achieving this purpose.

China's principle policy objectives in space are all related to promoting the country's scientific, economic and social development, securing its national security and independence (in its broader sense) and improving its international influence by engaging in space cooperation. More specifically, it relates space activities to achieving the objectives of its scientific and technological innovation policies. At the same time, it stresses the importance of maintaining independent space capabilities, while carefully trying to balance this with an open approach to international cooperation and insistence on the peaceful exploitation of space. In a nutshell, the new Chinese space policy's principal axes are:

- Enhance space science and technology capabilities through innovation.
- Maintain technological and operational self-reliance across the board.

[453] "JAXA to launch solid fuel rocket." 31 Oct. 2012. SpaceNews 30 May 2014 <http://www.spacenews.com/article/jaxa-launch-solid-fuel-rocket>.
[454] Ferster, Warren. "JAXA's Epsilon Rocket Scheduled for Aug. 22 Debut." 21 May 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/launch-report/35427jaxa%E2%80%99s-epsilon-rocket-scheduled-for-aug-22-debut>.
[455] Onuki, Misuzu. "Out-of-synch Computers Cited in Epsilon Launch Abort." 30 Aug. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/launch-report/37014out-of-synch-computers-cited-in-epsilon-launch-abort>.
[456] Ferster, Warren. "JAXA's Epsilon Small-satellite Launcher Makes Successful Debut." 23 Sept. 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/launch-report/37363jaxa%E2%80%99s-epsilon-small-satellite-launcher-makes-successful-debut>.
[457] Kallendar-Umezu, Paul. "Japanese Government Recommends Developing H-2A Successor." 27 May 2013. SpaceNews 30 May 2014 <http://www.spacenews.com/article/launch-report/35499japanese-government-recommends-developing-h-2a-successor>.
[458] Onuki, Misuzi. "Japan Approves $1.9B for H-3 Rocket." 13 Jan. 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/civil-space/39069japan-approves-19b-for-h-3-rocket>.
[459] Onuki, Misuzu. "MHI Formally Selected as H-X Prime Contractor, Operator." 25 Mar. 2014. SpaceNews 30 May 2014 <http://www.spacenews.com/article/financial-report/39971mhi-formally-selected-as-h-x-prime-contractor-operator>.
[460] White Papers of the Government of China. "China's Space Activities in 2011." Beijing 29 Dec. 2011. 6 Mar. 2012 <http://www.china.org.cn/government/whitepaper/node_7145648.htm>.

- Adopt an open and constructive attitude to international cooperation on the basis of mutual benefit.
- Oppose space weaponisation and protect the space environment.

All of the aforementioned policies converge to achieve the general national objectives of economic development, social progress and comprehensive national strength.

Apart from these general principles, China's new space policy recites in detail the country's achievements in space over the past five years and declares its programmatic intentions for the future. The level of operational and technological details provided is unprecedented for a Chinese document of this kind; combined with the clear description of future programmes, it implies a higher level of confidence and pride in the country's space capabilities than before. The Chinese five year space programme focuses on four mission areas: transportation, satellites, spaceflight and applications.

On 29 June 2013, China successfully test-fired the rocket engine destined to power the next-generation heavy-lift launcher, Long March 5. The first engine test lasted roughly three minutes from ignition to shutdown. The Long March 5, with its larger carrying capacity, is being pursued in China's 12th Five-Year Plan period (2011-2015). Moreover, China is also drawing up plans for a medium-size Long March 7 launcher. On 13 November 2013, China successfully test-fired the booster engine for the Long March 7, with all systems working stably, and within the tests operating procedure. Both the Long March 5 and Long March 7 have been improved by using non-toxic and pollution-free propellant.[461] The Long March 5 is closely tied to the development of China's embryonic space station, in addition to its developing Moon exploration programme, in which it will be mainly used for the lofting of China's manned space station, with the capacity to carry an 18 metric tons payload to NEO. The Long March 7 will be able to launch 12 metric tons into NEO, and will be capable of launching a cargo spacecraft to the country's manned space station. That said, a new Tiangong 2 space laboratory is planned for launch into orbit by 2015, followed by an experimental core module of the larger space station in 2018, and by 2020 China's manned space station should be completed. Both the Long March 5 and Long March 7 launchers are expected to fly before the end of 2015, and will launch from China's Wenchang Satellite Launch Centre which is currently under construction on the North-Eastern coast of Hainan Island. Once in operation, the complex will hoist heavy GEO communication satellite launches, in addition to space station modules, and missions to the Moon. However, piloted space missions will continue to be conducted from the Jiuquan Satellite Launch Centre. The total cost of the new launch port is estimated to be cost around $810 million.[462] Also of interest under China's 2011-2016 plan is Long March 6, which is described as a "high-speed response launch vehicle". This lightweight launcher will provide China with an operationally responsive launch capability for the first time, with obvious national security and commercial applications. China aims to have the Long March 6, capable of delivering 1 ton to LEO, developed by 2016.[463]

China is also beginning to draw up preliminary designs for a Long March 9 Super-Heavy launcher which is planned to be more powerful than the Saturn V launcher of the Apollo missions, and match the lift capacity of NASA's planned SLS Block 2 launcher. China's CALT has studied configurations similar to those that NASA considered to lift 130 metric tons to LEO; though China aims to build the largest space launcher in history. Preliminary work is already underway for the intended engines, and at the International Astronautical Congress held in Beijing on 23-27 September 2013, the CALT published the main specifications of the two possible configurations. The first concept would have four YF-660 engines mounted in the core first stage and one in each of four side-mounted boosters. In the second concept, most of the initial thrust would come from four solid-propellant boosters, each generating 1,000 tons of thrust, while four YF-220 concept engines would be mounted in the first stage. While work is underway on the engines, the Chinese industry is still awaiting permission to begin developing the Long March 9.[464]

In the field of satellite development, the new Chinese space policy describes a comprehensive programme embracing all fields of satellite and spacecraft use. It calls for the development of improved weather and communications satellites, as well as of an entirely new Earth observation and electromagnetic

[461] "Long March 7 Launch Vehicle Completed Booster Engine Firing Test." 26 Nov. 2013. China Manned Space Engineering 2 May 2014 <http://en.cmse.gov.cn/show.php?contentid=1355>.

[462] David, Leonard. "Chinese Rocket Engine Test a Big Step for Space Station Project." 15 July 2013. Space.com 2 May 2014 <http://www.space.com/21957-china-rocket-engine-test-space-station.html>.

[464] "Chinese Super-Heavy Launcher Designs Exceed Saturn V." 30 Sept. 2013. Aviation Week 2 May 2014 <http://aviationweek.com/awin/chinese-super-heavy-launcher-designs-exceed-saturn-v>.

monitoring satellite series. The key plank of this programme would be the development of a satellite fleet capable of all-weather 24-hour operations worldwide, which would imply making significant advancements in space borne SAR and high resolution optical instrument technologies. Finally, the new policy reiterated China's goal of fielding a regional satellite navigation capability by the end of 2012 and to complete the deployment of its entire thirty-five satellite Beidou GNSS constellation by 2020. On 27 December 2013, China announced that it expects to launch upgraded Beidou satellites by 2020, with accuracy expected to be improved to the meter or sub-meter level by that time. The Beidou system began providing positioning, navigation, timing and short message services to civilian users in China and surrounding areas in the Asia-Pacific region in December 2012, with accuracy to within 10 meters.[465]

In the area of orbital spacecraft development and human spaceflight, China has made substantial headway in fulfilling the goals of its manned programme's three-step strategy (i.e. first perfecting its human spaceflight transportation system, then building a space station and moving on to a manned moon landing), so far demonstrating the program's ability to stage simple spacewalks and to navigate and dock in orbit. However, those capabilities will need to be even further expanded prior to attempting to assemble China's planned modules into a 60-ton space station staffed by taikonauts for months at a time. Following the launch of China's Shenzhou 10 mission in June 2013, which lasted more than 14 days and featured television transmissions from the three-person crew inside Tiangong 1, China has moved onto the next stage in station development focusing on the 2015 launch and operation of a larger space station testbed named Tiangong 2, followed by a more spacious experimental space station around 2018.[466]

On 31 October 2013, the names of China's future station and cargo ship were released, to be listed as follows: China's manned space station is named "Tiangong" (TG); the core module is "Tianhe" (TH); the Experimental Module-1 is "Wentian" (WT); Experimental Module-2 is "Xuntian" (XT); and the cargo spaceship is named "Tianzhou" (TZ).[467] The primary emphasis of research on the station will be life and physical sciences, with the former divided into five areas: fundamental biology, biotechnology, space radiation biology, fundamental studies on cells and interdisciplinary studies; and the latter including biological mechanics research and hypomagnetic biology. Planned to operate in orbit from 2022 to 2032, officials in China aim to provide opportunities to scientists in China and all the world.[468]

While China has consistently pursued its goal to be self-sufficient in its space activity, it has done so by explicitly positioning itself between industrialized and developing countries. This approach implies a two-fold strategy seeking to exploit the country's comparative technological advantages vis-à-vis the latter and remedying its weaknesses compared to the former. It therefore implies that the Chinese officials are keenly aware of their country's unique position on the global space activities' scene, and they are hopeful to fully exploit it. Presumably, this would involve providing affordable space opportunities to their developing country partners, and engaging in high profile missions with more established space faring nations. In this context, the areas of scientific research, satellite applications, human spaceflight, technological cooperation, and satellite services' commercialisation are identified as principal future cooperation areas. When considering this list, it is indeed probable that Chinese officials aspire to establish their country as a satellite applications provider to emerging economies, and a peer partner to developed space powers for innovative space science, technology and spaceflight missions.

China's third Tianlian data-relay satellite, Tianlian I-03 was launched on 25 July 2012. It was preceded by the Tian-lian I-02 launched in July 2011, and the Tianlian I-01 launched in 2008. The Tianlian data-relay spacecraft support China's manned flights, in addition to being related to the development of China's Tiangong space station. China is now the third nation after the United States and Russia to build an operational data-relay service. This is viewed as being comparable to NASA's TDRS data relay satellites.[469]

[465] "China's BeiDou Satellite System Expected to Achieve Global Coverage By 2020." 27 Dec. 2013. Xinhuanet 2 May 2014 <http://news.xinhuanet.com/english/china/2013-12/27/c_133001847.htm>.

[466] Clark, Stephen. "Tests Loom in China's Next Decade of Human Spaceflight." 15 Oct. 2013. Spaceflight Now 2 May 2014 <http://spaceflightnow.com/news/n1310/15shenzhou/>.

[467] "China Manned Space Program Logo and Names of Space Station and Cargo Ship Officially Released." 31 Oct. 2013. China Manned Space Engineering 2 May 2014 <http://en.cmse.gov.cn/show.php?contentid=1354>.

[468] Klotz, Irene. "China Unveils Space Station Research Plans." 12 Nov. 2013. SpaceNews 2 May 2014 <http://spacenews.com/article/civil-space/38131china-unveils-space-station-research-plans>.

[469] Todd, David. "Chinese data relay satellite TianLian-1C is launched successfully on a Long March 3C." 26 July

China's intensive launching campaign continued in 2012 and 2013. For example, once again, within two consecutive days (25-27 November 2012) from two separate launch sites, China launched two satellites - the Yaogan 16 remote sensing satellite to LEO, and Chinasat 12 (APSTAR 7B) communications satellite.[470] Between 2012 and 2013, there were 6 occasions where Chinese launches occurred within four days of one another.

6.10 India

By tradition, Indian policy aims at achieving social and economic development through space activities. India's government approved the 12th five-year plan (2012-2017) with the aim of achieving an annual average economic growth rate of 8.2%, reduced from the 9% envisaged earlier, in view of fragile global recovery.[471] However, India's space programmes are driven by a decade profile and directions for 2025. The broad directions for the space programme for the next decade include: (i) strengthening operational services in communications and navigation; (ii) developing enhanced imaging capability for natural resource management, weather and climate change studies; (iii) space science missions for better understanding of the solar system and the universe; (iv) planetary exploratory missions; (v) development of heavy lift reusable launch vehicles and (vi) a human space flight programme. Innovations in space-based communications and earth observations will be pursued to achieve faster delivery of information to remote areas and finer observations of earth. Overall, 58 missions are planned for realisation during the Twelfth Plan period which includes 33 Satellite missions and 25 Launch Vehicle missions.[472]

While a human spaceflight mission will not be conducted before the year 2017, there are funds in the 12th five-year plan to continue with pre-project studies and to develop critical technologies associated with the proposed mission. However, India still lacks an operational GLSV needed to launch a two-member crew to LEO and have them return safely to Earth. While India's GSLV-Mk II rocket was proposed to be used for the mission, it would be able to carry only the two-member crew; the GSLV-Mk III that is currently under development will have additional mass left for conducting scientific experiments in addition to hosting a two-member crew.[473]

6.11 Brazil

Despite long-standing obstacles for Brazil's space and R&D development, and the lack of expertise in its workforce, Brazil is becoming an important space player of the future due to its geographic position close to the equator, and its rapidly growing economy. Brazil released its 'National Program of Space Activities 2012-2021' in 2012, with the advancement of industry as its top priority. As part of its strategic guidelines the country plans to consolidate the Brazilian space industry by increasing its competitiveness and innovation capacity, also through the use of the state's purchasing power and partnerships with other countries. It will develop an intensive programme of critical technologies in order to foster capacity building in the space sector, with greater participation of academia, S&T governmental institutions and industry. Partnerships with other countries will be expanded, by prioritizing joint development of technological and industrial projects of mutual interest. It will also encourage funding of programs based on PPPs, and will promote greater integration of the space activities governance system in the country by increasing synergy and effectiveness of actions among its main players and the creation of the National Space Policy Council, run directly by the Presidency of the Republic. Legislation affecting space activities will be improved by encouraging and facilitating government purchases, allocating more funds for the Space Sectoral Fund, and decreasing taxes on industry. And Brazil will encourage the development of human resources by training of experts needed in Brazilian space activities, both domestically and abroad - in addition to promoting public awareness on the relevance of the study, use, and development of the space activities in Brazil. Overall, Brazil's space plan calls for expendi-

2012. Seradata 19 May 2014 <http://seradata.com/SSI/2012/07/chinese-data-relay-satellite-t/>.

[470] Federal Aviation Administration. Commercial Space transportation: 2012 Year in Review. Washington DC: FAA, Jan. 2013: 32.

[471] "Government Approves 12th Five Year Plan." 4 Oct. 2012. The Times of India 3 May 2014 <http://timesofindia.indiatimes.com/business/india-business/Government-approves-12th-five-year-plan/articleshow/16672927.cms>.

[472] "Twelfth Five Year Plan (2012-2017)." 10 May 2013. Planning Commission Government of India 3 May 2014: p.264 <http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol1.pdf>.

[473] Radhakrishnan, K. "India Not to Undertake Human Space Flight Before 2017: ISRO." 17 Sept. 2012. The Economic Times 3 May 2014 <http://articles.economictimes.indiatimes.com/2012-09-17/news/33902713_1_cryogenic-engine-gslv-mk-iii-radhakrishnan-today>.

ture of 9.1 billion reals ($4.6 billion) on its space programme through 2021, in which the budgeting of 900 million reals per year is considered to be essential to generate the necessary growth and sustainability of Brazil's space sector.[474] A total of 47% of the budget is devoted to a series of satellite missions, while 26% is for space infrastructure and 17% for space access projects.[475]

Brazil has cultivated partnerships with space powers around the globe. With respect to China, the two nations have an ongoing global strategic partnership, mainly developed from the China-Brazil Earth Resources Satellite (CBERS) project that began in 1988.[476] On 9 December 2013, a malfunction in the third stage of China's Long March 4B rocket resulted in the loss of the CBERS-3 Earth observation satellite. Nevertheless, the partners are continuing with the CBERS programme, already beginning development of the CBERS-4 satellite. The first CBERS-1 launched in 1999, with CBERS-2 following in 2003, and CBERS-2B in 2007.[477]

Brazil is also undertaking cooperative programs with Ukraine to build six Cyclone-4 rockets that could launch heavy satellites into low Earth orbit (LEO) and small communications satellites to geostationary transfer orbit. Brazil and Ukraine created the binational company "Alcântara Cyclone Space" (ACS), with financing divided equally, for commercial launches using the Ukrainian vehicle Cyclone-4 from the Alcântara Launch Center (ALC) whose proximity to the equator gives the launch vehicle more capacity to orbit than can be offered from other spaceports.[478] The launcher development program is estimated to cost 1.58 billion reals ($802.5 million) over the 10 year period. The Cyclone-4 program, listed as a separate budget item, is allocated an additional 459.8 million reals ($233.8 million) during the 10-year period. Moreover, around 1.9 billion reals ($970 million) has been allocated for space infrastructure improvements, mostly going toward development of the ALC. Brazil hopes to launch the Cyclone-4 rocket from the ALC in 2014.[479]

Russia will aid Brazil in its plans to become self-sufficient in launcher and space technology, following its delegation's visit to Brazil during a Latin American tour on 14-17 October 2013. While Brazil's Satellite Launch Vehicle (VLS-1) project was paused in 2003 following an explosion on the launch pad killing 21 people, development recently began again, albeit with a shortage of funding and trained personnel. Under a previous agreement between Roscosmos and the Brazilian Space Agency (AEB), Russia will provide launcher technology to help complete Brazil's VLS-1 project.[480]

6.12 Emerging Space Actors

On 30 January 2013, South Korea successfully launched its Naro-1 rocket (previously known as the Korea Space Launch Vehicle (KSLV)). It lifted the 100kg Korean-built STSat-2C technology demonstration satellite to LEO orbit, to operate for one year taking measurements of the space radiation environment. This marked the first success of the launcher after two previous launch failures in 2009 and 2010, making South Korea the 11th nation to launch a rocket into space from its own territory. While this launcher uses a Russian built RD-151 engine that is a similar, less powerful version of the engine to be used in Russia's Angara launcher, South Korea expects to develop a more powerful indigenous NGL by 2021. A sum of 529 billion Korean won ($479 million) has been invested into the Naro vehicle by the Korean government since development began, with a total allocation of more than 1.5 trillion won dedicated to the launch vehicle program through 2021.[481] With hopes high for the development of the NGL, South Korea intends to launch the upgraded KSLV-2 launcher to the Moon, carrying a 10–20 kg lunar rover to search for rare minerals on the surface, sometime after 2020.[482]

[474] "National Program of Space Activities 2012-2021." 15 Mar. 2013. AEB 3 May 2014 <http://www.aeb.gov.br/wp-content/uploads/2013/03/PNAE-Ingles.pdf>.
[475] Messier, Doug. "Brazil Scales Back Launch Vehicle Plans." 10 Feb. 2013. Parabolic Arc 3 May 2014 <http://www.parabolicarc.com/2013/02/10/brazil-scales-back-launch-vehicle-plans/>.
[476] Ibid.
[477] De Selding, Peter. "China Blames Long March Failure on Third-stage Malfunction." 10 Dec. 2013. SpaceNews 3 May 2014 <http://www.spacenews.com/article/launch-report/38585china-blames-long-march-failure-on-third-stage-malfunction>.
[478] De Selding, Peter. "News from the 64th International Astronautical Congress | Backers Insist Brazilian Spaceport Is Nearing Launch Readiness." 4 Oct. 2013. SpaceNews 3 May 2014 <http://www.spacenews.com/article/launch-report/37550news-from-the-64th-international-astronautical-congress-backers-insist>.
[479] Messier, Doug. "Brazil Scales Back Launch Vehicle Plans." 10 Feb. 2013. Parabolic Arc 3 May 2014 <http://www.parabolicarc.com/2013/02/10/brazil-scales-back-launch-vehicle-plans/>.
[480] "Russia Offers Brazil New Joint Space Projects." 20 Oct. 2013. RIA NOVOSTI 3 May 2014 <http://en.ria.ru/russia/20131020/184250734.html>.
[481] De Selding, Peter. "Third Time Lucky for South Korea with Satellite Launch Success." 31 Jan. 2013 SpaceNews 4 May 2014 <http://spacenews.com/article/third-time-lucky-for-south-korea-with-satellite-launch-success>.
[482] Park, Soo Bin. "South Korea Reveals Moon-lander plans." 13 Nov. 2013. Nature.com 4 May 2014

South Korea remains one of the most active emerging space actors, especially in the field of space applications. The Kompsat-3/Arirang-3 was launched on 17 May 2012 on a SSO orbit, constituting Korea's first satellite with a sub-meter resolution. Its sister satellite, Kompsat-3R with additional infrared capability will be launched in 2014. The Kompsat-5/Arirang-5 X-band Synthetic Aperture Radar (SAR) spacecraft was placed into LEO on 22 August 2013, adding radar to South Korea's existing optical Earth observation satellite capacity.[483] This campaign brings the total number of Korean-built satellites in orbit to a total of five, significantly improving both ground resolution and operational flexibility. Although the satellites were poised to provide imagery for civilian and scientific purposes, their improved operational characteristics enable military use as well. It is noteworthy that Korean authorities opted for open commercial market procedures in awarding the programme's contract, because the same commercially oriented approach is expected to prevail in the distribution of the satellites' products.[484]

During the reporting period, Singapore emerged as another Southeast Asian country with significant space aspirations. Most international commercial space companies maintain offices in the country, encouraged by favourable tax laws. In February 2013, Singapore began taking formal steps to build its space-satellite industry by setting up the Office for Space Technology and Industry (OSTIn), as an Economic Development Board programme that comprises multiple Government agencies to plan and execute economic strategies in that pursuit.[485] Concurrently, the Singapore Space and Technology Association (SSTA) and the Singapore Science Centre Board (SSCB) have a memorandum of understanding with a hi-tech start-up, IN.Genius, which plans to develop a space science education programme and send the first Singaporean to space by 2015.[486]

And in the Middle East region, Iran continued to establish itself as a strong regional space actor, through the implementation of a comprehensive space programme. In 2012, the focus of Iran's space activities was space application. Iran conducted 3 launches in 2012, with two launches resulting in failure. While Iran's Navid-e Elm-o Sanat remote sensing satellite was successfully launched on 3 February 2012, its other two satellites launched on 23 May 2012 and 22 September 2012, failed to reach orbit.[487] The Navid-e Elm-o Sanat is another Iranian designed and built satellite, and is considered to be a technology validation mission, in addition to being a telecom, measurement and scientific satellite whose records could be used in a wide range of fields.[488] In 2013, Iran's pursuit of human spaceflight was central. On 16 December 2013, the country announced that it had successfully launched a monkey into suborbital space for the second time in 2013, sending it to a 120 km apogee altitude, with a safe return to Earth after a 15-minute ride aboard a Kavoshgar 5 rocket.[489] Earlier in the year, controversy arose when archive photos were used by a news agency instead of photos of the first space monkey's return, creating doubt as to the accuracy of the claims by Iranian officials.[490] Having reached a new milestone, launches of animals are expected to continue into 2014, helping scientists continue to develop space technology in the pursuit of sending a human to space by 2018.

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List of Acronyms

Acronym	Explanation
A	
ACS	Alcântara Cyclone Space
AEB	Agência Espacial Brasileira (Brazilian Space Agency)
AG	Aktiengesellschaft
AIA	Aerospace Industry Association
ALC	Alcântara Launch Center
ASAT	Anti-Satellite
ASD	Aeronautics, Space & Defence industries association
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ARM	Asteroid Redirect Mission
ATV	Automated Transfer Vehicle
B	
BMD	Ballistic Missile Defence
C	
CAA	Continuing Appropriations Act
CAGR	Compound Annual Growth Rate
CASBAA	Cable and Satellite Broadcasting Association of Asia
CAST	China Aerospace Science and Technology corporation
CBERS	China-Brazil Earth Resources Satellite
CCDev	Commercial Crew Development programme
CCiCap	Commercial Crew integrated Capability initiative
CCL	Commerce Control List
CGWIC	China Great Wall Industry Corporation
CHF	Swiss franc
CHIRP	Commercially Hosted Infrared Payload
CIC	China Investment Corporation
CNES	Centre National d'Études Spatiales (French Space Agency)
CNSA	China National Space Administration
CSA	Canadian Space Agency
CTS	Crew Transportation System

D	
DARPA	Defense Advanced Research Projects Agency
DARS	Digital Audio Radio Service
DBS	Direct Broadcast Services
DC4EU	Dream Chaser for European Utilization
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)
DoD	Department of Defence
DRDO	Defence Research and Development Organisation
DTH	Direct To Home
DWSS	Defense Weather Satellite System
E	
EADS	European Aeronautic Defence and Space company
EAP	Environmental Action Programme
EC	European Commission
ECA	Evolution Cryotechnique type A
ECSAT	European Centre for Space Applications and Telecommunications
EDA	European Defense Agency
EDRS	European Data Relay Satellite System
EELV	Evolved Expendable Launch Vehicle
EFT-1	Exploration Flight Test-1
EO	Earth Observation
EPAA	European Phased Adaptive Approach
EPS-SG	European Polar System Second Generation
ESA	European Space Agency
ESPI	European Space Policy Institute
EU	European Union
EUMETSAT	The European Organisation for the Exploitation of Meteorological Satellites
EUTELSAT	European Telecommunications Satellite Organisation
F	
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FP8	Eighth Framework Programme
FSS	Fixed Satellite Services
G	
GAO	Government Accountability Office
GCSP	Global Collaborative Space Programme
GDP	Gross Domestic Product

GEO	Geostationary Earth Orbit
GIFAS	Groupement des Industries Françaises Aéronautiques et Spatiales
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistemya (Russian GNSS Constellation)
GMES	Global Collaborative Space Programme Monitoring for Environment and Security
GNSS	Global Navigation Satellite Systems
GNI	Gross National Income
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
H	
HDTV	High-Definition Television
HoPS	Hosted Payload Solutions
HTV	H2A Transfer Vehicle
I	
IBDM	International Berthing and Docking Mechanism
ICBM	Inter-Continental Ballistic Missile
IGS	Information Gathering Satellite System
IMF	International Monetary Fund
IMO	International Maritime Organisation
IOV	In-Orbit Validation
IRGC	Islamic Revolution Guards Corps
ISR	Intelligence, Surveillance and Reconnaissance
ISRO	Indian Space Research Organization
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
J	
JAXA	Japan Aerospace Exploration Agency
JEO	Jupiter Europa Orbiter
JPSS	Joint Polar Satellite System
JUICE	JUpiter ICy moon Explorer
JWST	James Webb Space Telescope
K	
KISS	Keck Institute for Space Studies
KSLV	Korea Space Launch Vehicle
L	
LEO	Low Earth Orbit

M	
MAVEN	Mars Atmosphere and Volatile Evolution
MDA	Missile Defense Agency
MDA Ltd.	MacDonald, Dettwiler and Associates Ltd.
ME	Mid-life Evolution
MELCO	Mitsubishi Electric Co.
MEO	Medium Earth Orbit
METOP	Meteorological Operational Satellite
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MFF	Multiannual Financial Framework
MFG	Meteosat First Generation
MPCV	Multi-Purpose Crew Vehicle
MSG	Meteosat Second Generation
MTG	Meteosat Third Generation
N	
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organisation
NDAA	National Defense Authorization Act
NEC	Nippon Electric Company
NESDIS	National Environmental Satellite, Data and Information Service
NGA	National Geospatial-Intelligence Agency
NIRSpec	Near-Infrared spectrograph
NOAA	National Oceanic and Atmospheric Administration
NRO	National Reconnaissance Office
NSOAS	National Satellite Ocean Application Service
O	
OECD	Organisation for Economic Co-operation and Development
OHB	Orbitale Hochtechnologie Bremen
OMB	Office of Management and Budget
ONSP	Office of National Space Policy
OPEC	Organization of the Petroleum Exporting Countries
OSTIn	Office for Space Technology and Industry
P	
PCW	Polar Communications and Weather mission
PDV	Prithvi Defence Vehicle
PLA	People's Liberation Army
PND	Portable Navigation Devices

PPP	Public-Private Partnership
PSLV	Polar Satellite Launch Vehicle
PTSS	Precision Tracking Space System
Q	
QZSS	Quasi-Zenith Satellite System
R	
RCM	Radarsat Constellation Mission
S	
SAS	Société par Actions Simplifiée
SAC	Space Activities Commission
SAR	Synthetic Aperture Radar
SecTelSat	Secure Telecom by Satellite
SES	Société Européenne des Satellites
SpaceX	Space Exploration Technologies
SIA	Satellite Industry Association
SLS	Space Launch System
SM	Standard Missile
SNC	Sierra Nevada Corporation
SpA	Società per Azioni
SPC	Space Programme Committee
SS/L	Space Systems/Loral
SSA	Space Situational Awareness
SSCB	Singapore Science Centre Board
SST	SpaceShip Two
SSTA	Singapore Space and Technology Association
T	
TFEU	Treaty on the Functioning of the European Union
TG	Tiangong
TH	Tianhe
TZ	Tianzhou
U	
UAS	Unmanned Aerial Systems
UK	United Kingdom
ULA	United Launch Alliance
UN	United Nations

UN CTAD	United Nations Conference on Trade and Development
UN FCCC/COP	United Nations Framework Convention on Climate Change/Conference of the Parties
UN REDD	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
US	United States
USAF	United States Air Force
USAT	Ultra Small Aperture Terminals
USML	United States Munitions List
V	
VERTA	Vega Research and Technology Accompaniment
VLS	Brazil's Satellite Launch Vehicle
VSAT	Very Small Aperture Terminals
W	
WGP	World Gross Product
WT	Wentian
X	
XT	Xuntian

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