European space activities in the global context

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1. Global political and economic trends

In 2009 the global financial crisis entered a new stage, in which the adverse effects of last year's credit crisis started to weigh on worldwide economic activity. The year was marked by a fall in global industrial production and trade activity and a consequent steep rise in unemployment. However, the first signs of improvement also made their appearance, as bank earnings and capital levels began to rise again and GDP growth started to return, although it is not expected to reach pre-crisis levels for several years. In 2010 this trend is expected to continue, but economic recovery will be slow and precarious. This year's economic policies are expected to focus on continuing the reform of the financial and banking system, rebalancing the patterns of global trade, boosting private consumption, enhancing international cooperation and restraining unemployment rates before they change from cyclical to structural. The pace of economic recovery is expected to be slow and very different from country to country. Emerging economies will exit the crisis at a quicker pace than advanced ones, but the whole process will remain fragile and extremely vulnerable to adverse events such as rising commodity prices, geopolitical events, or a resurge of protectionism.

1.1. Global economic outlook

In 2009 the global economy appears to be expanding again and this trend is expected to continue in 2010. At present, Asian economies seem to be the driving force behind global economic recovery, whereas stabilisation and modest improvement is the case elsewhere. Apart from Asia however, recovery is projected to be weak and slow by historical standards and GDP growth will remain well below pre-crisis levels until 2014 at least.[1] For 2010 global activity is expected to expand by approximately 3%, after a 1% contraction in 2009. Growth in emerging economies will be significantly higher.[2] This sluggish recovery will be marked by long lasting post-crisis characteristics such as low inflation, a drop in private

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consumption and investment, and a steep rise in unemployment which may become structural. Markets and financial institutions have been stabilising and will continue to do so in 2010. Nevertheless, market financial stress and risk aversion will remain elevated for the foreseeable future, which will put considerable stress on households and medium-size enterprises, and will consequently continue to increase bank loan delinquencies. On the upside, international capital flows are on the way to recovering.[3]

In the financial sector the year has been marked by a slow return of risk appetite that has led to considerable currency fluctuations, with the Euro strengthening its position against both the Dollar and the Yen on the second half of 2009, before falling again in 2010. Bank loans to the private sector however are still stagnating, especially in advanced economies. In fact, credit risks remain elevated and the sustainability of bank earnings is still precarious at best: in October 2009 global bank write-downs were estimated to reach $2.8 trillion and more than half of this amount has not yet been recognised. The bulk of these losses are attributed to U.S., UK and Euro zone banks. In addition to this, a further $1.5 trillion wall of maturing dept will have to be met by 2012.[4] By comparison to European banks, U.S. banks have deleveraged faster and this may help credit conditions in that country to ease sooner. Nonetheless, financing conditions for consumers and medium-size companies in developed countries are expected to remain difficult.

In the second half of 2009 global markets continued to stabilise and this is expected to continue in 2010. Even though investment will not attain pre-crisis levels in the foreseeable future, a certain risk appetite has returned. For the moment, however, market recovery seems fragile, a number of financial stress indicators remains high and the fear of a possible reversal weighs heavily on investors. In the context of the credit conditions described above, global markets are thought to remain extremely sensitive to external factors such as geopolitical events or real-estate-related shocks. Real-estate in particular will continue to put pressure on bank balance sheets, whereas subsequent low construction activity is expected to create additional risks for the financial sector in general.[5]

On a global scale inflation moderated to 1% in mid 2009 down from 6% a year earlier and is expected to remain low in 2010 as well. Inflation rates in emerging economies varied considerably from region to region, dropping in Asian countries and rising in East European ones. Advanced economies are still facing mild deflation risks as the pace of economic recovery remains slow, even though inflation rates are expected to rise above zero in 2010. Deflationary dangers in these countries are aggravated by the fact that interest rates have been brought close to zero and there is little room left for additional financial stimulus from monetary policy measures.[6]

Unemployment rose throughout 2009 and is anticipated to continue rising in advanced economies throughout 2010. Both in the U.S. and the Euro zone, unemployment rates are anticipated to exceed 10% in 2010. Non-financial corporations and medium-size companies will continue to lay off workers due to the aforementioned difficult financial conditions. Countries with proportionately greater construction sectors will suffer even greater job losses. Euro zone countries are projected to face higher unemployment rates than the U.S. (up to 12% in 2010) due to a more sluggish recovery and a less adjustable job market. In the medium-term, historical evidence suggests that in the aftermath of major economic crises and the protracted recovering period that succeeds them, unemployment can become structural and difficult to deal with. This might be the case in the Euro zone, where unemployment rates are not expected to fall bellow 10% before 2014 at the earliest.[7] In any event, rising unemployment will pose a major challenge to all advanced economies throughout 2010.[8]

As a result of the above-mentioned factors, governments worldwide will continue to implement extraordinary public support measures for financial institutions well into 2010. These measures however will have to face the challenge of transforming from short-term financial stimulus schemes to medium-term comprehensive reform policies. Formulating these policies faces three major challenges: rallying the necessary public support, choosing the right timing, and respecting as much as possible macroeconomic budgetary and fiscal constraints. Indeed in 2009 and the first half of 2010, public support for the recapitalisation of financial institutions diminished considerably, especially in advanced economies. Public opinion is becoming more and more sceptical on measures that are perceived as generous government bailouts for firms that were largely responsible for the credit crisis in the first place.[9] This development, in conjunction with increasing unemployment, will make governments reluctant to increase recapitalisation measures in the face of mounting political pressure to do the opposite.

In 2010, political considerations together with an improving financial environment will push governments to consider lifting the extraordinary monetary accommodation that they offered to financial institutions in 2008. It seems that the most difficult task ahead will be to carefully choose the timing of this decision. If the unwinding of public intervention comes too soon, it will place the progress made in 2009 in jeopardy. If it is protracted for a longer period than necessary, it will distort market incentives and create fiscal problems for national budgets.[10] Although monetary accommodation measures are likely to stay in force throughout 2010, governments will probably have to decide on this matter before the end of the year.

Finally, lifting recapitalisation measures will have to be accompanied by medium term policy decisions on reforming the financial sector framework, while

restructuring fiscal policies to accommodate the large public dept that the crisis generated in many countries. Prudent macroeconomic decisions will have to be made on both issues in 2010 and this development is already under debate both on a national and an international level. In fact in 2009, there has been an unprecedented level of international cooperation in tackling the credit crisis aftermath. In 2010, this cooperation is expected to expand into taking specific regulatory decisions on reforming the financial sector operating framework, stabilising the economic circle, and avoiding financial protectionism. Indeed, protecting public finances and especially central banks' balance sheets already became a key plank of economic measures in the second half of 2009, and this is expected to continue. In conclusion, the main challenge that advanced economies are facing in 2010 is the need to find room for adequate macroeconomic countercyclical policies in the face of fiscal problems caused by accumulated public dept during the crisis period.[11]

One of the key trends in 2009 and 2010 has been that emerging economies have entered recovery much faster and easier than advanced ones. This is particularly the case for China and India, which escaped a severe recession. With considerable help from its robust fiscal position and the overall health of its banking sector, China has initiated large policy stimuli (up to 5% of its GDP in 2009) and successfully managed to overcome the fall of its exports, which in 2009 were reduced by 30% compared to 2008. This was mainly achieved through boosting domestic demand (private credit rose by 25% in the first half of 2009) and undertaking major infrastructure and industrial retooling projects. This led to an 8.4% GDP growth in 2009 and a continued expansion in 2010.[12]

In fact, China has been the driving force behind the recovery of the entire SE Asia region, where capital flows resumed in 2009 and markets rose sharply. Nevertheless, given the slow pace of recovery in advanced economies, it remains unclear whether Chinese growth will be able to sustain itself beyond 2010 without an adequate increase in exports. At the same time, boosting domestic demand by prolonged credit growth may increase inflationary pressure in the medium term. The Indian economy grew at a somewhat slower pace in 2009 and 2010 as well, at an annualised rate a little above 6%. Growth has been facilitated by adequate monetary policies and a relatively smaller dependence of the Indian economy on exports.[13]

In 2009, Russia experienced an estimated 8.7% contraction of its GDP.[14] This development was the result not only of the world credit crisis, but also of the fall of the oil price that occurred. Low oil prices caused a considerable surge in capital flows in the first half of 2009, which led to an important 5.9% depreciation of the ruble, but this trend was reversed in the 4th Quarter, following a rise in oil prices and a considerable increase in exchange and gold reserves.[15] Domestic demand in the country fell sharply, followed by production (−12.6% in tradable goods in

2009) and investment. Unemployment adjusted to 7.6% at the third Quarter of 2009, from 9.2% at the beginning of the year and it is projected to remain stable in 2010 as well. From the fourth Quarter of 2009 industrial output has been improving slowly and consumption has been regaining lost ground, but real wage reductions and tight credits have caused non-tradable goods production to continue stagnating. At the same time the credit market is not expected to ease throughout 2010.[16]

In economically advanced countries the pace of economic recovery has been considerably slower. In the U.S. the financial situation has been stabilising throughout 2009 and the first Quarter of 2010. GDP contraction has been slowing down from −6.4% at the beginning of 2009 to a 2.2% increase in the third Quarter.[17] On an annual basis, the U.S. economy is expected to contract by 2.45% in 2009, but a modest growth of 1.5% is expected for 2010. Although economic stabilisation is likely to continue, growth will probably not exceed the rate of 2% in the medium turn. In the mean time, credit conditions remain uncertain and unemployment has risen to the highest rates since the early 1980s (in 2009 it is expected to reach 10% on an annual basis). The greatest challenge for the U.S. economy in 2010 is to prevent high cyclical unemployment rates from becoming structural, as well as addressing long-term imbalances in public, corporate and household expenditures.[18]

In Europe, recovery seems to be more sluggish than in the U.S. The Euro zone did not emerge from recession before the end of 2009, and it is predicted to attain growth rates less than 1% in 2010. Further growth will only be attained gradually and in the medium-term. Unemployment reached 10% in 2009 and might reach 12% in 2010. Credit in the Euro zone remains tight due to the greater role of banks in the financing system, as well as major exposures to cross-border risks regarding banking activity in Eastern Europe. Emerging EU economies, such as those of the Baltic States, Bulgaria and Romania, have been hit particularly hard by the crisis, whereas countries with moderate current account deficits or surpluses have shown more resilience.[19] In 2010, public expenses in most EU countries are deteriorating sharply, and addressing this problem will be of great importance. Containing the rise of unemployment and supporting demand under strict budgetary restrictions will prove a major challenge in 2010 for most European countries.

In Japan, stabilisation started in the second half of 2009 and continues in 2010.[20] After a steep GDP drop (−11.9%) in the first Quarter of 2009, modest growth (2.7–1.3%) returned during the rest of the year and continued in 2010.[21] Unemployment rates throughout the aforementioned period remained high by Japanese standards, hovering above 5% on an annual basis in 2009, while at the same time real wages continued to decline. Corporate and bank profits were

substantially reduced and mild deflationary pressures appeared on prices. Business investment continued falling and uncertainty about the future of the economic outlook remained high among both investors and consumers. Nevertheless, industrial output has been increasing since the third Quarter of 2009, profiting mostly from the rise of regional commercial activity, and consumption has been increasingly showing signs of improvement.[22] In general terms, recovery in Japan is following the slow and gradual path witnessed in the rest of the advanced economies, with the addition of a relevantly elevated deflation risk.[23]

1.2. Political developments

1.2.1. Security

Security is a field in which space systems are vital. For the purposes of this report, security is defined in its traditional narrow definition related to defence and the ability to effectively engage in military operations. A broader definition of security is briefly discussed in section 1.2.5. Satellite systems are identified as key enablers of military capabilities. These space applications include image and electronic surveillance gathering, communications, meteorological and navigation/positioning data, among others.

A major development in 2009 and 2010 was the rapid deterioration of the security situation in Afghanistan. Taliban insurgents considerably improved their operational and logistics capabilities in the aforementioned period, resulting in a record high number of casualties for the ISAF coalition forces in the country. These amounted to 520 dead in 2009, a significant increase from 295 in 2008. During the same period, U.S. forces casualties marked a 100% increase, to 316.[24] The bulk of fatalities was attributed to improvised explosive device attacks, which were up by 60% from the year before. Civilian casualties also increased by 12%.[25] The total number of such incidents exceeded 7,200 from 4,169 in 2008, whereas their average explosive charges and destructive capability doubled.[26]

For the first time since August 2009, Taliban insurgents launched a series of suicide attacks inside Kabul. On 28 October 2009 a United Nations personnel residence came under an attack that resulted in the loss of 5 U.N. staff members. As a direct result of this incident, more than 340 U.N. personnel members were relocated outside the country, seriously downgrading the U.N. assistance mission's performance in the area.[27] Taliban forces also resumed their intimidation tactics against the local population with a series of targeted assassination attempts. The overall deterioration in security conditions crippled the United Nation's humanitarian aid and reconstruction programmes.[28]

Security conditions in the country were also affected by mounting political instability. On 19 November 2009, Afghanistan's President H. Karzai was finally inaugurated for a second term. This development ended two months political turmoil between the President and his principal political opponent Dr. Abdullah over the latter's accusations of electoral fraud in the 20 August presidential ballot. President Karzai was proclaimed the winner of the electoral process only because his opponent refused to participate in the second round. However, the run-up to the finalisation of the result increased civilian unrest and paralysed the government. Consequently, public confidence in the country's reconstruction and future also waned.[29]

In the midst of these negative developments, the U.S. President announced on 1 December 2009 a new strategy for Afghanistan. He announced the dispatch of an additional 30,000 troops reinforcement to the country. At the same time, President Obama reiterated his plan to begin the gradual withdrawal of U.S. forces from the country by July 2011. The additional forces proposed would increase annual war costs by $30 billion, or almost by 50% in comparison to the current budget.[30]

The new U.S. policy in Afghanistan followed from a comprehensive strategy document released on 27 March 2009. The new strategy widened the scope of U.S. objectives in the region by including neighbouring Pakistan in its scope of operations. It also recognised that the Taliban principal logistics and command posts were concentrated in Pakistan's border regions with Afghanistan. The proposed action plan included disrupting terrorist operations inside Pakistan, while at the same time increasing military and political assistance to that country. Supporting Pakistan would also involve increased financial cooperation and government building measures to promote democratic rule in that country. The new U.S. policy also called for state building actions in Afghanistan itself, including a new strategic communications and joint civilian-military counterinsurgency strategy.[31]

Another issue that continued to provoke tensions on the international scene was the negotiations regarding the Iranian nuclear programme. On 18 February 2010, the International Atomic Energy Agency (IAEA) published its latest regular two month revue of Iran's atomic energy related activities, in the framework of the relevant U.N. Security Council resolutions. In this document, the IAEA clearly stated that Iran was not cooperating in the verification of the peaceful purposes of its nuclear programme. Furthermore, the Agency found that Iran had failed to meet the requirements set by the U.N. Security Council in order to provide assurances for the nature of its programme. Finally, it particularly took notice of the continued operation of the enrichment facilities in Natanz.[32]

In a considerable departure from its past reports, the IAEA explicitly claimed for the first time that Iran could have possibly started the development of a nuclear payload for a missile. It also went on to give specific technical details of Iran's possible nuclear weapons development capabilities, based on its information.[33]

1.2.2. Environment

Space applications have an important role in environment monitoring and protection. Space assets are uniquely positioned to offer a global perspective on climate change. They often also represent a common multinational platform for collecting relevant meteorological and environmental data. This characteristic makes them ideal promoters of international understanding and cooperation in this field.

Climate change and the concerted international effort to control it continued to be the main issue in environmental policy in 2009 and 2010. Global warming remains a major threat not only to the environment, but also to long-term economic growth and prosperity worldwide. It can potentially disrupt food supply, cause major humanitarian catastrophes, destabilise developing countries and consequently endanger their population.[34] From a political point of view the most important development was the UN Climate Change Conference held in Copenhagen from 7 to 18 December 2009. Its proceedings included the 15th conference of the 193 parties to the UN Framework Convention on Climate Change (UNFCCC/COP) and the fifth meeting of the 189 parties that have adhered to the 1997 Kyoto Protocol (CMP).[35] The Conference was attended by more than 15,000 participants, including 119 Heads of State on its final day, and it attracted unprecedented public attention and press coverage.[36] The conference's principal aim was to discuss appropriate measures against global climate change that will have to be implemented before the Kyoto Protocol's provisions expire in 2012.[37]

Despite the great expectations nourished before the conference and the fact that all participants acknowledged the urgent nature of the measures that had to be taken, progress during the conference was modest and decisions did not arrive until its very last day. The conference's main declared objectives were: to set new long-term emission reduction rates for 2020; to adopt appropriate mitigation actions for developing countries; to initiate a long-term funding commitment from developed countries to sustain these actions; and to set up an appropriate institutional framework for addressing the needs of developing countries.[38] The key objective was to cut down emissions to 25–40% lower than 1990 levels by the year 2020.[39]

Reaching an agreement proved difficult due to the different views between developed and developing countries. The final result of the deliberations was the "Copenhagen Accord", an agreement for industrialised countries to voluntarily limit their emissions by 2020 and for developing countries to muster their efforts to reduce emissions and to communicate their results every two years. All voluntary pledges to limit emissions were listed in the accord by the end of January.[40] It was also agreed that the accord would be reviewed before 2015. Raising funds among developed countries for appropriate actions also proved more difficult than expected. However, a dedicated fund (the "Copenhagen Green Climate Fund") was established to support immediate action against climate change over the next three years, with a total budget of $30 billion. At the same time, the long-term goal of raising $100 billion by 2020 was also reiterated. The next UNFCCC conference is scheduled to take place by the end of 2010 in Mexico City, after two preparatory negotiating sessions in Bonn in 31 May and 11 June.[41]

In addition to this, the 3rd World Climate Conference (WCC-3) was held by the World Meteorological Organisation (WMO) in Geneva between 31 August and 4 September 2009, almost 20 years after the last one in 1990. Participation included an expert panel as well as high-level government representatives. Its main scope was to enhance international cooperation and global capabilities in the field of climate information and weather prediction. In a way, it gave scientists the opportunity to review climate related scientific practices ahead of the Copenhagen Conference. WWC-3 concluded its work with a high-level political declaration and a separate conference statement.[42] Participants agreed on establishing a Global Framework for Climate Services, in order to coordinate and strengthen production and availability of climate prediction services worldwide. They also decided to set up an independent task force of experts that will deliver recommendations on the structure of this Framework within 12 months. These recommendations will then be presented for adoption at the next WCC Conference in 2011.

At the EU level several initiatives were taken by the Swedish Presidency in the first half of 2009. The key subject was preparing the EU's participation in the Copenhagen conference. EU policy objectives for the conference were ambitious. They focused on making considerable progress towards a new comprehensive and binding global treaty to replace the Kyoto Protocol after 2012. In order to achieve this, EU members looked forward to obtaining tangible emission reduction commitments from all conference participants; assuring public finance to implement these reductions until 2020; adopting a new institutional framework for international cooperation on climate change; and implementing a strict follow-up process to monitor the progress made.[43]

In spite of the fact that the EU offered to contribute €2.4 billion by 2012 to meet its funding obligations, its expectations for the conference were not met. Although the conference's decisions were considered a positive first step, emission reductions rates were considered insufficient, long-term financing was not secured and the overarching objective of negotiating a new legally binding treaty was not attained.[44] However, EU Member States associated themselves with the Accord's provision for a 20% emission reduction and offered to increase cuts to 30%, if developing countries would agree to contribute to gas emissions as well.[45] Other key environment policy objectives during the Swedish presidency included protecting biodiversity and promoting the EU's transition into an eco-efficient economy based on renewable energy sources, energy-efficient systems and adequate community planning. Eco-efficient economy in particular is now seen as a possible competitive edge for EU that will enable it to develop new technologies and to become more self-sufficient in terms of energy and natural resources supply.[46]

1.2.3. Energy

Space systems can contribute from orbit to the exploitation of Earth's energy resources. Imaging satellites help determine surface resources and underground deposits alike. Communication and space observation satellites help operate and monitor fossil energy transport corridors. Space applications provided motivation for solar panel technology improvements that are now at the forefront of renewable energy technologies. With recent developments in solar energy gathering satellites, space could become a source of energy for terrestrial use itself.

From mid 2009 to mid 2010 energy demand began to rise again. After a turbulent 2008, when oil prices fluctuated violently, oil prices in 2009 and the first half of 2010 have stabilised to roughly $75–82 bbl.[47] This price level represents a 15 month high and a significant rise from December 2008's $33bbl.[48] Rising oil demand in the developing countries and a particularly cold winter in the northern hemisphere drove the prices up by the end of 2009. This trend continued in 2010, fuelled mostly by economic recovery in SE Asia, as well as by increasing investment flows to commodity assets. Oil supply has been rising mildly throughout this period (roughly by 0.4 billion barrels) while demand was declining. As a result, commercial oil inventories remain significantly high, to approximately 60 days of forward cover. This development, in conjunction with rising demand in 2010, has driven spot and freight prices up.[49]

Although oil demand is increasing in developing countries and it has stopped decreasing in developed ones, global oil consumption remains considerably lower

than pre-crisis levels (app. −2.3 mb/d) and this trend is expected to continue throughout 2010. The continued upward trend of the oil market price in spite of sufficient production and increasing inventory volumes is mainly attributed to increasing investment flows in commodities markets. In fact, the financial sector's exposure to energy commodity assets rose by 70% in the period between December 2009 and January 2010. Since oil production fundamentals do not support these prices, we might be facing the possibility of a downward price spiral in the second half of 2010.[50]

In the medium-term these trends are not expected to change. Oil consumption will not attain pre-crisis levels before 2012, provided that recovery continues. In OECD countries it will remain particularly sluggish and global consumption will mainly be sustained by SE Asia's emerging economies. Almost 80% of the projected increase in oil consumption until 2030 is expected to come from these countries, and the transportation sector will be the driving force behind this demand. Supply is expected to rise modestly, mostly thanks to increasing output by non-OPEC countries. This increase will be the result of exploitation of non-conventional oil sources (e.g. Canadian oil sands). Although OECD countries' supply is expected to decline, natural gas and renewable sources' exploitation will compensate for this loss and overall spare oil supply capacity will remain adequate. Nevertheless, since current price levels do not encourage investment decisions in oil supply, OPEC countries are projected to slightly increase their share of the market and a new price boom cannot be excluded in the medium-term.[51]

Gas prices declined considerably in 2009, due to limited industrial demand, which dropped by up to 10%. Gas-generated power demand, in particular, fell by up to 8% because of its position in the merit order. However, cold weather has kept domestic and commercial heating demand strong and this fact has partially compensated for the decline in industrial use.[52] Price fluctuations varied from market to market. U.S. prices were relatively stable in 2009, because they had already adjusted to the crisis in late 2008. Oil-based prices in Continental Europe and Japan dropped sharply in 2009 as a result of the 2008 crisis, due to the fact that inbuilt time lags in supply contracts did not allow them to adjust earlier. Gas prices in Europe, in particular, remained considerably higher (up to 100%) than those in the U.S. where production actually increased in 2009, mostly thanks to unconventional gas production growth. This development actually allowed U.S. liquid natural gas shipment to be diverted to the Pacific market and to fuel booming industrial demand there. Nevertheless, U.S. future gas output remains one of the main uncertainties concerning future market behaviour.[53]

Another major development in gas markets in 2009 and 2010 was the dramatic increase in LNG supply capacity. Many LNG production development plans started production in 2009, leading to an unprecedented increase in output

capacity (over 370 billion cubic metres). Excess supply capacity will probably test the market's flexibility and resilience in 2010.[54] As with oil, the main issue will be inadequate investment for future projects, under the adverse current financial conditions. With the pace of economic recovery remaining very slow in advanced economies, any prediction for future LNG demand is risky. As a result, most supply development projects are likely to be put on hold for a while, thus creating a shortage of new output capacity after 2012. Obviously, the longer the recovery takes, the greater the LNG supply shortage will be in the medium-term and the higher its price.[55] As gas use in advanced economies is stagnating, developing economies like China or India are emerging as major gas users. In the medium-term, both countries are expected to exceed 100 bcm in annual consumption rate. At the same time, new gas suppliers from the Middle East such as Qatar and Iran are appearing, although the latter is not expected to become a significant exporter before 2015.[56]

In Europe, the early 2009 gas supply crisis left its mark on the entire year and well into 2010 as well, making paramount the issue of strategic gas supply security. The crisis underlined chronic interconnectivity, reverse flow and storage capacity deficiencies in many European countries, especially in Central and Eastern Europe. Better and time-efficient cooperation among European countries in this area has become a key subject of discussion in 2009 and 2010. The objective for the EU in particular is to enhance energy security through varying gas sources and routes, increasing storage capacity and diversifying electrical power sources. However, implementing these policies will require considerable funding in the short-term that is not guarantied in the current financial conditions. Furthermore, diversifying power supply by embracing renewable energy sources might actually increase gas consumption in the medium-term, as environmentally poor power sources will be abandoned and renewable ones will not yet be able to entirely substitute for them .[57]

In conclusion, global and especially European energy policies from mid 2009 to mid 2010 are facing multiple challenges with often contradictory solutions. Improving environmental efficiency will necessitate adequate funding that is difficult in times of financial insecurity. Limited investment will result in greater dependency on imported gas supply in the medium-term and limited energy security. Advanced economies will have to improve energy efficiency, while at the same time coping with the price fluctuations caused by booming demand in emerging economies. Increasing gas demand in SE Asia combined with stable or declining demand in the U.S. (and possibly Europe) will raise international pressure to disassociate their price index.[58] In general, long-term policies designed to improve the environmental impact and efficiency of energy resources will decrease energy security in the medium-term by consolidating the market power of

traditional resource suppliers, such as Russia and the Middle East countries. Consequently, an unprecedented level of international cooperation, prolonged investments and strict market transparency measures will be indispensable, in order to tackle all of these issues simultaneously.

1.2.4. Resources

Space applications can also be useful for accommodating international trade and improving the exploitation efficiency of other natural resources as well. Imaging and meteorological satellites can make agricultural output bigger and more reliable. Furthermore, communication satellites are indispensable for making international business transactions and payments, which continue to grow in today's globalised commercial environment.

After a sharp drop in 2008 and in the first half of 2009, international trade and commodity prices began to rise again from the third Quarter of 2009. This development was principally due to industrial output recovery in the emerging economies of Asia, and especially China. However, the slow pace of economic recovery in developed countries is still limiting commodity demand and pushing prices down. Overall global trade in 2009 contracted by approximately 17.6%.[59] As a result of weak recovery and weak base effects, commodity prices are not expected to reach pre-crisis levels before 2011 at the earliest.[60] For 2010, global trade growth is not expected to exceed 4.2%.[61] Low industrial production levels caused metal prices to plummet in 2009 (aluminium: −11%, copper: −9%). Chinese demand supported price levels considerably, mostly thanks to extensive restocking. If Chinese demand were excluded, metals price decline would have exceeded 20%.[62] In 2010, the modest price raise is expected to continue. In general, demand from China had a rather stabilising effect on commodity prices throughout 2009.[63]

Although agricultural products declined by 22% in 2009 compared to their 2008 peak, they still remain almost twice as high as the lows recorded earlier in the decade. Higher oil prices and bio fuel demand, together with an increase in stockpiling, contributed to an upward trend in prices in 2009 and 2010. Lower production costs, however, helped counterweight this tendency and keep prices stable. At the same time, most countries have eliminated export restrictions in agricultural products that were put in place at the peak of the crisis.[64] Demand for food commodities is generally insensitive to the cycles of economic activity. As a result, agriculture has been more resilient than other sectors of the economy to the effects of the global economic crisis. Agricultural commodity prices are therefore expected to rise modestly but steadily throughout 2010.[65]

In spite of a relatively stable price environment, price volatility in the commodities market remained high in 2009 and the first months of 2010. This has proven to be a major trend in the aftermath of the financial crisis and it is mainly attributed to two factors: the volatility of the dollar exchange rate through most of this period and the increasing "financialisation" of commodity markets. As commodity prices are typically denominated in dollars, its exchange rate has a bearing on their prices by intensifying pro-cyclical price movements. For example, dollar depreciation in the second half of 2009 was accompanied by a steady increase in prices.[66] For this reason, real commodity prices fluctuation has been much more moderate than nominal prices.

The second trend is related to the increasing participation of financial investors in commodity futures exchanges, in order to diversify their portfolios and hedge against possible inflation risks. Recent statistical evidence indicates that financial investors accelerated and even amplified pro-cyclical price movements, especially in food commodities.[67] This was particularly evident in cases where placements were purely speculative and tended to ignore the commodity market fundamental values. Consequently, their involvement may be considered partially responsible for both the boom in commodity prices before the financial crisis and their rapid decline afterwards, at least to the extent that it cannot be attributed to changes in demand and supply. With financial market movement remaining unpredictable and recovery slow, investor participation in commodity markets in 2010 is increasing again and with it price volatility as well. In addition to this, investor involvement in the commodities market complicates price hedging for traditional commercial users, with all the negative effects that this could have on future commodities supply.[68]

In conclusion, market speculation in the second half of 2009 and the first half of 2010 has increased price volatility and pro-cyclical effects in commodity prices, bringing an element of cyclicality even in markets where it traditionally did not exist, such as the food market. This development, in combination with the fact that agricultural productivity in poor countries is still short of keeping pace with increasing population, might create further food emergencies in the short-term.

1.2.5. Knowledge

Space systems play a key role in promoting scientific research and development in three ways. First, they are the means for taking scientific discovery beyond the boundaries of our planet, expanding our knowledge of astronomy and physics through space exploration. Second, space assets themselves are very demanding engineering inventions, the development of which motivates scientific innovation

across the board in multiple disciplinary fields. Third, by offering worldwide communication services space systems contribute to the global flow of information and the free exchange of scientific knowledge. Consequently, they help promote scientific cooperation and they distribute its benefits to all of mankind.

An important step in developing a European scientific and innovation policy occurred in December 2009, when the European Security Research and Innovation Forum delivered its final report. Its plenary council of 65 members from 32 countries was mandated by the European Commission and the 27 EU Member States in September 2007 to propose a future European Security Research and Innovation Agenda (ESRIA) for the next 20 years. During its two years deliberations, the panel was supported by more than 600 experts from various government and industry sectors, making it the only high-level initiative of its kind in Europe.[69]

In conducting its research, ESRIF set up different working groups to investigate future technologies that could have an impact on European security, including one on Situational Awareness and the Role of Space in it. Its report identified key capability areas where space systems would be indispensable. These included Integrated Communication Networks, Information Management and Decision Support Systems, Command and Control etc. The report also listed a number of required space based systems that would be essential to the future EU security capabilities and prioritised them according to European needs.[70]

The panel's recommendations proposed better coordination in the use of existing space assets through collaborative and multiple uses of space services, information and data. It also stressed the importance of interoperability and the creation of common European operational picture and information distribution platforms. It asserted the crucial role of space based communications, Earth observation and satellite navigation, timing and positioning for European security. In this perspective the report praised the importance of the Global Monitoring for Environment and Security (GMES), Galileo and the European Geostationary Navigation Overlay System (EGNOS) programmes.[71]

In addition to these, the panel devoted particular attention to the creation of a European Space Situational Awareness (SSA) system. It identified the SSA programme as a major driving force for technology innovation in relative fields, such as automated satellite operation, formation flying architectures, multi-sensor fusion, protection of critical infrastructure and in-orbit networking, among others. Finally, ESRIF recognised that building the SSA infrastructure would require a cooperative approach from all stakeholders, including the European Space Agency (ESA), the European Commission and the European Defence Agency (EDA).[72]

In conclusion ESRIF adopted a holistic approach to security, calling for making security related innovation an EU priority, developing common European rules

and procedures and exploiting knowledge synergies for security purposes whenever possible. Its key recommendation was that technological innovation and security planning should interact systematically, with the latter being an integral part of the former.

1.2.6. Mobility

Mobility is another activity area revolutionised by space technologies and their applications. Maritime commerce accounts for the bulk of global trade, whereas airplanes carry 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.

The transport sector continued to suffer from the effects of the global financial crisis in 2009 and 2010. As the crisis has proved, the global economy works in a completely interdependent and concerted fashion, to the point where a crisis in any place can affect the entire system. As the transport sector is the epitome of this global trade interconnectivity and interdependence, it was hit particularly hard by the current economic crisis. As supply and demand fell sharply, the transport of materials and goods followed suit.[73] Furthermore, the financial crisis put a strain on the credit flow that is essential to international commerce transactions, with several banks refusing even to issue letters of credit. According to some sources, unmet demand for trade financing in developing economies is estimated between $100 and $300 billion.[74]

Maritime transport that represents the bulk of global transport (90%) suffered the greatest blow. The financial crisis put an end to a constant growth in maritime trade since 1993, one of the longest in recorded maritime history. The timing of the crisis was particularly adverse, as ship owners had enjoyed the most profitable financial results of all time before the crisis, and had an unprecedented number of vessels under order, accompanied by an equal increase in shipyard capacity.[75] During the last 12 months decreased maritime activity has led to a wave of cancellations of ship orders, an unprecedented level of distress demolitions (projected to reach 15–18% of world fleet capacity in 2010) and an almost six-fold contraction in shipping revenues. If these estimates materialise, all sectors of the maritime industry will suffer from considerable unemployment. A further medium-term consequence of the financial crisis for sea trade could be the appearance of protectionist measures that would further hinder world trade.[76]

Another challenge for the maritime industry in the past 12 months has been the increased number of piracy incidents, especially off the Somalia coast. Although international military presence in the region has somewhat increased security,

piracy incidents have persisted. This surge in piracy acts at the Gulf of Aden has generated considerable costs, especially for Europe as 80% of shipments that pass through the area are coming from or to this continent. Re-routing shipments around the Cape of Good Hope alone is estimated to generate over $7.5 billion of additional shipping costs annually. At the same time, insurance costs for ships passing through Suez currently stand at 40 times their normal price, because of the war risk coverage included.[77] The problem has taken such proportions that on 2 December 2009 the International Maritime Organisation Assembly in London adopted a resolution calling for more international cooperation in the fight against piracy, quicker adoption of the Djibouti Code of Conduct by all states in the region, and an enhanced role for the United Nations.[78]

Air transport was equally struck by the crisis' repercussions. According to ICAO, 2009 saw the worst performance of airline traffic in history. International passenger traffic declined by approximately 3.9% and domestic traffic by 1.8%. However, domestic flights traffic decreased primarily in advanced economies, with emerging economies maintaining a positive albeit modest growth rate, especially in SE Asia and the Middle East.[79] In Europe and North America, low cost carriers performed somewhat better than more traditionally operating airlines. A modest increase of 3.3% in passenger traffic is expected for 2010 according to some observers, but full recovery will have to wait until 2011 at the earliest. Furthermore, cargo traffic also contracted by 15% in 2009, including in developing regions of the world. It is noteworthy that air traffic activity contraction in 2009 even exceeded that of the 9/11 aftermath.[80]

This drop in airline traffic translated into approximately $9 billion revenue loses in 2009. As with the shipping industry, bank financing became scarce and customer confidence waned. Most analysts agree that the picture will remain unchanged in 2010 as well, on a yearly basis. The biggest challenge ahead for airline companies is to manage excessive passenger capacity, which might lead to an increasing liberalisation of the market worldwide and possibly to major job cuts. Cutting costs throughout the chain of supply, increasing capital flow, abolishing ownership restrictions and encouraging international regulatory convergence will probably be the keys of this liberalisation concept that is becoming known under the name of "Open Aviation".[81]

1.2.7. The financial crisis and its consequences for the space sector

As demonstrated by the global economic and political outlook presented above, the time period under consideration has been marked by the consequences of the

financial crisis that started in 2008. 2009 saw the spreading of these consequences from the financial sector to the entire economy. In 2010, we are witnessing the geopolitical repercussions of the economic downturn.

One resilient characteristic of the 12 months in question has been the quicker recovery of emerging economies, by comparison to developed ones. The main cause behind this fact seems to be the emerging economies' greater adaptability to the crisis conditions. In particular, when faced with rapidly decreasing demand for their manufactured products, developing economies were fast in directing a greater part of their output to regional and domestic demand. Developed economies apparently did not react as quickly. One possible explanation could be that in their case regional and domestic demand was already saturated before the crisis, because of their greater degree of economic/social development and regional economic integration (as in the case of Europe, for example). In other words, the current economic crisis may be interpreted as a slowdown of global economic integration in favour of a more regional one, especially in the case of regions where principal emerging countries cluster, such as SE Asia and the Middle East. Consequently, the different pace in which developed and developing countries exit the crisis may accelerate the already evident slow migration of the global economic centre from the western edge of the Eurasian Continent to the eastern one.

The above conclusion implies that the economic crisis will certainly have global geopolitical consequences of a currently unpredictable nature and magnitude. No country has been left untouched by the crisis and they have all entered it at approximately the same time. However, each one of them seems to be exiting the crisis at a different pace. The relative pace at which countries will recover will also determine their power and influence on the international scene. Economies that have some kind of "edge" seem to respond better to the crisis conditions. The first in line for recovery seem to be countries with rich natural resources, especially in the Middle East. Russia could also potentially fall under this category. Second are countries with huge internal markets and a relatively cheap working force, like China, India, or Brazil. Third are countries with strong industrial output and accumulated profits from positive commercial balances. Finally, the last to recover would be countries that have relied heavily on the financial and services sector for their development.

In addition to this, the different pace in which recovery comes in different parts of the world will probably exacerbate global and regional antagonisms and increase the centrifugal forces in the international relations system. In regions where recovery is more or less homogenous, as in SE Asia, regional economic cooperation and commercial relations will develop further. In regions where the pace of recovery differs from country to country, as in Europe, the resulting economic disparity could impede further regional economic integration and it might even

encourage protectionist measures. In general, the crisis has created a very fluid and unpredictable situation on the international scene, where the relative economic as well as geopolitical value of countries and even entire regions can change rapidly.

As far as space activities are concerned, the financial crisis seems to have two distinct effects. On the up side, the commercial space sector could profit from the various financial stimulus funding that governments distribute to the private sector to boost recovery. Some of these measures for example include communication infrastructure development, which could certainly involve satellite communication services operators. On the down side, the credit crunch has made banks more risk wary and investing in space systems still entails a great deal of development and operational risks.

The greatest difficulties, however, might be encountered in the public funding of space activities. After last year's generous recapitalisation aid to financial institutions failed to keep the crisis from spreading to the "real" economy, public opinion in developed countries may become increasingly sceptical of indiscriminate government spending. In the face of rising unemployment, people could demand that more government funding is directed to creating jobs and mitigating the effects of the crisis to the "real" economy. In this context, space programmes that have high development costs, a slow technological maturity process and long-term benefits, could be considered as superfluous in the face of other, more urgent fiscal needs. In this sense, expenses that have no immediate effect on economic recovery could come under public scrutiny, and space budgets could fall under this category.

In order for the space sector stakeholders to successfully avert such a development, they would have to engage public opinion more than ever before. Explaining to people how space activities produce concrete financial and social benefits that are worthwhile should become a principal task for all actors involved. Furthermore, future space programmes should demonstrate their capacity to produce such positive results for society even from their conceptual phase of development.

1.3. Main science and technology indicators relevant for space activities

The space sector demands generally cutting-edge technologies which are the input of a global network within the society. The investments necessitate an effort not only carried out by the private entities but also by the states. Economy, space activities and states sustain thus complicated relations which ask a great involvement and a form of synergy between the different entities concerned. This is particularly true for the European Union's economy allegedly based mainly on

knowledge and innovation. A lot of measures have recently symbolised this determination like the ERA[82] (European Research Area). The space sector is at the forefront of this reality. Input are defined as 'investments in the resources necessary to conduct scientific activities, like money and technical personnel while outputs are what comes out of theses activities, namely knowledge and invention.[83] Since the 1960s, the input-output are commonly used as tool to gauge sciences activities closely related to the Space sector. New technologies are therefore a key issue in competitive market and developed countries, it becomes even the determinant element in the race to Space.

1.3.1. Science and technology inputs

Those last years have been particularly eventful concerning the R&D due to the financial crisis. After having known a steady increase in most countries, it has been particularly expected to assess the consequences on the R&D of the world economic turmoil. The different effects concerning the crucial period of 2008–2009 will be measured by two statistics tool, namely the GERT (gross domestic R&D expenditure), the R&D intensity and the Government budget appropriations or outlays for R&D (GBAORD) related to the GDP. The GERD shows the nominal evolution of the expenditures in R&D. It is noticeable that the spending in R&D increased in Russia of 12.7%[84] during this period while in the EU during the same period the amount decreased of 1.3%. Without constituting a sharp drop it is all the same an important phenomenon given that the European economy policy is due to be mainly based on knowledge and innovation. However, it is worthy to note that the distribution is not equivalent among the European members.

The most noticeable exceptions concern Poland which increases its spending of 17.7%, Norway 4, and France 2.5 while Romania falls of 20.9% and Sweden 5.5. The GERD considers a nominal amount particularly affected by the financial crisis which has entailed a fall of the GDP. In comparison the investments of Japan have dropped from 8.3% in the same period. However these figures must be put into perspective with the R&D intensity which measures more efficiently the effort provided by a country in R&D. This indicator reveals that Europe is rather constant in the intensity of its expenditures related to the GDP, which is a good indicator of the strategy chosen by the states to bypass the crisis. Germany, Ireland and Finland particularly increase the part of GDP spent in this area. Japan that is much more suffered from the economic turmoil has seen a brutal drop of its R&D intensity.[85] The consequences have not been therefore so dramatic for the EU and its member countries which have even in general slightly augmented their

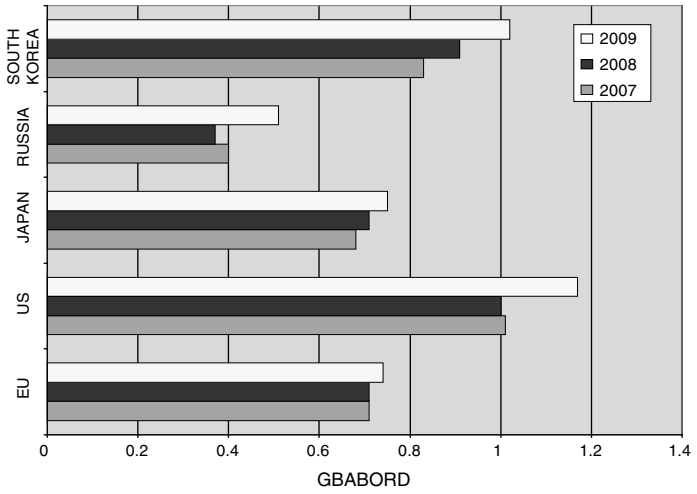

Fig. 1: *Global shares in GERD.*

investment in R&D in spite of the context. Another indication of the will of government to invest in R&D is illustrated by the Government budget appropriations or outlays for R&D (GBAORD).

The public investments in the EU are still stable especially between 2007 and 2008 while the world economic crisis just began.[86] Except in the EU public investments in R&D as a part of GDP globally increase in the other areas illustrating a strong governmental involvement to use this tool to get over the turmoil. This is particularly true concerning Russia that augments the share in 2008 from 0.37% to 0.51 in 2009. As for the U.S. we observe a rise of 0.17% between the two years whereas during the same period it is only 0.03% of the EU. Japan severely affected experienced a similar increase. The crucial role of the European Union and especially the European Commission could be in the future to take the lead in this domain which is at the core of its economic policy and counterbalances the limited investments provided by the member states by developing join programmes. This is already partially the case with a budget in 2010 devoted to improve the competitiveness of the EU around €14 Billion.[87] The EU is still overtaken in its effort by South Korea and the U.S. while it becomes very closed to Japan.

The public investments are crucial to understand the evolution of the R&D but the private sector is a major actor of it as well. A comparative study concerning the R&D intensity among the world's top 1400 companies between the U.S. and the E.U shows that the firms created before 1975 have roughly the same percentage of investments in R&D (2.8% for the EU and 3.6% for the U.S.) but the gap is

constituted with the companies created after 1975 and more likely to be connected to new technologies.[88] The informatics sector illustrates perfectly this reality with a strong domination of the U.S. (Microsoft, Appel etc . . .) that has a lot of innovative companies in this field. This is also a result of a strong involvement of the government by military and civil researches programmes which ultimately yielded by the U.S companies enhance their competitiveness. This effect is all the more significant as the U.S. structure is made of 54.4% of companies created after 1975 against 17.8 in the EU.[89] In a more international perspective we can observe therefore that U.S. invests more by both the public and private sector. Japanese companies tend to even more spend than their American counterparts what is not astonishing given their speciality in new technologies champion like Sony dependant on innovation. EU companies are also overtaken by China's one. Within the EU concerning the most important economies, the firms from Finland, Sweden and Germany take the lead.[90]

The European effort towards innovation and a more knowledge based economy is thus to put into perspective. The public effort is still rather timid and quite similar to Japan which have been more sharply hit by the financial crisis. The real weakness of Europe would be more constituted from its private structure much less innovative than its international counterparts.

1.3.2. Science and technology outputs

The output of R&D is gaugeable by two sides, namely the scientific publications and secondly the inventions patented. In spite of the economic crisis the EU keeps the leadership in 2009 concerning the scientific publications constituting 33.4% of the worldwide ones.[91] An important part that besides experiences a decrease of 4.3% from 2000. The evolution is quite similar while the participation of China soared during the two period from 6.4 to 18.5%. However the EU is still a dominant actor in this field. An important success which is less obvious in patent deposed by European countries to the great displeasure of the European Commission.

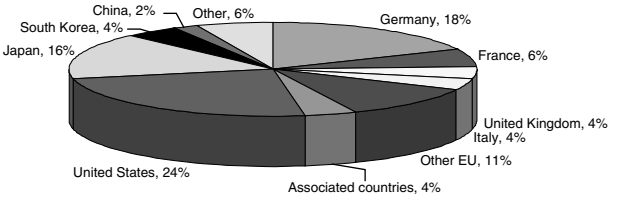

Fig. 2: *Global Shares in patent applications.*

Unfortunately it is harder to judge the effect of the economic crisis on this field given that the data available are limited to 2007. However we can already underline some trends which are not likely to change in the next years. In 2007 47% of all EPO patent were invented in Europe, followed by the U.S. 24% and Japan 16%. An analysis within the union shows quickly that Germany is the European champion of patent application representing almost haft of the all European patents deposed.[92] These figures confirm what has been studied herein with a strong correlation between business R&D expenditures and patent deposed for countries such as Switzerland, Germany and the Netherlands with a very efficient rate contrary to Central and Eastern European countries are those which invent the fewest EPO patents per euro of business R&D expenditure. An EPO patent applications by inventor's country of residence per billion GDP provides another overview of the patent policy efficiency at the international scale. Between 2000 and 2007 the EU experienced an important decrease of from 8 to 6 which is slightly got ahead by Japan which is experienced a contrary movement from 4.5 to 7.

However, this phenomenon can be in part explained by the integration of new countries with a less efficient innovation policy. As for the U.S., it is still around 3. However, the most striking observation in the figure below is the outstanding progress observed in South Korea from 2 to 7 and to a lesser extent in Japan. These two countries have by far overtaken the United States in inventing EPO patents, relative to the size of their economy.[93] Some examples which could inspire the EU in the future. It will be particularly interesting to asses the effect of the crisis on the production of patterns as soon as the relevant data are available.

2. Worldwide space policies and strategies

An interesting trend between mid 2009 and mid 2010 has been the steady rise in the number of space agencies worldwide. In spite of the global economic crisis' impact, an increasing number of governments have seen fit to create a central administration body for their space activities. This trend has begun in the late 1990's and it has continuer uninterrupted ever since. From 2000 to 2009 the number of space agencies worldwide has risen from 40 to 55, according to a study conducted by Paris-based Euroconsult. Space related global spending has also continued its upward trend, reaching $36 billion for civil (up 9%) and $32 billion (up 12%) for military programmes. In 2009 U.S. space related expenditures amounted to $48.8 billion (or 72% of total), Europe's ESA members to $7.9 billion, Japan's to $3 billion, Russia's to $2.8 billion, China's to $2 billion and India's to $900 million.[94]

2.1. The United Nations system

Various institutions within or associated with the United Nations are relevant for space policy. In this subchapter, the UN General Assembly (UNGA), UNGA Committees and other UN bodies and organs are discussed regarding space activities.

2.1.1. United Nations General Assembly (UNGA)

In December, the 64th session of the United Nations General Assembly (UNGA) was held. On 2 December 2009, it adopted the Resolution 64/28 "Prevention of an arms race in outer space". In the resolution, the GA put emphasis on transparency and confidence building measures (TCBM) to avoid an arms race in space. TCBMs were seen to possibly form an integral part of broader agreements on the prevention of an arms race. The GA recalled that the existing legal framework for outer space does not guarantee the prevention of an arms race and asked the states, especially the major space faring nations, to negotiate further. The Conference on Disarmament (CD) was seen as the sole multilateral disarmament forum. The Resolution also called for establishing and Ad Hoc Committee on the Prevention of an Arms Race in outer space within the CD. In general, it also acknowledged the complementary nature of multilateral and bilateral efforts in this issue area.[95]

Also on 2 December 2009, the GA adopted the Resolution 64/49 "Transparency and confidence-building measures in outer space activities". The Resolution was identical to the one tabled in 2008. It stated that an arms race in space would constitute a significant danger to peace and security and it invited the Member States to continue submitting proposals on TCBM to the Secretary General. In addition, the GA decided to include the issue in the agenda of the 65th session.[96]

A Resolution on "International cooperation in the peaceful uses of outer space" (64/86) was adopted on 10 December 2009 by consensus without a vote. The resolution reminded of all central aspects and challenges of the peaceful use of outer space. It also recalled the crucial importance of international cooperation to tackle the corresponding issues and it reviewed some of the steps that have been taken in this regard, like conferences, sessions of relevant entities and progress in implementation of corresponding programmes.[97]

2.1.2. UNGA Committees

The UNGA disposes of several committees that are involved in space policy and associated matters. Some of them are discussed here.

2.1.2.1. Disarmament and International Security Committee

The resolutions on the prevention of an arms race in outer space and on transparency and confidence-building measures had been introduced in the Disarmament and International Security Committee, also referred to as the First Committee, beforehand. The debates were marked by enduring differences between the U.S. on the one hand and Russia and China on the other hand.

2.1.2.2. Committee on the Peaceful Uses of Outer Space (COPUOS)

The activities of COPUOS were marked by its plenary session and the sessions of its subcommittees, along with various workshops and conferences. The Scientific and Technical Subcommittee held its 47th session from 8 to 19 February 2010. Topics discussed included the use of nuclear power sources in outer space, possible dangers from near-Earth objects, space debris, space-based disaster management support and developments in global navigation satellite systems. The Subcommittee received and considered information provided by the Member States on their activities in all these fields. Moreover, the implementation of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) were reviewed.[98]

A very important part of this session was the topic "Long-term sustainablitity of outer space activities". The Subcommitte discussed space situational awareness and agreed to establish a working group on the long-term sustainability of outer space activties, preparing a report and proposing measures and guidelines. This should include its contribution to the achievements of the Millenium Development Goals and should be consistent with the peaceful use of outer space.[99]

Also, a Symposium on National space legislation was held in Vienna during the 49th Session of the Legal Subcommittee. The topics discussed on this event were: needs for national space legislation, elements of national space legislation as well as their consequences.

2.1.3. Other UN bodies and organs monitoring outer space activities

Beyond the UN General Assembly and its Committees, there are other UN bodies, programmes and organs related to space activities. In the following, ITU (being a specialised agency of the UN), UN-SPIDER; the UN Programme on Space Applications, the International Committee on Global Navigation Satellite Systems (ICG), the United Nations Spatial Data Infrastructure (UNSDI), the Conference on Disarmament (CD) and UNIDIR are discussed.

2.1.3.1. International Telecommunication Union (ITU)

The International Telecommunication Union (ITU) held its World Radiocommunication Seminar (WRS) 2008 on 8 to 12 December 2008 in Geneva. Among other things, it discussed the application of the ITU Radio Regulations that had been changed in the course of the ITU World Radiocommunication Conference (WRC) 2007. The meeting provided a forum to exchange views on the associated technical, procedural and operational aspects. One of the relevant issues is given by the revisions made to the Fixed-satellite service plan that draws upon new technical developments and facilitates satellite system to access the frequency spectrum. The next World Radiocommunication Conference is scheduled for 6 to 10 December 2010.[100]

2.1.3.2. UN-SPIDER

Several workshops and regional meetings were organised in the framework of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER). This platform was set up by the UNGA in 2006 with the aim of providing universal access to all types of space-based information and services relevant to disaster management support.

The International Charter on Space and Major Disasters was activated several times by the Office of Outer Space Affairs (OOSA) at the request of other UN entities. The concept model for a UN-SPIDER knowledge portal was developed further in cooperation with German institutional partners.

2.1.3.3. UN Programme on Space Applications (SAP)

The UN Programme on Space Applications (SAP) is concerned with cooperation in space science and technology. Several activities were carried out under its auspices in the reporting period which dealt with, for instance, Technology Contribution to Infection Surveillance and to the Health-related MDG Goals, Basic Space Science and the International Heliophysical Year 2007, Integrated Space Technologies and Space-based information for Analysis and Prediction of Climate Change, Space Law, Integrated Applications of Global Navigation Satellite Systems, and Integrated Space Technology Applications for Socioeconomic Benefits.[101]

2.1.3.4. International Committee on Global Navigation Satellite Systems (ICG)

The aim of the International Committee on Global Navigation Satellite Systems (ICG) is to promote cooperation in matters of satellite navigation. OOSA serves

as the Executive Secretariat of the ICG and the associated Providers' Forum. The fourth meeting of the ICG took place in Saint Petersburg, Russia, on 14–18 September 2009. It saw attendance from industry, governments, non-governmental organisiations and academia and it reviewed and discussed developments in global navigation systems.

The ICG work plan was organised in four working groups: on compatibility and interoperability, on enhancement of performances of GNSS services, on information dissemination, capacity building, and on interaction with national and regional authorities and relevant international organisations. In the joint statement it was noted "that substantive progress had been made in furthering the workplans of ICG and the Providers' Forum that had been approved at the previous meetings of ICG".[102] The next ICG meeting will take place in Turin in October 2010.

2.1.3.5. United Nations Spatial Data Infrastructure (UNSDI)

The United Nations Geographic Information Working Group (UNGIWG) held its tenth annual meeting in Bonn, Germany, on 19-21 October 2009. The UNSDI is understood as a comprehensive, decentralised geospatial information network to facilitate decision-making.[103]

2.1.3.6. Conference on Disarmament (CD)

The Conference on Disarmament (CD) is the only multilateral disarmament and arms control negotiating forum within the international community. It was in session from 11 June to 2 September 2009 and from 19 January to 23 March 2010. The stalemate in its work regarding space security has been ongoing. In the course of the 2009 session, the prevention of an arms race in outer space was again a central topic on the agenda.[104]

2.1.3.7. United Nations Institute for Disarmament Research (UNIDIR)

Several projects of the United Nations Institute for Disarmament Research (UNIDIR) deal with space security, directly or indirectly. Among other things, UNIDIR intends to review former proposals and to propose new options for breaking the deadlock in space weaponisation matters at the Conference on Disarmament (CD).

2.2. The Group on Earth Observation

The Group of Earth Observation (GEO) is a voluntary partnership of governments and international organisations whose task is to coordinate effort to build a GEOSS. In 2009 and 2010 GEO had a busy activity mainly composed of workshop and symposia. The main interest of such an organization is to share the best practises and experiences while preparing the future challenges. The topics treated in such event were various, that concerned among others, environmental aspects (especially forest and ocean monitoring), support agricultural monitoring, natural disaster management, water researches, help Africa to take advantage of Earth Observation, atmospheric observation and climate change. An important meeting concerned the Forest Carbon Tracking (FCT) Task Information meeting which is a worldwide issue. The event was an occasion to procure an overview of the situation and solution available to address it.

In 2010, certain workshops were especially dedicated to definite area such as Black Sea on 4 May 2010 or sector like bio energy. Some multilateral projects ongoing were also tackled concerning EnviroGRIDS Project, EuroGEOSS. 2010 finally ended with the 20th executive committee meetings and GEOSS Monitoring and Evaluation Meeting followed of 4th International Meningitis Environmental Risk Information Technologies 'MERIT' Technical Meeting. A strong and diversified activity which has been mainly focused on environmental aspects given the emergency of the situation.[105]

2.3. Europe

2.3.1. European Space Agency

After reviewing the EU space activities programmes from July 2009 to June 2010, the crucial role of the European Space Agency in all of them becomes obvious. In fact, from a space policy standpoint, the most significant development has been the de facto transformation of the agency into the implementing arm of the EU space policy. This fact becomes apparent given ESA's increased involvement in shaping and building most of the necessary infrastructure for EU space projects. This gradual process however has not yet acquired a more institutionalised or de jure form. It therefore still remains a more or less empirical and result-driven cooperation process between the EU and ESA, guided by the space policy aspirations of one and the unique capacity to materialise them of the other. This cooperation therefore remains a step-by-step process that still operates under

conditions of constantly evolving tasks and the need to produce tangible results for Europe's space activities.

On a policy level, the period in question witnessed the implementation of most of the key orientations given by ESA's Ministerial Council in November 2008. These focused on expanding ESA activities into financing space applications programmes while at the same time increasing space exploration activities. ESA's increased space applications-related workload can be depicted in its participation in several EU programmes described above. Increased funding for the above-mentioned projects also accounts for an 18.6% in the agency's budget in 2009, compared to 2008. Total payment appropriations have been increasing at an annual rate of 10% over the last four years, reaching €3.35 billion in 2009. This increase brought the agency's budget to the desirable levels approved by the Ministerial Council.

On the other hand, in 2009 the continuing global economic crisis began to weigh on the ESA Member States' space budgets and contributions to the agency. Acknowledging the new financial realities, ESA Director General J.J. Dordain announced on 14 January 2010 that the agency's budget spending would remain at these levels for the next two years, 2010 and 2011. This decision was not expected to seriously affect ESA's project schedule, as the agency's budget had already attained an adequate level in 2009. Nevertheless, it was a form of recognition of the difficult new financial realities, and a message that ESA would not overstretch itself financially without previous approval by its Ministerial Council, set to convene again in 2011. In order to avoid any programme cancelations due to this freeze, Mr. Dordain explained that from now on ESA would be stretching the payment periods of any new contracts.[106]

In general, however, current ESA operations have been relatively little touched by the economic crisis and they have continued as expected. The agency's operations suffered only indirectly from the crisis in November, when it announced it would be freezing payments for contracts valued over €10 million for a month (until 2010) due to a cash-flow shortage. This temporary stop was attributed to a €400 million cash reserves deficit, created by the accelerated pace of contract payments to its industrial partners that was part of a deliberate attempt to counter the effects of the global financial crisis on the space industrial sector. It is unclear however, whether the financial stresses of some of its 18 Member States also contributed to the problem. Instead of delaying €400 million worth of contract payments, ESA officials preferred the possibility of taking out a bank loan in order to cover the gap.[107]

Nevertheless, on 18 December 2009 ESA reinitiated payments after only a three weeks self-imposed spending moratorium. Financial auditing revealed that the deficit's figure was exaggerated and that it would not exceed €200 million, which

ESA officials described as "manageable". The first programmes to be funded (for over €500 million) were the construction of the first three Sentinel Earth observation satellites for the European Commission and preliminary work on a new upper stage for the Ariane 5 rocket that would enable it to lift a 12 tons payload to the GEO transfer orbit.[108]

On the other hand, in spite of the financial crisis Galileo's budget overrun of €376 million was approved by the European Commission in June 2009, after three months of audits. The auditors found that additional charges were reasonable, given the contract modifications ordered by the customer. Their report concurred with a similar investigation performed by ESA earlier that year. After this development, additional payments were approved for Galileo's in-orbit Validation phase, which includes building four satellites as well as most of the required ground control infrastructure by 2010. However these budget and schedule overrides increased fears that the system might exceed its projected €3.4 billion budget and might not be fully operational by 2013 as planned.[109]

Among the ESA's key policy related activities, one can distinguish the joint EU-ESA International Conference on Human Space Exploration, held in Prague on 23 October 2009. During this conference, it was decided that a space exploration road map for Europe should be drawn by the end of 2010. The meeting reaffirmed Europe's determination to remain a principal space-faring player in the face of rising Chinese and Indian space ambitions. But it also concluded that any meaningful future space exploration effort should be of a truly international nature in order to succeed. However, participants did not debate specific space exploration proposals. Of course, a key element of any meaningful new European space strategy should be a considerably increased budget for space activities. The European Commission currently has less than a €1 billion annual budget for space projects, which it hopes could triple for the seven-year budget period starting in 2014.[110]

Another field where increased EU-ESA cooperation appeared was in the development of the European Space Situational Awareness system (SSA). This programme is simultaneously funded by ESA (through its GST and SSA core element activities) and the European Commission (through its dedicated "Space" work programme of the FP7). Both institutions have initiated research and concept demonstration projects related to SSA. Therefore, achieving complementarity between the two programmes and avoiding duplication of development efforts has become a matter of the utmost importance. Consequently, coordination and interaction between the three programmes (SSA preparatory programme, GSTP and FP7) is crucial to minimising development risks and maximising benefit returns.[111]

2.3.2. European Union

The European Union maintained and augmented its engagement in space activities in the second half of 2009 and the first half of 2010, under the Swedish and Spanish EU Council Presidencies respectively. Key developments in this period included the entry into force of the Lisbon Treaty: the considerable progress made in the Galileo and GMES programmes, the increased cooperation between the European Commission (EC), the European Space Agency (ESA) and the European Defence Agency (EA), in promoting European non-dependence in critical space technologies and infrastructures, the meeting of the 6th "European Space Council" in May 2009, and the announcement of the third space-related call for proposals within the 7th Framework Programme for research and development in Europe.

As in many other areas of European Union activities, the key development from July 2009 to June 2010 was the entry into force of the Lisbon Treaty on 1 December 2009. The new Treaty on the Functioning of the European Union is the first document of its kind to set out an explicit EU competence in space activities. Under Article 189 of this Treaty, EU institutions are invited to draw up and implement a long-term European space policy, including the possible creation of a European space programme, in close cooperation with ESA.[112] One of the key features of this article was the fact that it referred not only to the exploration, but also to the exploitation, of space by the EU. This addition is thought to allow for the inclusion of a security dimension to EU space activities. It is also thought to push toward a closer cooperation between the EU, ESA and their respective Member States, as well as to create the necessary impetus for further developing the competitiveness of the European space industry on a global scale.[113]

In another development, on 29 May 2009 the European Space Council (the EU Competitiveness Council and the ESA Council meeting concomitantly) met for the sixth time in Brussels, in order to assess the progress made on implementing a common European space policy and to identify further objectives. The Space Council noted that the "structured dialogue" among all European institutional space actors was advancing well. It particularly took notice of the cooperation between the European Commission, the EDA and ESA on identifying critical space technologies in which Europe should become non-dependent on outside sources. The Council also noted the inclusion of the Multinational Space-based Imaging System (MUSIS) in the EDA programme list, as well as the adoption of the ESA Preparatory Programme for the development of the European Space Situational Awareness system (SSA).[114]

Another area of particular interest to the Council was the potential contribution of space related technological innovation and competitiveness to the overall

European Economic Recovery Plan (EERP) for 2010 and 2011. The Council recognised the importance of space activities to economic recovery and recommended their full funding from the €5 billion economic stimulus package of the EERP. The Council paid particular attention to the participation of satellite communications providers in the broadband connectivity promotion programmes of EERP, valued at €1.02 billion.[115] In the same context, it called for the full development of services based on the EGNOS, Galileo and GMES programmes. Especially as far as the latter was concerned, the Council identified the long-term funding of its space segment by the European Commission as a key objective. In this regard, it also encouraged closer cooperation between the European Commission, ESA and EUMETSAT.[116]

In a related development, the European Commission announced in October 2009 that it was considering maritime surveillance as its next major investment in space-based applications after Galileo and GMES. The European Commission was already financing pilot projects in this direction, including the space-based Automatic Identification System (AIS) that uses signals emitted by commercial vessels to determine their identity, destination, speed and cargo. However, in order for such systems to become useful for maritime surveillance in the field, they would have to improve their operational response times. All ships over 300 tons displacement are required to have such transponders by international maritime regulations. ESA has also developed two experimental AIS receivers that were launched to the ISS in September 2009.[117]

The increasing importance of space activities for the EU was made even more evident on 15 October 2009, when the European Commission President José Manuel Barroso made for the first time a speech dedicated entirely to the European Space Policy. During his presentation in a conference on this subject in Brussels, he reiterated the usefulness of space systems for EU policies and the need to achieve autonomy in relevant space technologies. An independent EU capacity in the field of Earth and near space observation should be a top priority, he said. Furthermore, he maintained that EU space activities should not be confined to producing direct financial results, but should seek to implement broader European policies as well. Finally, he called for further developing space programmes, including an independent European human spaceflight capability.[118]

Another European programme that saw considerable progress in 2009 and 2010 was the Galileo satellite navigation and positioning system. As early as June 2009, discussions among the European Space Agency (ESA), the European Commission and industrial partners were approaching their conclusion over the best way to contract the deployment of the system's satellites. The contract for the building of the 28 spacecraft required was due for signature later in the year and the two companies biding for it were Astrium Satellites and OHB System.

European authorities were disputing whether they should order all satellites from one manufacturer or split the contract between them. Another undecided issue was whether the entire constellation should either be ordered from the beginning, or split into two procurement stages to allow for last minute modifications. Finally, the question of which launcher to use remained open, with ESA preferring an exclusively Soyuz launching campaign and Astrium Space Transportation pushing for the use of Ariane 5 as well. Although a decision has not been reached yet, ESA and European commission seemed favourable to dividing the contract into two phases and splitting each phase between the two bidders.[119]

A decision on deploying the system's first fully operational constellation was repeatedly delayed, most recently in October, when ESA's Director General Jean-Jacques Dordain announced that last-minute satellite manufacturing difficulties were reported by its principal contractors, Astrium Satellites and ThalesAlenia-Space. The new timetable given foresaw a first launch in November 2010 and a second early in 2011, always onboard Soyuz rockets launched from the European Spaceport in French Guiana.[120]

In late December however, it was made known that the European Commission had finally decided to select OHB Technology of Germany to build at least the first 8 Galileo satellites for approximately €350 million. The European Commission chose the OHB-led consortium that included Britain's Surrey Satellite Technology Ltd. over its competitor EADS Astrium Satellites consortium that also included ThalesAleniaSpace, although it was widely considered lacking the industrial depth to build the entire 22 spacecraft constellation. However, the European Commission's decision to maintain competition in the programme weighed heavily on its decision. The situation was further complicated by its refusal to simultaneously award the remaining 14 satellites contract to the Astrium consortium, due to what was described as the company's non-compliance with the competition's bidding guidelines. Both Astrium and ThalesAleniaSpace had made considerable industrial investments at the early stages of the Galileo programme, when they were given sole charge of the project.[121]

The official announcement of the European Commission's decision came on 7 January 2010, when a team led by OHB Technology of Germany was selected to build the first batch of 14 Galileo navigation satellites. The consortium would also include small satellite specialist Surrey Satellite Technology Ltd. (SSTL). This decision was a setback for competitor EADS Astrium Satellites that was expected to get the order. The contract was valued at €566 million and launches were scheduled to begin in October 2012 and continue in three month intervals. Eighteen more satellites would be ordered in the near future, through a new open competition. In choosing OHB, the European Commission manifested its

intention to double source the programme in order to minimise financial and technological risks.

Another key plank in the European space policy during the past 12 months has been the increased cooperation among different European institutions in the field of space security. The European Defence Agency's (EDA) increased participation in relevant space projects was particularly important. The inclusion of MUSIS in EDA development programmes already mentioned above was significant in this trend. Another positive development has been EDA's participation, together with the European Commission and ESA, in a joint task force to investigate European strategic non-dependence in space activities. EDA's contribution was particularly welcome in identifying key security related space technologies that should be developed in the near future within Europe in order to achieve this non-dependence.[122]

Furthermore, EDA increased its efforts to pool security related space services demand among EU Member States, in an effort to reduce their cost. In this regard, it signed an agreement with satellite communications provider Astrium Services to set up a European common contracting vehicle for commercial bandwidth procurement for military use. Astrium Services came under a €130,000 contract from EDA in November 2009 to pool European commercial satcom requests under a common contracting scheme known as the European Satcom Procurement Cell. This scheme would allow Astrium to sign longer term bandwidth lease contracts with commercial operators on behalf of participating European governments through London Satellite Exchange, its subsidiary that acts as an intermediary between commercial satcom suppliers and buyers. In this way EDA hoped to secure a 30 to 50% discount from currently used spot prices that European countries are usually paying. Until that time, five countries had confirmed their participation in this scheme, namely France, Italy, the Netherlands, Poland and the UK. The European Satcom Procurement Cell drew its operating principle from its French counterpart Astel-S, a commercial bandwidth pooling procurement contract set up between Astrium and the French Armed Forces in 2005.[123]

Finally, in July 2009 the European Commission of the European Union issued its 3rd call for proposals on space related R&D projects within the framework of the 2007–2013 FP7 research funding programme (for a total budget of €114 million). Proposed funding was divided into three categories of activities, namely space-based applications (€47 million), space technologies R&D (€58 million) and cross-cutting activities (€9 million). Space applications mostly referred to developing GMES products, with a special focus on providing multipurpose Earth observation services and down streaming them to European users, especially on a regional level. Space related R&D was approached through the scope of interoperability and harmonisation of products, as well as ensuring their long term

sustainability. This budget line also included funding for developing critical technologies to support Europe's independent access to space. Finally, under the theme of cross-cutting issues the European Commission aspired to enhance space cooperation with third parties and especially Russia and African countries.[124]

2.3.3. Eumetsat

On 1 July 2009, the European Meteorological Satellite Organisation, EUMETSAT, decided in favour of a $90 million contribution to the Jason-3 ocean-altimetry satellite, a joint U.S.-France project. Securing funding was strenuous, as a number of Member States regarded Jason-3 as a bilateral U.S.-France programme. Additional support for the project has been secured from the European Union's GMES programme and ESA, which have both announced they would be purchasing Jason-3 data.[125]

On 9 December, the European Space Agency (ESA) bid-evaluation board failed for the second time to select a winner for the €1.4 billion contract to build six Meteosat Third Generation (MTG) satellites on behalf of Europe's meteorological satellite agency EUMETSAT. ESA will cover 75% of the project's budget and EUMETSAT the remaining 25%. The principal competitors for the contract were EADS Astrium and ThalesAleniaSpace. According to industry sources, the delay could be attributed to political pressure surrounding the contract as Germany which, together with France, is the programme's main financial contributor, was determined to acquire MTG prime contractor status for its industry.[126]

On 3 February 2010, an ESA evaluation board chose the consortium of ThalesAleniaSpace and OHB Technology to build the next generation of Europe's meteorological satellites for Eumetsat. The contract for the six spacecraft (four imaging and two equipped with sounding devices) known as Meteosat Third Generation (MTG) was expected to reach a value of €1.4 billion. The satellites were to include significant improvements compared to their predecessors, including a three-axis stabilization system instead of a simpler spin-stabilised design. Negotiations between the consortium and the European Space Agency (ESA), which had assumed the role of the contracting authority on behalf of Eumetsat, were expected to start immediately after the announcement of the decision. The full life-cycle cost of the programme was expected to exceed €3.3 billion over a period of 20 years, 75% of which would be covered by EUMETSAT. As the competition for the MTG satellites would likely be the biggest single satellite construction contract to be signed in Europe in 2010, the selection process proved to be a highly contested one. The ESA evaluation board had to convene three times before reaching a decision and the agency's Director General J.J. Dordain publicly

admitted to unusually high political pressure surrounding the programme. The other contestant for the project was Astrium Satellites.[127]

2.3.4. National governments

2.3.4.1. France

In 2009 and 2010, France maintained its ambition to remain the leading European nation in space activities. This effort was reinforced by the successful reorganisation of its national space agency, CNES. Under a renewed six year contract with the French government through 2015, CNES is expected to consolidate France's position in the European space sector. As is the case elsewhere in Europe, the agency's strategic planning focuses on developing downstream services for users, improving the country's space industry competitiveness and leading multinational European programmes, but without duplicating ESA ones. The key strategic objective for France is to maintain its individual status as a principal space faring nation, while at the same time increasing its participation in international cooperative space projects.

More precisely, the French civilian space programme has three major tiers: space applications (with a particular focus on Earth observation), access to space, and space related research and development. In the field of space applications, French policy is evolving along two axes, with the development of high performance optical imagery satellites (such as Pleiades) on the one hand, and the outsourcing of lower resolution ones to commercial users through the management of the SPOT constellation by AstroTerra (now an Astrium-Spot Image joint venture) on the other. This policy is aimed at maintaining French technological capabilities in this field while reducing operating costs at the same time. In the same spirit of resource economies, dual use space systems and civil-private synergies are consciously and constantly being pursued. It should be recalled that CNES operates under a double mandate under the Ministry of Defence as well as the Ministry of Research.

Two examples of this dual approach can be seen in the following examples. In June, the French Military Intelligence Directorate announced it was leaning towards outsourcing future production of high-resolution satellite images, under a €750 million project to build world-wide digital terrain models by 2020.[128] Simultaneously, Astrium Satellites announced that it had secured a €66 million contract with the French military to start development on the next batch of two military observation satellites, set to be launched in 2014–2015. These were poised to replace the current Helios system. The new satellites are expected to be a higher resolution capability version of the civil-military Pleiades constellation. French officials assured, however, that in spite of this development France was still

committed to the multi-national MUSIS program to build a common European satellite imaging system.[129]

At the same time, on 18 December 2009, Helios 2B, the French new generation optical imaging satellite, was launched onboard an Ariane 5 GS rocket from French Guiana. The 4.2 tons spacecraft was an identical copy of the Helios 2A launched in December 2004, except that it fielded a more accurate optical instrument, believed to provide up to 35 cm ground resolution. It was placed in the same 700 km altitude near-polar Low Earth Orbit as Helios 2A, at a 180 degrees distance from it. EADS Astrium Satellites built the spacecraft, while its principal optical imager was built by ThalesAleniaSpace. The two-satellite Helios system has an estimated cost of €2 billion. Apart from France, four other European countries participate in the programme with a 2.5% stake, namely Italy, Spain, Belgium and Greece. Germany also has access to its data through a bilateral agreement to exchange Helios data with radar imaging data from its own SAR Lupe spacecraft. The Helios satellites are controlled by the French space agency CNES trough its Toulouse facility, but their daily tasking is conducted by dedicated centres in the participating countries, each using its own encrypted data links. The system's expected life span is five years.[130]

Free access to space is also considered a critical national capability for strategic reasons. France maintains and covers a third of the French Guiana launch facility's operating costs. It is also heavily involved through CNES in the development of future more capable versions of the Ariane 5 rocket, in coordination with ESA (within the frame of the ARTA programme). Unrestricted access to space has been recognised as a priority in the country's national security strategy documents as well. Finally, space launchers have been an area of increased bilateral cooperation with Russia, especially in regard to the development of the country's next generation rocket.

The close cooperation with former soviet republics seems to be expanding, driven by broader government policies as well. During a state visit of the French President Nicolas Sarkozy to Kazakhstan in October, EADS Astrium closed a deal with the country's government to build and launch two observation satellites. The deal, which also included the construction of a satellite integration and test centre, the training of Kazakh satellite engineers and the integration of the satellites with the Spot Image services network, was valued at €230 million. Astrium will also oversee and cooperate with the Kazakh space program, which according to the country's officials should have a $253 million annual budget.[131]

Finally, close cooperation with neighbouring Germany on a bilateral level remained a key plank of French space policy. On 4 February 2010, for example, the French President Nicolas Sarkozy and the German Chancellor Angela Merkel held their regular joint inter-ministerial meeting in Paris. On that occasion, a

number of important agreements between the two countries relating to space activities were announced. First, it was agreed that France and Germany would jointly build a methane concentration monitoring satellite, capable of measuring the results of greenhouse effects to global climate change. The 180 kg spacecraft called the CH4 Atmospheric Remote Monitoring Explorer (CHARME) would be based upon the CNES Myriade small satellite platform and it was expected to be launched on a Vega rocket in 2013 or 2014. France and Germany would equally share its €120 million cost.[132] Second, the two leaders concurred on the timely development of MUSIS, the Multinational Space-based Imaging System that will secure interoperability among European countries' Earth observation satellites ground segments. Third, they agreed that their two countries' space agencies would jointly study the development of a new generation of the Ariane launcher. This programme has been financed by the French government's economic stimulus package. The final decision for the building of the vehicle, known as Ariane 6, would be made by the ESA Ministerial Council in 2011.[133]

2.3.4.2. Germany

From July 2009 to June 2010, Germany continued its effort to position itself as the European space technology leader. In order to achieve this, the country has developed a two-fold strategy. On the one hand, it takes the lead in key European space technology development projects, both in the frame of the EU and ESA. On the other hand, it constantly increases the visibility and public impact of its technological capabilities, either through its participation in the International Space Station (ISS) or in initiating its own national space exploration programme.

The bulk of Germany's funding for civil space activities is still dedicated to ESA programmes (over 75% of its 2009 space budget). However, the country has been also increasingly allocating funds to exclusively national high visibility space exploration projects, such as a lunar orbiter mission planned for 2015 (LEO project). Although the budget of these projects is still marginal compared to Germany's participation in ESA programmes, they are however considered strategically important in Germany. The drive behind this trend is clearly to demonstrate the nation's technological capabilities through exclusively national projects, which in return would increase the German space industry's reputation and client base, creating profit returns for the entire sector.

The same approach has been adopted in regard to German participation in the ISS. Although European participation in the station is represented by ESA, the German government was keen on underlining its industry's key role in building ESA's Columbus ISS laboratory compartment. The ISS has indeed a crucial role

in the overall German medium-term space strategy: it will facilitate the scientific research and development of the country's future space technologies, it will function as a demonstrator of the German space industry's capabilities, and it will increase the visibility and reputation of the country's national programmes.

Germany has made a strategic investment in the ISS. Although France is currently the European country with the biggest contribution to ISS activities, Germany has subscribed for more future scientific projects onboard the station and has become its largest operating costs contributor. It is therefore the country that has the greatest stake in keeping it in use for as long as possible. An example of this particular interest in ISS operations appeared on 27 January 2010, when the German space agency's (DLR) chairman openly disagreed with ESA's intention to limit the ISS operating budget in order to cut expenses. As ESA was contemplating reducing the number of ISS astronauts, or of its control centres (U.S., Russia, Europe, and Japan each have one), the official DLR position was against any change in future ISS operations.[134]

Another field of particular interest to German space policy is space applications. In the past 12 months, the country has increased its involvement both in communications (Satcom) and Earth observation (EO) satellites. As with space science and exploration, the German strategy consists of developing independent national space technologies and then incorporating them into a larger European system. This method enables German industry to expand its technical know-how and to increase its market share, while respecting the country's engagement in common European policies. This strategic development concept is consistent with German industrial planning and political aspirations at a European level. However, the balance between these two strategic objectives is not easy to maintain, and it could result in Germany duplicating on a national level space capabilities that are already under development on an EU or ESA level.

For example, Germany is a prime partner in MUSIS, the future multinational European optical Earth observation system. In October, however, German industrial and government sources disclosed that they were considering the development of a national high resolution optical Earth observation satellite as well. According to these sources, the system, known as the High Resolution Optical System (Hi-ROS), would consist of two or three spacecraft featuring a 70 cm ground resolution and a quick operational response time provided by onboard Ka-band communication terminals linked to geostationary data relay satellites. This development was presented as a logical next step in developing German space observation capabilities to complement its existing radar reconnaissance satellites. Hi-ROS was expected to profit from the R&D undertaken for the German-made optical observation payload of Korea's Kompsat-3 optical imaging satellite, which is expected to be launched in 2011.[135]

The same situation applies to a certain extent to telecommunications satellites as well. On 13 October for instance, ESA and DLR announced that they had reached an agreement on the management of the planned space based European Data Relay System (EDRS). This should replace the existing Artemis spacecraft. The proposed EDRS would consist of one dedicated GEO satellite and two payloads on commercial satellites. In 2008, ESA had requested €230 million to begin its development, of which Germany had agreed to contribute 50%. Negotiations included resolving the issue of intellectual property rights in the system's German-built laser communication terminals. The system is envisaged to cooperate with the EU's Global Monitoring for Environment and Security Sentinel satellites and could be launched as soon as 2013.[136] At the same time, however, Germany is also developing similar technologies on a national level, such as the Heinrich Hertz space broadband demonstration spacecraft and the very high data rate Laser Communication Terminal (LCT) payload. This would imply that complementarity in the Satcom sector between national and European levels is also compromised from time to time.

Finally, in the past 12 months Germany appeared to come closer to a decision to build its first in-orbit satellite servicing demonstrator. More precisely, satellite manufacturer OHB of Bremen announced on 24 February it had been selected as the prime contractor for a technology demonstration experiment of in-orbit servicing and de-orbiting of satellites. The programme, known as the German Orbital Servicing Mission (DEOS in German), is run by the German space agency DLR. Although it has been under study for more than a decade, it was recently promoted to more detailed design work. However, the decision to build the first demonstrator, which could cost up to €200 million, had not been made yet. Nevertheless, this development demonstrates the increasing interest of European countries in these potentially revolutionising technologies. In-orbit servicing of LEO satellites would permit the extension of their operational life span at a fraction of their replacement cost. De-orbiting technologies would allow for the clearing of saturated orbital paths from obsolete spacecrafts, thus helping to mitigate the problem of orbital space debris and to minimise the danger of collisions with operational satellites. The DEOS demonstrator envisaged would have the ability to track satellites, autonomously rendezvous with them in orbit and refuel or repair them by the means of a robotic arm. Furthermore, it would be able to capture the target satellite and guide it into a destructive re-entry trajectory. A significant number of critical technologies would have to be validated before an operational system becomes available. In addition to this, the legal problem of determining liability in the case of the servicing spacecraft accidentally damaging its target satellite would have to be resolved.[137]

2.3.4.3. Italy

The recently elected president of the Italian Space Agency (ASI), Enrico Saggese, announced in January that the global economic crisis would not affect the agency's budget for 2010 and 2011, which was expected to remain at approximately €700 million annually (excluding military-related expenditure).[138] However, this would also imply that no increase could be expected in the near future. Given these financial constrains, Italian space policy would probably focus on maintaining currently announced projects, without expanding to new ones. Happily for Italy, the current financial crisis coincides with a period of limited additional budgetary needs, as a number of key programmes are completing their development phase (e.g. the Vega launcher), while others are only starting theirs (e.g. the next generation Cosmo-SkyMed).

In general, Italian space projects evolve around space applications, with the bulk of the funding going to Cosmo-Skymed services. As is the case in other European countries, ASI has focused on increasing the Italian industry's share in efficiently down streaming services to customers. A major milestone for the commercialisation of Cosmo-Skymed products to market customers was achieved in the past 12 months with the creation of E-Geo, a joint venture between Telespazio and ASI set up for this purpose. At the same time, the Italian space agency has begun development of the next generation of Cosmo-SkyMed that is expected to fly in 2016 (for an estimated €600 million budget). As in the case of its other European counterparts, Italy also participates in the effort to effectively downstream Galileo and GMES products (for which the country covers 30% of the budget). For the Galileo data utilisation project, ASI estimates that €100 million to €150 million of additional funding would be required.

Earth observation is also the basis of Italy's bilateral cooperation with France in the framework of the Orfeo programme that should combine Cosmo-SkyMed SAR data with the French Pleiades system optical data. In the mean time, cooperation between the two countries has turned to Satcom projects as well. ASI's president confirmed the upcoming acquisition of two new satellites by ASI in close cooperation with its French counterpart, CNES. The new spacecraft would be the telecommunications satellites Athena-Fidus and Sicral-2 (the second intended for military use). Sicral-2, the newest of the Italian military Satcom spacecrafts, would host a separate French payload to complement its Syracuse 3 constellation.[139]

Finally, the Italian space industry is also heavily involved in the development of the future small-satellite launcher Vega, an ESA programme for which ELV SpA of Italy is the prime contractor. ASI is paying for 60% of the project's budget, a fact that reveals its strategic character for Italian space policy. According to ASI's president, the first launch of the rocket is expected in early 2011. After that, he said,

ASI would most likely invest further launcher development funding into the next generation Ariane rocket.[140]

Italian space exploration initiatives are more modest than that of France or Germany. However, the country has a key participation in the ISS and has adopted an approach similar to Germany's in favour of using ISS facilities to their maximum capacity in the service of space science and technology development.

2.3.4.4. The United Kingdom

The year 2009 was a significant one for UK space policy, as it witnessed the decision to replace the British National Space Centre (BNSC) with a dedicated space agency. This development will surely lead to a profound restructuring of UK space activities and their administration. UK space policy has long been oriented towards producing concrete technological and industrial benefits for the country. It is therefore apparent that this decision was driven by the desire to increase value for money in UK space activities and to help the space industry improve its position in the European space market. BNSC, which is not a space agency but a coordinating body, relies on funding from ten different government departments. Through this user-oriented approach, BNSC has not always been able to secure adequate funding for British industrial participation in ESA's space applications programs. Through the creation of a more traditional space agency, UK officials hoped to assure a prime contractor's role for British firms in future ESA projects. Characteristically, the announcement that the government was contemplating its creation was immediately applauded by Astrium Ltd., UK's largest space company.[141]

Creating a UK space agency was a gradual process. On 22 July, Lord Drayson, the British Science and Innovation Minister, announced a three months public consultation on the possibility of creating a national space agency in the UK. After several months, the British government finally announced on 10 December that it would create a national space agency to replace BNSC by the end of 2010. According to the rationale of the decision, a dedicated space agency would be a better vehicle for strategic decision making, handling multi-partner programmes, coordinating space-related research and securing long-term funding for it. It would also go further in securing British participation in ESA projects, where 90% of the country's £270 million space budget is currently invested. The decision met the immediate approval of UK aerospace industry officials, who expected it to boost their participation in ESA programs and increase investment returns for their companies from them.[142] It also seems to be related to a steady increase in UK participation in ESA budgets over the past three years (from £158 million in 2007 to £205 million in 2009).

On 10 February 2010, the committee of experts finally delivered its study on the future of United Kingdom's space policy. The document, entitled the Space Innovation and Growth Strategy (IGS), was commissioned by the British government to propose reforms in the functioning and scope of UK's space activities administration and policy. The study included 16 recommendations on how Britain could raise the political profile and industrial impact of its space programmes. A first step towards this direction was taken in late 2009, when the creation of a dedicated space agency to overview all of the country's space activities was announced. The current UK space budget stands at £265 million, over 75% of which represents the country's contribution to ESA. One of the report's key recommendations was to double the amount of the British contribution and to manage it in such a way as to maximise industrial returns for the country. In fact, the panel of experts suggested that UK contribution to ESA should reach the levels of its French and German counterparts, if the country was to achieve the full potential benefits of its participation in ESA. Furthermore, the experts concluded that Britain should increase and support the competitiveness of its national space industry. To that effect, it proposed the backing of UK's exports in this field by the country's Export Credit Guarantee Department.[143]

Another policy advice included in the document was to expand the future British space agency's area of responsibilities to include military space activities as well. In this sense, the report's authors looked up to the example of France and Italy which both have space agencies with dual civil-military role. For that reason, the committee recommended that the development of national military space application should be considered in the country's new Strategic Defence Review, expected to be published later during the year. Unlike other European nations, Britain does not have national Earth observation (EO) satellites yet. According to the report, this capability gap should be addressed by the creation of a dedicated EO services agency in the UK, which would develop and use its own satellites. Furthermore, the committee included in its recommendations the need to formulate a coherent and explicit national space policy document in order to assure the long term strategic guidance of space programmes.[144]

Finally, on 23 March the British government announced it had decided to establish the UK Space Agency on 1 April 2010. The Agency would operate along the general principles mentioned above. It would not however benefit of any additional budget, since the financial conditions in the UK would not allow it. Nevertheless, the new administrative structure was expected to produce immediate benefits for the British space industry's exports. In addition to this, it would certainly secure a more visible presence within the European Space Agency for the UK as well as better industrial returns from ESA programmes for British companies.[145]

2.4. The United States

The most significant development in the U.S. in 2009/2010 has been the announcement of a new Space Policy, on 28 June 2010. This was a document describing the general strategic and policy guidelines and priorities that all the different U.S. government agencies delegated to conduct space activities should follow. All U.S. Presidents since Eisenhower have issued such policy papers, recognising the unique place and importance of space activities to their country's international standing, economic development, scientific advancement and national security.

The announcement of the Obama space policy did not come as a surprise. Soon after his election, the new administration officials and the President himself identified space activities as an area of great significance to U.S. policy, attributing to it a high priority within its working plan. Interagency consultations on the drafting of the policy began already in the summer of 2009, one year prior to its release, based on the authorisation of the Presidential Study Directive No 3. Consultations on the policy's content were not limited within the U.S. government, but on the contrary included inputs from close friends and allies among space-faring nations. During this process, separate talks were held with EU authorities, which underlined the latter's increasing competence in the field of space policy.[146] At a later stage of the review process, other important space actors such as Russia, China and India were informed of its outline, making international cooperation one of the new policy's key elements, already during its making.

The new U.S. space policy itself is a 14 page document with a carefully balanced structure. The first 4 pages include a brief introduction and a 2 page declaration of the policy's key strategic orientations and objectives, labelled "principles" and "goals" respectively. Then, the rest of the paper is evenly divided into two parts. The first provides the broad policy guidelines that all government authorities conducting activities in space should observe ("intersector guidelines"). The second part lays down the more specific actions that they should undertake in order to achieve the policy's objectives, divided into three fields of activity: commercial, civil and national security ("sector guidelines"). In short, the new policy demonstrates a very clear and articulate methodological approach, moving from its broad strategic orientations to the narrower policy guidelines and then to the specific objectives that should be met in every sector.[147]

The key strategic orientations of the new U.S. policy include: the creation of a sustainable, stable and freely accessible near space environment for all nations; the reiteration of the U.S. leading role in space activities; the expansion of international cooperation in space; the improvement of the space industry's manufacturing and commercial competitiveness; the increase of U.S. space assets' resilience against

interference; and the implementation of innovative scientific research and development, including exploration and space applications programmes, with a particular focus on Earth observation missions. "Intersector guidelines" in the policy address an important number of key issues, such as: maintaining and enhancing U.S. space capabilities; fostering international cooperation; preserving near space environment through the promotion of a more responsible use of space; implementing more effective export policies to the benefit of the country's industries; advancing research on space nuclear power; improving the management of radiofrequency spectrum and protecting national space assets from interference; and finally increasing the resilience of mission-essential capabilities.

If one takes a closer look at the various policy guidelines presented above, it appears that they all evolve around three principal thematic areas. The first is protecting and improving U.S. space scientific and industrial competitiveness. This prerogative includes reviewing barriers to the private space sector's development, such as strenuous and counterproductive export control procedures. This point is linked to the overall Obama administration policy that seeks to mitigate the effects of the present economic crisis by increasing U.S. exports, including a review of the State Department's International Traffic in Arms Regulations (ITAR).[148] The ITAR list includes most of space system's components and preparations for its revision have started at the same time as the consultations for the drafting of the new space policy. In the framework of the same effort to revitalise the country's space industry and to reduce its dependence from government expenditures, the new space policy also calls for increasing government funding into innovative research and development, modernising infrastructure in a targeted manner (for example giving priority to space launch capabilities) and relying as much as possible on commercial services for government space operations. In general, the new policy clearly sees the current publicly managed space business model as problematic (perhaps in view of the recent financial turmoil) and it clearly indicates a preference for private investments, or public-private partnerships in space that it regards as more cost-effective.

The second tier of the Obama administration's strategic vision for space is that of an increased international cooperation. Cooperation in space activities has always been appreciated by the country's space policies, since it was considered as a stabilising factor in international relations and a field where the U.S. could leverage its technological advancement into an increased diplomatic status and recognition of its global leadership role. International cooperation is envisaged for all areas of space activities: space science, research and exploration, space transportation and especially nuclear power related research. Furthermore, the new policy pays particular attention to two areas of cooperation: preserving near space environment and developing transparency and confidence-building measures (TCBMs) in space.[149]

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

The third and final tier of the U.S. space strategy is to assure and enhance current U.S. capabilities in space. This aspect of the policy mostly relates to the concept of Operationally Responsive Space (ORS), which is not explicitly stated in the document, but it is however described as the ability to operate in a "degraded, disrupted or denied space environment".[150] The ORS concept is also implied when the policy calls for assuring the mission-essential functions that are indispensable to meet the minimum U.S. government operational requirements, together with increasing space infrastructure protection measures. Finally, the new policy pays particular attention to improving the management of radiofrequency spectrum and limiting intentional or not interference, in close cooperation with international partners.

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

encouraging U.S. companies to be more extroverted and minimising regulatory burdens that might hinder activities abroad.[151]

Civil space guidelines, on the other hand, are divided into three categories: a) space science, exploration and discovery, b) environmental and weather Earth observation (EO) and c) land remote sensing. As far as the first is concerned, the policy mostly sets long term objectives, perhaps in the light of the U.S. government's previous decision to cancel the Constellation project. They include keeping up with robotic exploration missions, developing next generation space launch systems capable of supporting human missions to Mars by the mid 2030's, continuing ISS operations at least until 2020 and further pursuing scientific missions to explore the Sun and accurately catalogue Near Earth Objects (NEOs). Finally, it calls once more for the creation of PPPs to develop private spaceflight capabilities and invest in advanced space technologies. With regard to EO missions, the Obama space policy divides them into environmental (including weather) monitoring and land observation. With respect to the first, it underlines the importance of satellite assets to sustained global climate change monitoring and stresses the need for international cooperation in this field as well.[152] Furthermore, it evenly divides the labour for polar-orbiting satellite based weather monitoring between NOAA and the Department of Defence. Concerning land observations, the document clarifies the competencies of the different services using space assets and calls for the increase of government EO data openness, availability and compatibility for commercial use.

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

This chapter will present a brief analysis of the Obama national space policy and comparison to these published by the Bush (2006) and Clinton (1996) administrations. A similarly comparative approach was also adopted by administration

officials in promoting the new policy, which they described as returning in many aspects to the spirit of the Clinton space policy.[153] Given the limited scope of this paper, previous policies will not be presented in detail.

First of all, it seems pertinent to assume that the order in which sector guidelines are presented is significant of each administration's priorities. Indeed, in the Clinton policy civil space guidelines were given first, followed by national security and commercial activities, whereas in the Bush policy national security came first, followed by civil and commercial space.[154] In short, the new U.S. space policy is the first to place commercial activities first and national security last. Clearly, this is a sign of the increased importance that the current President attributes to the commercial sector, which appears at the top of the list for the first time in history. According to this analysis, the increased importance attributed to commercial space does not perhaps signify a change of paradigm in the U.S. space policy, but it clearly indicates the administration's changed priorities.

Indeed, encouraging private entrepreneurship in space is clearly the new policy's top priority. Although the Clinton administration also attempted to exploit the competitive advantage held by U.S. commercial companies in space activities, the Obama policy adopts a more energetic approach and seeks to actively support their further development. In order to do so, it accepts to finance part of their R&D costs through PPP funding mechanisms, something that was explicitly ruled out by the last two administrations.[155] Furthermore, it demonstrates a preference to purchasing commercial services to the fullest extent possible (depending on their affordability), instead of using their government owned counterparts. To that effect, it does not exclude the utilisation of foreign based services.

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

It appears that the approach presented above also determines the administration's stance towards export control measures. Several government officials have linked the new policy to the revision of the export control regime on space-related

items, which currently poses restrictions upon their free commercialisation. It remains to be seen if a significant number of such items will be removed from ITAR. Nevertheless, it is clear that such a decision would be dictated by the administration's favourable view of an open and extroverted commercial space industry, as the only way to ensure its competitiveness on the long term. This attitude constitutes a clear return to Clinton policies, prior to the inclusion of space technologies to the ITAR list. It also differs from the Bush administration's introverted view of space technologies as a crucial national security and industrial asset, only to be shared with selected allies and "on a case-by-case basis".[156]

The second novel characteristic of the U.S. space policy is the fact that it does not limit itself to describing broad strategic outlines, but on the contrary it goes into specific details on how guidelines should be realised and objectives reached. This detailed approach is an indirect recognition of the increased complexity of the international space activities environment, with its multitude of emerging actors. It also implies that the administration was inclined to clarify the strategic vision on which related policy decisions were based, such as cancelling Constellation and providing a new direction for NASA.[157] The detailed nature of the new space policy was underlined by U.S. government officials. On the other hand, it has also raised some criticism to the fact that it fails to mention the budget required for its programmatic declarations.[158]

Another key plank of the new policy is its focus on international cooperation and its consequent multilateral approach to space activities. This characteristic signifies a clear departure from the previous administration's more unilateral tone and it does seem to return to the views held by the Clinton policy, if not expanding them even further. Indeed, the thread of multilateralism runs through the entire policy document. For example, it manifests itself in the potential for GNSS cooperation, which was not present in the 2006 policy.[159] Furthermore, the administration approaches the space debris issue in a broader, more global and coherent way than its two predecessors. This is especially the case when it discusses international cooperation in SSA projects in a systematic and detailed fashion. By doing so, it moves the debate forward from simply dealing with the debris threat to creating a more sustainable space environment and engaging all space faring nations through the promotion of more responsible policies and behaviours in space. In this sense, it implies a truly global and long term vision, according to which multilateral, and not simply bilateral, cooperation in space could become a stabilising factor for international relations in general.

It is worth noting that the current administration's vision of international cooperation and security in space does not limit itself to describing U.S. policies towards it. On the contrary, it places its attitudes in the broader context of a new order in space activities, based on all nations' adherence to the principle of

preserving a sustainable space environment and demonstrating a responsible behaviour in space in order to protect it. Consequently, contrary to the previous policy of protecting the nation's narrowly defined interests against foreign competition in space activities, the new one places the U.S. in the centre of a multipolar but stable international environment in space activities. Needless to say, the U.S. still reserves for itself a leading role in formulating the rules of international conduct in space. Nevertheless, it tacitly recognises the fact that an increasing number of emerging actors would have to accept them, if they were to be meaningful. In this sense, the U.S. space policy rediscovers the virtues of the Clinton era's indirect strategic approach of "soft power".

Last but not least, one should note Europe's improved bearing upon the formulation of this new international setting. Administration officials have pointed out the consultations with EU authorities that preceded the publication of the policy. More importantly, they singled out the EU proposed Code of Conduct as a good starting point for discussing and implementing such rules of behaviour in space, albeit on a strictly voluntary basis.[160] This development was good news for Europe, as it demonstrated its own capacity to influence its strategic environment regarding space activities and constituted in itself a significant recognition of its standing.

However, in addition to the above the Obama space policy couples its multilateral approach with an acute sense of pragmatism when it discuses arms control initiatives. In fact, the new policy accepts in principle to consider arms control in space, provided that it serves the country's national interests. In doing so, it reiterates the Clinton administration's approach and reverses the previous policy of discarding such initiatives as restrictive to U.S. freedom of action in space. However, the new policy goes even further in this direction by considering the possibility of TCBMs in space, a tool so far related to strategic arms negotiations. By mentioning the possibility of TCBMs for the first time, the U.S. government adopts a space security approach that is more sophisticated than before. Furthermore, it builds upon the experience of bilateral strategic talks and advances them to a multilateral level for space security purposes. Finally, it creates a linkage between space security and ballistic missile defence, acknowledging that the two issues are related in sharing their operational medium.[161]

In relation to space security and space defence missions as well, the new policy adopts a more pragmatic and sophisticated point of view than before. In doing so, it takes into account the increased number of emerging space actors and the proliferation of space capabilities and services. Admittedly, national security objectives in space remain unchanged and they represent a major constant throughout all three last U.S. space policies. Consequently, the Obama administration pays equal attention to protecting its own national space assets and

capabilities as its predecessors. Nevertheless, when examining it in its entirety, the new policy clearly refines the Bush era's unilateral approach of security through space control and the right to deny access to space to adversaries. Instead of this, it emphasises the resilience of critical capabilities, which implies not only the ability to deter any attacks against space assets, but also to maintain core capabilities in the face of such an event. Consequently, it places ORS at the centre of its national space security concept, on an equal foot as deterrence and protection.

Finally, a less substantial but politically important change has occurred in the new policy's choice of words regarding counterspace operations. The Obama administration remains adamant in its right to actively protect its space assets in the face of threat. It considers this as inherent to its national sovereignty rights and consistent with the UN recognised principle of self defence. Nevertheless, the new space policy document states that such counterspace actions will be taken "if necessary", replacing the phrase "if directed" used by both previous administrations. It would be exaggerated to presume that this difference implies any kind of change to the rules of engagement applied in such a case. It does, however, create the impression that such operations (and especially of destructive nature) would be considered as a last resort, when deterrence or other options have failed.[162]

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

Finally, another example of improvement upon previous policies is the case of radiofrequency protection and counter interference measures, which seem to preoccupy the policy more than before. In this field as well, the administration demonstrates its preference for international cooperation in mitigating interference and its willingness to protect U.S. commercial providers from it too. Apparently, it recognises the fact that the growing number of space actors makes a cooperative approach to this issue more appealing than before. It also goes into length in describing U.S. actions in this policy area, which will seemingly become more and more important in the near future.[163]

Just like the ones that preceded it, the Obama administration's space policy is a product of its time. It recognises that the existence of a multitude of new government and commercial actors will create a radically new international space activities environment. It anticipates the emergence of a more pluralistic and multipolar order in space and attempts to prepare U.S. commercial and government entities to face the increased competition and complexity it will entail. It does not aspire to protect itself from this new reality by safeguarding its technological advantage and unilaterally protecting its narrow interests in space like the Bush policy did before. But it does, however, claim for itself the leading role in setting internationally accepted standards and rules of good conduct in space.[164] By doing so, it aspires to further extent its strategic influence and "soft power" in the field of space activities. In this sense, it finds itself closer to the Clinton policy. But in reality it moves further than this in proposing a coherent international cooperation model, based on a multilateral approach rather than the separate bilateral discussions held in the past. In conclusion, it does not simply seek to protect U.S. interests in space, but it regards a new international order in space activities itself as the highest U.S. national strategic interest in space.

The change in U.S. space policy was preceded earlier between mid 2009 and mid 2010, with a complete revision of the U.S. space programme and a restructuring of the NASA budget. The principal characteristic of the new policy was the cancelation of the Constellation manned spaceflight programme and the diversion of considerable funds to public-private sector space technology development schemes. This change in NASA policy direction was mostly focused on access to space policies and it will be presented below

Another issue that preoccupied administration officials was the possible removal of satellites from the U.S. munitions list. On 25 June, Ellen Tauscher was confirmed by the U.S. Senate as the new Undersecretary of State for Arms Control and International Security. During her confirmation statement she suggested that one of the Obama administration's top priorities would be to revise the U.S. export control regime, known as the International Traffic in Arms Regulations (ITAR). She specifically acknowledged the need to consider removing commercial communication satellites from the U.S. Munitions List (USML). The inclusion of such satellites in the list was decided by the U.S. Congress in 1999, when commercial satellites' export control jurisdiction was moved from the Commerce Department to the State Department.[165] This situation has created serious obstacles for satellite operators, since clearing USML items for export can take up to 90 days. This has practically obliged satellite operators to launch all satellites built in, or using components made in the U.S., from U.S. territory. Mrs Tauscher said that including satellites in the munitions' list has impeded

technological innovation from U.S. companies in this field and it has decreased their competitiveness on a global scale.[166]

Earlier in June, the U.S. House of Representatives passed the Foreign Relations Authorisation Act for 2010 and 2011 that enabled President Obama to remove commercial satellites from the USML. However, the bill was still awaiting approval by the U.S. Senate Foreign Relations Committee.[167] At the same time, the U.S. House Permanent Select Committee on Intelligence picked up the ITAR issue in its 2010 Intelligence Authorisation Act. In it, the Committee underlined that strict export control of commercial satellites and related technology has had the exact opposite effects from those anticipated. In fact, it had encouraged local research and development of banned items in foreign countries and it had particularly motivated European companies to establish an international non-U.S. collaborative research environment in order to produce them.[168] For that reason, the Committee proposed that the administration progressively removes space-related items from the USML.

The Obama administration returned to the subject again on 13 August, when the White House indicated on its official website that it would move forward with export-control reform. The same commitment was reiterated again in a public statement by Assistant U.S. Secretary of State Andrew Shapiro on 9 September. Mr Shapiro asserted that bureaucratic struggle to remove certain items from the USML would be long, but that it had the backing of key officials, including U.S. Secretary of State Mrs Clinton. In the meantime, he said, the U.S. State Department was working on simplifying and speeding up its export licence application procedure.[169]

The entire public discussion on export regulations was conducted amongst fears that the U.S. industrial and technology base might erode in the near future because of extensive market consolidation, an aging work force and the absence of new major defence programs. Senior Pentagon officials had already expressed concern over losing irreplaceably skilled defence-related workforce due to retirement. If this trend continues, it is estimated that in the near future the U.S. industrial base will not be able to support every procurement policy the Pentagon decides. And on the other hand, the U.S. Defence Department will have to be content with facing monopolies in several defence product markets.[170]

Throughout the year the debate on removing satellite components from the Munitions List continued in both U.S. legislative bodies. But it proved to be a highly polarising one, with national security "hawks" facing aerospace industry officials that saw their global market share suffer since ITAR controls were imposed in 1999. In this context, on 2 December the President of the U.S. Aerospace Industries Association (AIA) M. Blakey addressed a letter to President Obama urging him to consider loosening the export control restrictions.[171]

During his state of the Union speech on 27 January 2010, U.S. President Barack Obama confirmed that he considered the reform of the U.S. export control system as one of his top priorities. This reform was the objective of the administration's National Export Initiative, which foresaw the creation of an Export Promotion Cabinet to assist the President. Further recommendations on how to relax export restrictions were due to be circulated by 29 January within the government by an interagency working group set up for this purpose. The group was mandated to review the entire export control procedure from scratch. The principal objective of this initiative was to increase export volumes in the face of the global economic crisis, as well as to maintain the U.S. industrial competitive edge. The proposed review had reputedly received full backing from the Pentagon. This development was greeted on the following day by Marion Blakey, the president of the Aerospace Industries Association, who highlighted the initiative's positive impact on employment within the defence and aerospace sector.[172]

2.5. Russia

During our reporting period, Russia continued the modernisation of its space infrastructure according to the ten-year Federal Space Programme announced in 2005. This document provided the key objectives and guidelines for the Russian space programme through 2015 and is still in force.[173] One more space policy related paper was produced in 2008 by Russia's Security Council, updating the security related project priorities.[174] The implementation of this programme so far has demonstrated the country's commitment to developing full scale capabilities across all areas of space activities.

According to the goals set in 2005, Russian space activities should have three key objectives: stabilise the country's economy, develop space science for the benefit of society, and consolidate its defensive power. These objectives were in fact in hierarchical order. Space technologies were first to contribute to the country's economic recovery after the "lost decade" of the 1990's, increase the volume of external trade and exploit the Russian industry's competitive advantage in space in order to consolidate its market position. Secondly, further space technology development should be targeted on space applications in order to enhance domestic stability (for example by extending state television broadcasting throughout Russian territory) and facilitate government work. Furthermore, scientific research should be conducted in close concertation with the industry in public-private joint ventures and should aim at diffusing its benefits to the entire society. Finally, military space capabilities should be preserved and modernised as much as possible and with the widest feasible utilisation of dual use systems.

Overall, one could say that so far the Russian space programme has, to various degrees, attained most of its objectives. The main challenge that it had to face was marrying two inherently divergent objectives. On the one hand, there was the necessity to maintain a widely degraded and even obsolete space infrastructure inherited from the 1990's. On the other, major investments had to be made simultaneously for the development of new systems. Apparently Russia has succeeded in this undertaking, mostly thanks to increased funding made available from the country's flourishing energy and armament sector. Indeed, the Russian space budget has manifested the largest growth in the world during the past 10 years. In 2009 alone the country's civil space budget rose to Rub 88.64 billion, representing a 100% increase from 2008.

Finally, the Russian space industry's output grew by 18% in 2009, in spite of the financial crisis. This positive development has been the result of the carefully planned financial support that the Russian government extended to the country's space industry. More specifically, in the last two years the latter have received over 21 billion Rubles ($609 million) in public funds. When one considers that this stimulus package was carried out as planned in the midst of a major financial crisis, it becomes apparent that the country's space programme enjoys strong political support. In deed, the Russian Prime Minister Vladimir Putin himself has underscored the space industry's importance for the country's economy in several occasions. In order to achieve the objectives mentioned above, the Russian space programme has focused during the past 12 months on three main activity areas: completing the deployment of the Glonass satellite navigation constellation, initiating the creation of a new space port in the Far East, and restructuring the country's space industrial base. In conclusion, during this financial stimulus programme the country's space industry has had the chance to improve its production facilities.[175]

2.6. Japan

Between July 2009 and June 2010, Japanese space policy saw important developments and changes. A long transitional period ended with the creation of a coherent new space strategy for the country. This is forged by two key documents, the Basic Space Law (BSL) of 2008 and the Basic Plan for Space Policy (or Basic Space Plan – BSP) adopted on 2 June 2009. The first was Japan's first comprehensive national space law, aimed at regulating all space activities, public and corporate, and setting the strategic scope of the Japanese space programme. The second was mandated by the BSL as the country's fundamental space policy document, in order to define and materialise BSL into a coherent Japanese space

activities roadmap. The BSP was issued by the Strategic Headquarters for Space Policy, the inter-ministerial governing body for Japan's space activities, also set up by the BSL.[176] At the same time, the Japanese government has continued the administrative reorganisation of space activities, with the explicit aim of simplifying governance by concentrating authority under the single roof of the Japanese Cabinet Office. The Japanese Space Exploration Agency (JAXA) will coordinate and finance all government space activities, following the example of NASA.

The BSP established a five year roadmap for 2009–2013, along six basic pillars. 1) The realisation of a "secure, pleasant and affluent society" utilising space. 2) The enhancement of Japan's national security. 3) The promotion of "space diplomacy". 4) The creation of a "vigorous future" by promoting space related research and development. 5) Fostering of strategic space industries for the 21st century. 6) Considering the environment.[177]

The Basic Plan clearly demonstrates the strategic importance given to space for the future prosperity and security of the entire country. Furthermore, it identifies the future areas of interest for the country's space policy. These are space applications, security, international cooperation, scientific development, industrial development and environment protection. It should be noted that security in its broader sense (military, diplomatic and economic) becomes the cornerstone of the new policy, as it is depicted in three of the six pillars. Other key policy objectives include achieving full autonomy in space technologies and increasing public-corporate synergies in space activities. Finally, space exploration (including independent manned flights) also receives special attention in the document.[178]

Japan's ambitious new space policy has also secured adequate funding, a fact that in the face of the current financial crisis underscores its importance in the eyes of the country's government. The proposed 2010 space budget foresees a 25% increase that will bring its total sum to ¥436 billion ($4.7 billion). This is the total inter-ministerial funding according to the Basic Plan for Space Policy. However, even this sum falls short of the ¥2.5 trillion budget through 2013, recommended by the BSP. This is due to the Finance Ministry's intervention, which usually curtails space funding in its cost revisions in December.[179]

The principal civilian space activities funded in 2010 include the Daichi Earth observation satellite, a satellite for the Quasi Zenith GPS augmentation system and the new Advanced Solid Rocket for launching small payloads. Funding for defence space capabilities includes space situational awareness development, a dedicated military communications satellite, research in infra-red missile warning sensor technology and microsatellites. In spite of an expected change in the Japanese government in September, space programmes seemed to have secured the necessary political consensus to continue.[180]

A report, requested by Japan's cabinet official for space policy, Seiji Maehara, and delivered on 20 April 2010, urges Japan's government to form a new space agency and close the existing JAXA. The aim is a better, quicker and more efficient response to Japan's national needs concerning space activities. Nowadays, JAXA's policy and planning is in the responsibility of the Ministry of Land, Infrastructure, Transport and Tourism, while the budget is part of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) causing unnecessary complications according to this report. It proposes a new space agency controlled by a small executive committee under the direct authority of the Prime Minister and Maehara. As 2011's space budget has to be requested in August 2010, the report recommends the establishment before this date.[181]

2.7. China

China's space policy evolves around the country's five years' economic development plans, the current plan having been decided in 2006. China's space programme is therefore meant to support the country's overall development objectives, while maintaining a comprehensive set of objectives for space activities. The main challenge for the Chinese programme is to mix the desire to develop independent capabilities to the maximum with the need to participate as much as possible in international space cooperation. No key strategic document was published in the field of Chinese space policy in the past 12 months, as the current ones were published at the beginning of the five-year plan and are valid until the end of 2010. New documents may be expected at the beginning of the new planning cycle.

China has a long-standing, full fledged space programme which spreads over a variety of activities. However, its main focus lays on manned space flight, space applications and the further development of its Long March family rockets. It is difficult to distinguish Chinese civilian and military space activities, as several systems have dual use and some key civilian projects (such as the Shenzhou spacecraft) are in fact under military control. Another cause of confusion is that Chinese authorities have a strict confidentiality policy regarding their space systems and they withhold information on the costs and annual budgets of most of their programmes. Although no accurate data is publicly available, the Chinese space budget is thought by most experts to increase constantly over the past few years.

China has also been increasing its involvement in international space cooperation, albeit through bilateral rather than multilateral agreements. On 17 November 2009 for example, the U.S. and China announced that the heads of their

respective space agencies would exchange visits in 2010, in an effort to step up cooperation in space exploration, including human space flight. This joint statement was issued during the official visit of U.S. President Barack Obama in Beijing on 15–18 November. An agreement between the two agencies to talk at least once a year was reached during NASA Administrator M. Griffin's first historical visit to China, but the Chinese ASAT test in January 2007 postponed its implementation. In spite of this, NASA and the China National Space Administration (CNSA) have formed joint working groups for space science and space-based climate research since 2008.[182]

On 14 April 2010, Wang Wenbao, head of the China Manned Space Engineering Office, gave an overview of China's plans to build a 30-ton space station until 2022. The first steps would contain the launch of Tiangong 1 target and Shenzhou 8 doing docking and rendezvous experiments in 2011. This is meant to be the beginning of further docking, rendezvous and refuelling experiments including manned spacecrafts like the Tiangong 3 spacelab which was to be launched between 2014 and 2016. While these launches were to be conducted by Long March 2F rockets, the three modules in order to construct the space station between 2016 and 2022 were to be launched by China's new heavy-lift rockets yet in development. China's space station should be able to host three astronauts and it is planned to last 10 years.[183]

2.8. India

Indian policy traditionally aims at achieving social and economic development through space activities. The Indian space programme currently operates under the guidelines of the current 11th five year plan (2007–2012) which focuses on creating space applications capable of providing tangible products that improve life conditions in the country. Self reliance and space services oriented projects are the corner stones of India's space policy. These include two operational space systems, one for satellite communications and television broadcasting services and one for Earth observation.

As the five year plan develops, Indian space budgets have been increasing accordingly. In July 2009, the Indian Space Research Organisation (ISRO) announced that its 2010 budget would stand at Rp 49.79 billion ($1.04 billion), an increase of 40% from the previous year. This is the largest increase ever recorded in ISRO's history. The largest share of funding was set for launch vehicle development, followed by satellite technology and space applications. Rocket development plans include the Mk 3 version of the Geosynchronous Satellite Launch Vehicle (GSLV), with a lift capability of four tons. Its first flight is

expected in 2010 or 2011, soon after a new indigenous cryogenic upper stage engine has been tested. The Indian human space flight program also acquired additional funding for the development of a two person capsule capable of attaining a 400 km orbit. In fact, ISRO reaffirmed its intention to proceed to its first manned flight by 2015.

Satellite technology research also secured funding, driven mainly by the Regional Navigational Satellite System. This is a proposed seven satellite navigation and positioning constellation to cover Indian national territory and neighbouring states. Other space applications projects include the environment monitoring missions Oceansat-3 and Resourcesat-3, as well as the new cartography satellite Cartosat-3.[184]

2.9. Emerging space powers

From 7 to 9 December 2009, the Third African Leadership Conference on Space Science and Technology for Sustainable Development took place in Algeria and as a result, Algeria, Kenya, Nigeria, and South Africa signed an agreement to build up the African Resources Management Satellite Constellation. The purpose of this constellation is to help with environmental monitoring, public health, and water as well as land usage.[185]

The Nigerian space programme is one of the most advanced of Africa. On 17 July 2009, the director of the Nigerian Space Agency signed a Memorandum of Understanding defining a roadmap of cooperation with the German based Infoterra in order to prepare a radar mission that Nigeria is considering.[186]

Nigeria is also planning to launch its second satellite, the NigeriaSat-2, in the fourth quarter of 2010 on a Dnepr rocket. The last milestone of this mission was reached in October 2009, when the spacecraft passed its flight readiness reviews.[187]

When it comes to South Africa, although a bill was signed in January 2010 by South African President to establish the South African National Space Agency (SANSA) in 2009, it is not done yet. However, in autumn 2009 the nominations for a board were approved. Once the space agency is established, it seems likely that one of its core programmes will be dedicated to Earth observation.[188]

Good news can be reported from the Sumbandila project – the first South African government-owned satellite that was launched on 17 September 2009 with delay. It was developed by SunSpace, the company that launched also the satellite-project of the University of Stellenbosch called SunSat in 1999. Sumbandila passes four times a day over South Africa and will collect images for governmental use for instance in water management, agriculture, and urban planning.[189]

On 22 February the Thaicom satellite fleet operator of Thailand announced a small 1.7% drop in its 2009 revenues. This result was mainly attributed to a 28% fall in broadband satellite terminals sales. Thaicom provides satellite broadband services through its dedicated Thaicom 4 (also named Ipstar) spacecraft. The firm expected this downward trend to reverse in 2010, as it planned to expand its operations to India and Taiwan. On the contrary, Thaicom's conventional satellite communications services' revenue increased by 1.6%, in spite the retirement of its Thaicom 1A spacecraft at the end of 2009. The company currently uses one more satellite, the Thaicom 2, which is also approaching the end of its expected operational life span. In 2009 Thaicom reported $134.7 million in total revenues.[190]

The conflict in Thailand had impacts on Thaicom as the government forced Thaicom to shut down broadcasting of the People Channel Television (PCT), although PCT was not a direct Thaicom customer. After demands to its customer were not accomplished, Thaicom started to jam PCT on 7 April, but the channel moved to another Thaicom customer based outside Thailand. After threats of Thaicom to shut down the whole C- and Ku-band capacity of its customer, the latter stopped broadcasting on 23 April. Thaicom found itself between government's instructions, "company's employees and assets" and decided in favour of the government.[191]

In January 2010, the question of satellite broadcasting interference came under the spotlight in the Middle East. In particular, France's National Frequencies Agency (ANF) asked the Geneva based International Telecommunication Union (ITU) to intervene with Iranian authorities in order to persuade them to cease jamming of BBC World Service's Farsi speaking programme over Iranian territory. French authorities were involved as the programme was transmitted through the Eutelsat Hot Bird 6 satellite. According to French sources, jamming had started during the Iranian election campaign in the spring of 2009 and had not stopped since. After repeated failed attempts to address this issue directly with Iranian authorities, ANF appealed to the ITU. However, since the latter is a purely regulatory organisation with no means to enforce its decisions on its Member States, it was unclear whether its involvement would bring about any results. In the meantime, the BBC had decided to move its broadcasting to another Hot Bird 6 beam and ultimately to another Eutelsat satellite over the region, in an attempt to overcome the interference.[192]

In the past 12 months, Brazil has continued to expand its scope of bilateral cooperation agreements on space activities in an effort to develop necessary technologies for its ambitious space programme. On 8 October for example, the country's space agency AEB signed a technology exchange agreement with Belgium's Liege space centre. This four year agreement includes a wide area of

technologically advanced fields of activity, from nanosatellites to space instruments validation.[193]

Finally, joint Brazilian-Chinese cooperation in building the next generation of Earth observation CBERS satellites for the country suffered a set back in February 2010, when AEB announced the postponement of the CBRS-3 spacecraft launching to 2011. The delay was attributed to technical problems identified during the system's design review.[194]

3. Worldwide space budgets and revenues

Although it was not clear if the trend of increasing institutional space spending would continue in times of financial crisis, it can be observed that the previous year's trend persisted during the last 12 months. The institutional spending on space activities is estimated to have reached $68 billion. A more detailed view on institutional budgets can be found in the following paragraph 2.2.

In terms of commercial revenues of space activities, the Space Report 2010 indicates the total revenue of commercial satellite services to have been about $91 billion comprising telecommunications, Earth observation and positioning services. The revenue of space-related commercial infrastructure including manufacturing of spacecrafts and in-space platforms, launch services as well as ground equipment is estimated to have reached around $84 billion. In conclusion, the commercial space revenues of 2009 can be sum up to $175 billion.[195] A closer look on the commercial revenues is provided in paragraph 2.3.

3.1. Overview of institutional space budgets

The total institutional spending on space in 2009 can be estimated to be approximately $67.8 billion, a figure which shows a nominal increase of 9% compared to 2008.[196] This space spending is comprised of $36 billion in civil expenditures (or 53.1% of the total) and $31.8 billion in defence expenditures (or 46.9%). Consequently, the share remained virtually the same compared to last year's figures. Out of the estimated $31.8 billion of defence related space expenditures worldwide, $28.7 billion were spent by the United States, representing a share of 90% and indicating a minor percentage decrease compared to the year before. These funds came from the Department of Defence (DoD), the National Reconnaissance Office (NRO), the National Geospatial-Intelligence Agency (NGA) and other government entities. It should be borne in mind that not all

relevant funding is made public, resulting in a degree of uncertainty regarding the exact figures of expenditures on defence space activities.

Adding up civil and defence space expenditures, the United States had the biggest institutional space budget in 2009, spending $48.8 billion ($20 billion civil expenditures and $28.7 billion defence expenditures). The total U.S. public space budget constituted 72% of the global institutional spending in 2009. The next largest space budget does not belong to a state but to the European Space Agency, which coordinates civilian space programmes on behalf of its Member States. ESA's budget in 2009 reached approximately $4.8 billion. The next largest national space budgets are furnished by Japan ($3.0 billion), Russia ($2.8 billion), France ($2.8 billion), China ($2.2 billion), Germany ($1.4 billion) and Italy ($988 million), all a considerable distance from the United States. A noteworthy fact was the enormous increase in Russian space spending that nearly doubled, compared to the $1.5 billion spent in 2008. Looking at the rest of the European countries, their accumulated total public spending on space activities in 2009 reached $7.2 billion, representing a 10.6% share of global institutional spending in 2009.

Combined, the United States and Europe accounted for almost 83% of the global institutional spending on space in 2009.

Consulting the absolute numbers alone only tells one side of the story, as comparisons between countries with different economic conditions like prices or

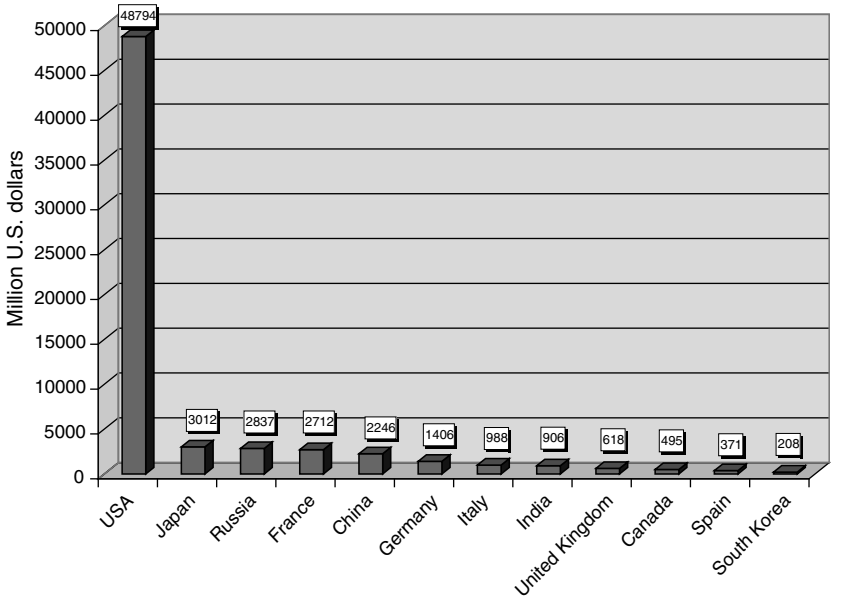

Fig. 3: *Public space budgets of major space powers in 2009 (Based on Euroconsult data).*

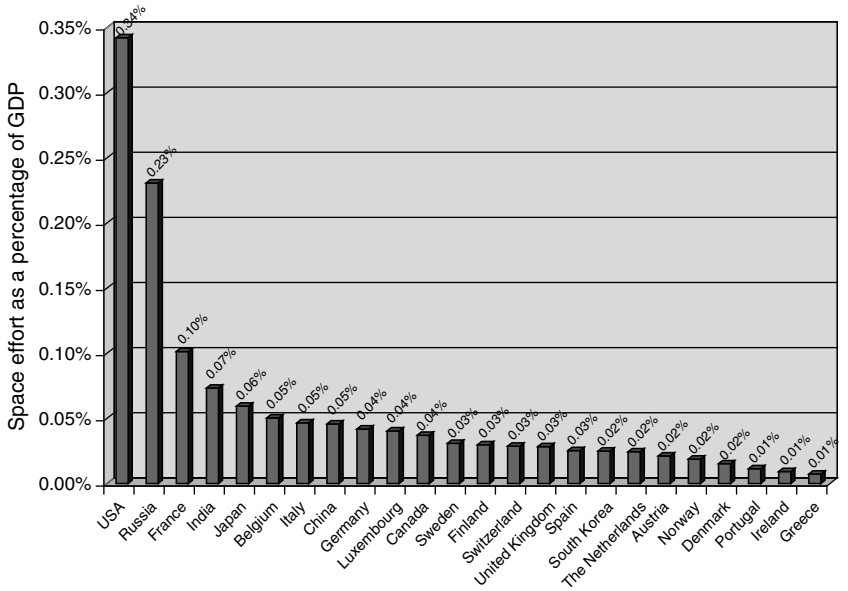

Fig. 4: *Public space budgets (selection) as a share of nom. GDP in 2009 (source: Euroconsult data, IMF[198]).*

wages levels can be misleading. It therefore makes sense to relate the amounts spent to the GDP or to population size. This gives a better indication of the comparative value assigned to space spending in different countries. Figure 2.2 shows the space budget share of GDP for selected countries.[197]

The United States devoted the biggest share of its GDP to public space expenditure with a value of 0.34%. Russia was second with a share of 0.23%, followed by France (0.10%) and India with a value of 0.07%. Noteworthy again is the increase in Russia's space budget. Whereas in 2008 Russia's space effort consumed 0.08% of their GDP, in 2009 Russia spent 0.23% of its GDP whose value remained nearly even. Most European countries featured values between 0.01% and 0.06% and did not change the share compared to 2008.

As another relative measure, figure 2.3 shows the institutional spending per capita for selected countries in 2009.

Again, the United States spending more than $155 per capita in 2009, led by far. France and Luxembourg completed the podium with each spending around $43 per capita. Japan and a number of European countries spent in the vicinity of $20 per capita. It is also possible to rate the GDP share of public space funds against the public space funds per capita. This is done in figures 2.4 and 2.5, with the latter excluding the United States and Russia to display the other countries more clearly.

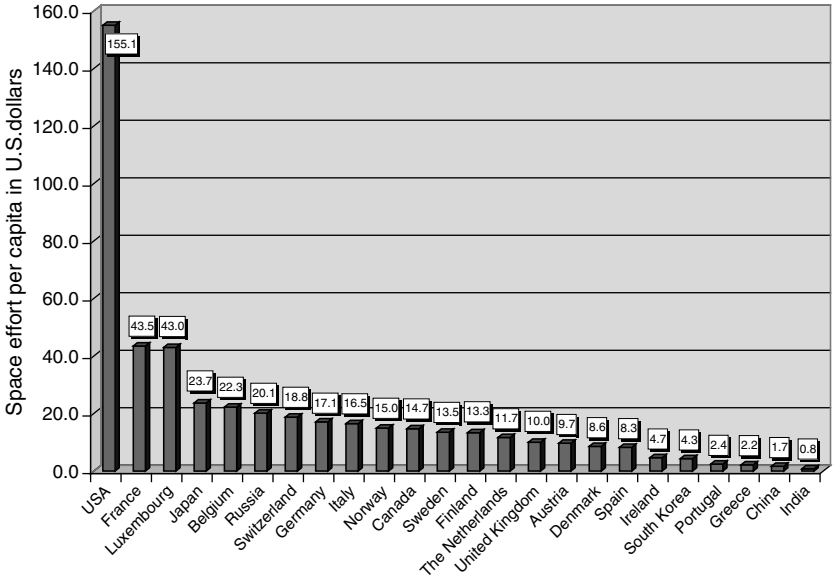

Fig. 5: *Public space budgets per capita (selection) in 2009 (source: Euroconsult data, UN World Population Prospects[199]).*

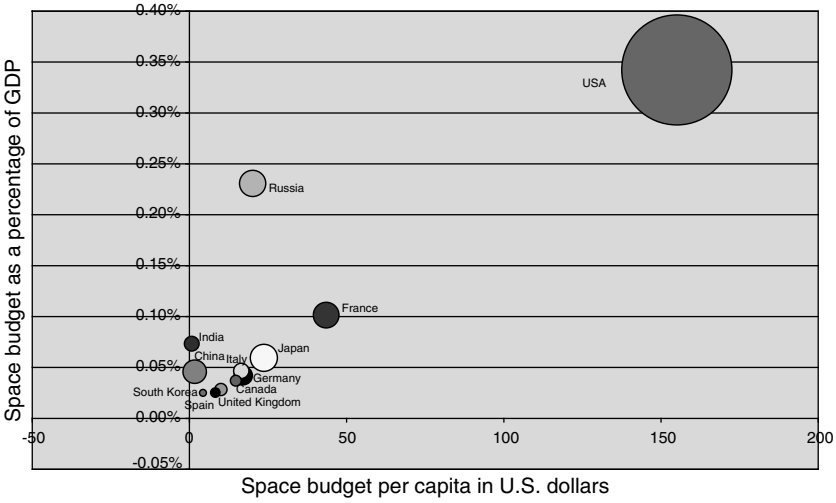

Fig. 6: *Public space budgets as share of GDP mapped against space budgets per capita in 2009 with the bubble size indicating the absolute space budget (source: Euroconsult data, UN World Population Prospects[200]).*

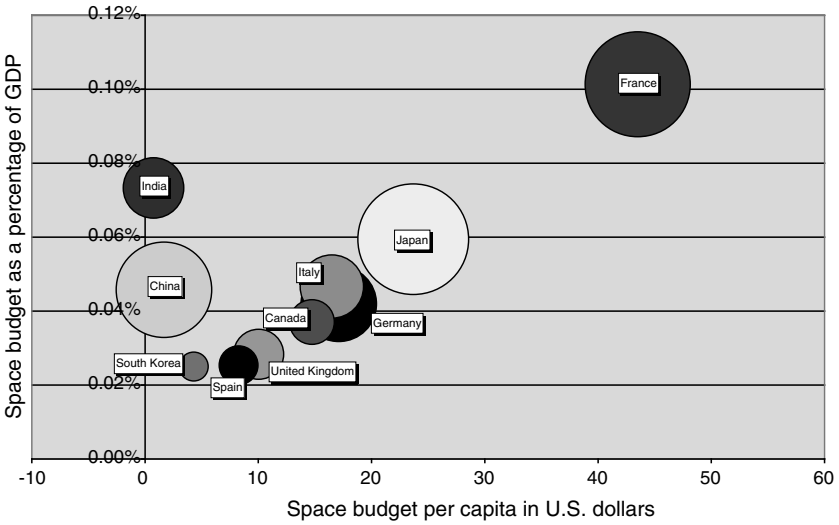

Fig. 7: *Public space budgets as a share of GDP mapped against space budgets per capita in 2009 with the bubble size indicating the absolute space budget, excluding the U.S. and Russia (source: Euroconsult data, UN World Population Prospects[201]).*

The United States is unique by evidently excelling in both dimensions, i.e. in the public space fund share of GDP and in space budget per capita. France and Russia follow. While France is also way ahead of the other countries in both dimensions, Russia has made big efforts and now has a very high and remarkable position in the share of GDP. Although Russia nearly doubled the space budget per capita, it still remains far behind the U.S. and has a noteworthy proportional discrepancy between per capita spending and GDP share, compared to most other countries that are approximately lined around the same proportion. India and China show average values in regard to space budget as a share of GDP, but lag behind in regard to space budget per capita. This is probably due to their large population. There is a cluster of countries like Japan, Italy, Germany, and the United Kingdom that display comparable values in both dimensions.

3.2. Overview of commercial space markets

Satellite services revenues, as depicted by the principal market actors' accounting statements, manifested robustness and resilience to the financial crisis' effects throughout the last 12 months.

On 5 November for example, Eutelsat, the world's third largest commercial satellite operator based on revenue, announced an 11.6% increase in revenue in the

3rd Quarter of 2009. This result was mostly attributed to a 46% increase in multi-usage revenues to €22.9 million, driven by increased sales in the Middle East and Central Asia regions. The announcement confirmed that major commercial satellite operators were largely untouched by the financial crisis.[202]

On 16 November EADS Astrium also announced €3.23 billion revenue from the first three quarters of 2009, an increase of 17.4% over the previous year. Pre-tax profits however were down to 4.8% of revenue (€155 million) from 5.1% during the same period in 2008. According to the same announcement, Astrium Space Transportation accounted for 41% of total revenue, Astrium Services for 38% and Astrium Satellites for 21%. Astrium Services were severely curtailed by the drop in the British Pound, as the company's principal revenue source is its contract with the UK military to provide the Skynet 5 satellite communication services.[203]

Earlier, in July, EADS Astrium had reported a 29% revenue increase (at €2.19 billion) and a 22% backlog increase (at €15.6 billion) in the first half of 2009. These results were attributed, among other factors, to the acquisition of Spot Image the previous year. Astrium's pre-tax profit margin however was down to 4.5% from 5.2% the previous year. This decrease was attributed by Astrium officials to restrictions due to government procurement rules relating to space systems.[204]

3.2.1. Direct Broadcast Services

Direct Broadcast Services (DBS) refer to direct-to-home satellite television and radio broadcasts. This business category manifested considerable improvement in the period under examination, fuelled mostly by growing demand in Europe and emerging markets, such as India. On the contrary, demand in the U.S. market showed signs of stagnation, probably because of its rapid expansion during recent years, in conjunction with the financial crisis' effects.

Eutelsat for example, the world's third-largest satellite fleet operator, announced a 7.2% revenue increase (at €940.5 million) in the 12 month period from June 2008. According to the company's statement, this increase could sustain 7% annual growth throughout 2012. According to the same sources, satellites operated by Eutelsat were filled to capacity (over 97%) and efforts were undertaken to reposition some of them in order to reduce the fill rate to 80%. Strong television demand in Europe and U.S. government bandwidth demand in the Middle East contributed mostly to these financial results.[205]

The second largest satellite fleet operator, SES, also reported record gross profit margins in July and announced that it was still on track with its target to attain a 5% annual growth rate throughout 2010. However, the company's recurring revenues

in the first half of 2009 were up by only 2% from last year, to €843 million. These results were attributed to SES's lower than expected growth in North America, the opposite of its satisfactory performance in Western Europe. In total, 81% of the company's revenues were attributed to satellite lease operations.[206]

On the other hand, satellite services and space hardware provider ThalesAlenia-Space reported a flat revenue growth rate and a drop in pre-tax profits for the same period. New orders however were up 30% from the previous year, at €904.6 million. Company officials attributed these mediocre results partially to the destruction by earthquake of one of its satellite component facilities in L'Aquila, Italy.[207]

In another development, the Indian space agency ISRO announced in July an 18% increase in the number of direct-to-home (DFH) pay television subscribers over the first quarter of 2009. Although India has been long considered one of the greatest potential DTH markets, its protectionist regulatory environment and excessive import taxes have limited foreign access to that market. Antrix, ISRO's commercial arm, has only recently introduced non-Indian satellite systems to the market, on the condition that it acts as their reseller.[208]

3.2.2. Fixed Satellite Services

Fixed Satellite Services (FSS) refer to the use of spacecrafts that utilise land terminals in fixed positions to broadcast. They include broadband internet, communications and network televisions and radio broadcasts. FSS business demonstrated considerable resistance to the crisis' consequences. Demand was fuelled by long-term agreements for communication services that were largely unaffected by the crisis, as well as a steady increase in satellite broadband internet demand. However, risk aversion created among service providers by the general financial conditions led some of them to reconsider their medium-term plans for broadband internet development, mainly because of the considerable up-front investments related to it.

In a 22 September report to the London Stock Exchange for example, satellite broadband service provider Avanti Communications of Britain announced a return to pre-tax profits during the 12 months ending in June 2009, after reported losses the year before. The company reported £8 million annual revenue (up from £5.9 million) and pre-tax gains of £1.8 million, from £1.4 million losses last year. Avanti also reported it was receiving penalty payments from Astrium Satellites for the delay in the delivery of the Hylas broadband satellite. Hylas would be the first dedicated broadband satellite in Europe, scheduled to be followed by Eutelsat's Ka-Sat later in 2010. In the meantime, several European governments have

announced financial incentives to stimulate commercial satellite broadband projects.[209]

The same trend was evident in the U.S. as well, where in May 2009 the Federal Communications Commission issued a report on the future expansion of broadband services in rural areas in that country. The report made an appeal to President Obama to increase the project's budget beyond the $7.2 billion already allocated to it under the American Recovery and Reinvestment Act of 2009. The report also underlined the importance of satellite communications in reaching the project's objectives in the near future, reminding that their use would be indispensable in order to achieve full coverage of rural areas. Finally, the Commission urged greater coordination among U.S. federal agencies involved, as well as for a review of all existing broadband programmes.[210]

In general, the global financial crisis has tightened credit supply throughout the satellite industry. As a result, national export-credit agencies were stepping in more and more often to help finance commercial space projects, usually by guaranteeing their bank loans. In September, for example, France's export-credit agency Coface approved a loan guaranty to Gazprom Space Systems of Moscow for acquiring two Yamal-400 communication satellites. The spacecrafts would be built by ThalesAleniaSpace and launched onboard an Ariane 5 rocket. Coface's U.S. counterpart, the Export-Import Bank, is also engaged in similar schemes. Although both agencies are set up as private companies (Coface is owned by Natixis) they often finance projects based not only on financial reasons, but also on the need to support critical industrial space infrastructure in their respective countries.[211]

In a related development, SES and Eutelsat announced on 31 July that they were rethinking their involvement in providing S-band satellite services in Europe. The two companies had formed the joint venture Solaris Mobile and won one of the two European Union Commission licences to operate S-band satellite services in Europe. After a failure in deploying an S-band antenna onboard Eutelsat's W2A satellite in April however, the two companies would have to launch a new satellite in order to abide by their licence obligations. Representatives from both companies expressed their concern over making such an investment and announced that they would wait to receive their insurance claim before they made their decision.[212] One possible solution to this financial impasse, they said, would be a possible merger of the two licensed S-band providers in Europe, Solaris Mobile and Inmarsat of London. Such a solution however had been explicitly ruled out by the European Commission at the time of the licensing process.[213]

In October, the market research firm Tauri Group issued its annual report on the state of the personal spaceflight industry in the U.S., commissioned by the Commercial Spaceflight Federation. The report found that although the sector

grew by a modest 6% (to $261 million) in 2008, total investment rose by more than 20% (to $1.46 billion). Of that, individuals provided more than 50%, private equity funds 30% and government only 15%. However, government clients still accounted for over a third (or $126 million) of the industry's revenues. The report's findings confirmed the growing investor interest in commercial spaceflight, as well as the increasing involvement of bigger companies that enter the industry as vendors or services providers.[214]

At the same time, NGA is moving forward to increase the amount of imagery provided by commercial optical reconnaissance satellites. In April 2009, Director of National Intelligence Dennis Blair announced that NGA would be purchasing images from at least two satellites equipped with 1.1 metre apertures. DigitalGlobe and GeoEye are among the principal candidates for acquiring these contracts.[215] In September 2009, NGA also announced that it would launch a new contracting vehicle for acquiring image data, called EnhancedView. This project will be similar to the current NextView programme, with the difference that NGA will be requesting 0.25 metre resolution products, instead of 0.5 metre that was the usual standard until now. This would require operators to fly their satellites in lower altitudes, at the expense of their operating life span. It would also complicate operations for private companies as U.S. legislation prohibits the sale of better than 0.5 metre resolution images outside U.S. government agencies.[216]

In spite of this development however, U.S. satellite broadband providers expressed scepticism over how much funding they would get from the broadband stimulus package. In a 30 September submission to the Commission, the U.S. Satellite Industry Association (SIA) urged officials not to focus on local labour-intensive terrestrial installations. In all, satellite operators have applied for $2.2 billion in loans and grants under the programme, out of a total $28 billion funding requests. Among them, Echostar has applied for $483 million under a joint venture with ViaSat Inc. intended to launch a dedicated broadband satellite by 2012, as well as for $530 million for a similar venture with WildBlue Communications of Denver. Other contenders include Skyterra, Spacenet Inc. and AtContact Communications LLC.[217]

Faced with financing difficulties and unsure government backing, companies involved in broadband satellite services have shown a tendency to consolidate their market positions. Apart from the joint ventures mentioned above, ViaSat Inc. announced in September the purchase of satellite broadband services provider WildBlue. The transaction cost $443 million in cash and $125 million in stocks. With this purchase, the future market for broadband services in the U.S. will most likely be contested by two companies, ViaSat and Hughes Network Systems. Both companies have scheduled launches of dedicated broadband service satellites, ViaSat of ViaSat-1 in 2011 and Hughes Network Systems of Jupiter in 2012.

Both Satellites are developed by Space Systems/Loral and they should field an over 100 GB Ka-band capacity.[218]

In August, the U.S. government announced its intention to simplify contracting arrangements for purchasing commercial communications satellite capacity. The plan involves consolidating the government and defence purchasing contracts into one common scheme by 2011. By doing so, U.S. government will be able to buy bandwidth directly from commercial satellite operators, something that is not currently possible. The new contracting vehicle is known as "Future Comsatcom Services Acquisition" (FCSA) and it will greatly simplify contracting procedures. In 2008, the U.S. government spent $397 million on satellite transmission contracts, of which $350 million were for defence purposes.[219]

3.2.3. Remote Sensing

Remote sensing refers to commercial companies that provide optical and radar images to the open market, mostly to government entities that have been increasingly outsourcing such capabilities over the past few years. Although image procurement is usually conducted through short-term agreements that acquire data at spot market prices, their demand was not considerably affected by the crisis, mostly because of growing corporate and public demand for these products. This trend has also led to an increasing simplification of related public procurement policies and a consequent ease of existing export controls applied to satellite image data.

The U.S. government announced on 7 October, for example, that it would relax its commercial radar satellite data restrictions. This should allow commercial operators to offer high quality images of up to 1 meter ground resolution to the open market, instead of the existing 3 metre limit. Northrop Grumman Aerospace Systems of Los Angeles would be the first company permitted by the U.S. Department of Commerce to operate a Synthetic Aperture Radar (SAR) image satellite under the new regulations. Company officials claimed that the proposed satellite, called Trinidad, would be based on components from the Israeli TecSAR satellite, tested by the USAF earlier in the year. According to the same sources however, the satellite's development would require firm government purchasing commitments to start. With this development, European SAR image commercial providers will be facing U.S. competitors within the next two years.[220]

3.2.4. Mobile Satellite Services

Mobile satellite services (MSS) relate to applications delivered to mobile terrestrial terminals such as ships, aeroplanes, automobiles, cell phones etc.

According to a market forecast published by Euroconsult of Paris in October, mobile satellite services revenue growth is expected to average 8% over the next decade, reaching some $2.5 billion by 2018. Satellite broadband services should account for the bulk of this increase, as they were projected to rise by 25% annually over the same period. Smaller growth rates were expected in machine-to-machine applications (+16%), maritime mobile satellite services (+7%) and aeronautical services (+13%),[221] among others.

In July, mobile satellite services provider Globalstar Inc. completed a life-saving financial rescue package, which included a $586 million credit from a consortium of French banks guaranteed to 95% by Coface, the French export-credit agency. This package would allow Globalstar hardware providers Arianespace and ThalesAleniaSpace to resume deliveries of the 24 second-generation Globalstar satellites due for launch onboard Soyuz rockets in 2010.[222] After this development, Globalstar announced to investors on 8 July that it expected to return to a 30% annual revenue growth rate by the end of 2010, when its new 32 satellite constellation (including eight existing ones) would become operational, putting an end to the service degradation of the past three years caused by satellite problems.[223]

The market for mobile satellite telephone calls is expected to experience intensification in the next months. Thuraya, United Arab Emirates-based satellite telephone provider, is offering cheap handhelds, the new Thuraya XT model, and also Inmarsat is to step into the handheld market with the aim to gain a 10% share.[224]

The satellite manufacturing revenues in 2009 experienced a significant increase compared to 2008. The total revenues of satellite manufacturers that built satellites both for governmental and commercial launches are estimated to have reached $16.15 billion in 2009 which indicates a rise by 48% from the $10.94 billion gained in 2008. It can be observed in Figure 2.6 that this augmentation marks an abrupt end to the trend of slightly decreasing revenues from 2006 on. The increase of $5.21 billion is primarily due to the construction of high-value defence satellites, whereas the share of the manufacturing revenue of the commercial satellites slightly decreased from $5.2 billion in 2008 to $5.14 in 2009.[225]

It is difficult to assess the exact annual revenues for launch services or the allocation between partners or countries. This is due on the one hand to the often complex package of financing mechanisms and industrial structures in some countries, and on the other hand to the reduced visibility of revenues from national institutional launches. These often draw on military budgets and, in addition, commercial launch service prices are usually not disclosed. The Federal Aviation Administration (FAA) estimates commercial launch revenues for 2009 at $2.49 billion. This represents an increase of $520 million from 2008 commercial launch

revenues. Europe again had the lion's share, with more than $1 billion, representing 42% of the total annual revenues, followed by Russia ($742 million and 31% of the total revenues), the United States ($298 million and 12% of the revenues) and Sea Launch and Land Launch ($280 million and 12% of the revenues – Figure 2.7). As a whole, commercial launch revenues grew steadily between 2004 and 2009, witnessing an increase of almost 150% from roughly $1 billion in 2004 to almost $2.5 billion in 2009.[226]

Ground equipment revenues include infrastructure elements, such as mobile terminals, gateways and control stations, and consumer equipment, such as very small aperture terminals (VSAT), ultra small aperture terminals (USAT), DTH broadcast dishes, satellite phones and digital audio radio satellite (DARS) equipment.

Portable Navigation Devices (PND) form one of the sub-segments of end-user electronics incorporating GPS chip sets. Although the PND market grew by more than 30% in 2008, it decreased in the last quarter of 2008. Indeed, growth was affected by the crisis as the PND business is very dependent on the automotive sector. TomTom and Garmin are the two leaders in the PND market. Although both companies experienced reduced revenues in 2009, their expectations for 2010 are optimistic and they assume growing markets. Furthermore, TomTom notes the upcoming threat to their business by free turn by turn navigation on smartphones, as for instance offered by Navigon in cooperation with telecommunication providers.

TomTom reported $1.48 billion revenue in 2009, which represented a 12% decrease compared to 2008 and indicates a trend of diminution since 2007.[227] Garmin had total revenues of $2.95 billion in 2009, a 10% increase compared to 2008 ($3.49 billion). It sold 16.6 million units in 2008, which indicates a small decrease. Also, three of its four activities areas (i.e. automotive/mobile, aviation and marine segments) experienced a retracement; only the consumer-related area of outdoor and fitness increased. Accordingly, their revenues considered by region also dropped by 16–18%, however, their small asset in Asia increased by 3%. Garmin itself names the economic crisis and the "depressed global economy" as reasons for its performance and expresses optimism concerning improvements in the global economy and therewith revenues in 2010.[228]

As the space industry continues to demonstrate increased hardware reliability, low accident rates and booming growth in recent years, insurance costs have been decreasing. In fact, the repeatedly good performance of insured commercial space assets has attracted new insurance capacity into the market, pushing premiums to historically low levels. This trend has continued uninterrupted in the past 12 months. For example, insurance companies that cover space launches have demonstrated an increased appetite for risk by raising the maximum underwriting

value for a single space launch. In March 2010 in fact, the launch of two communications satellites onboard an Ariane 5 rocket broke all records, with an accumulated liability coverage value of $700 million. Given that commercial space launches are expected to grow in the following years and the technologies involved have proven their worth in practise, one can expect this trend to continue. Nevertheless, this unusually long period of higher insurance limits and lower rates is beginning to raise concerns among insurers on the long-term viability of their business. Indeed certain commercial space underwriters, such as Paris Re, have announced that insurance rates were approaching a level where they may no longer support the assumed risk. In that case, some insurance brokers may consider their withdrawal from the market all together. The global space insurance market currently has a total coverage value of approximately $17 billion, distributed across 175 insured satellites.[229]

Also interesting is the development of space insurance activities in the coming years in and with Islamic organisations and countries. In 2009, the satellite fleet operator Yahsat of Abu Dhabi agreed with underwriters to sign the first Shariah compliant satellite insurance package. This could be a first step for further insurance agreements and also more space activities of the Islamic World due to higher security.[230]

3.3. Evolution of the space industry

3.3.1. Industrial evolutions in Europe

On 10 June, the French commercial image satellite operator Spot Image assured its customers that it would be willing to field two new medium resolution satellites, Spot 6 and Spot 7, starting in 2012. The two new satellites should complement the highly successful Spot 5 that currently accounts for the majority of the company's revenues and is expected to operate until 2014. However, Spot Image declined to give more specific details on the project, as the financing decision had not yet been made by its principal shareholder, Astrium Services, which was still negotiating on this issue with the French government.[231]

A few days later, on 18 June, Astrium Services announced that financing issues had been resolved and that the company would cover the approximately $500 million cost of the two satellites, without asking for any financial support from the French government. However, Spot Image officials asked for some kind of commitment from the French government to buy images from the future satellites. Companies in the United States (such as GeoEye and DigitalGlobe) already operate in this fashion. In general, it appears that the commercial image industry

is in the middle of a transition from a fully government financed business model to a mixed private-public financing, based on guarantees of future government contracts.[232]

On 1 July, satellite services provider Telespazio and the Italian Space Agency ASI agreed on the creation of a joint commercial platform for selling data from the Cosmo-SkyMed radar imaging satellite constellation. A new company called e-Geos has been set up for this purpose in Rome, with Telespazio holding 80% of its shares and ASI 20%. Under the agreement, the former transferred its Earth observation division to the new company and the latter its rights to commercialise Cosmo-SkyMed images. According to company officials, e-Geos was close to striking a deal to supply images to clients in the Middle East.[233]

In a related development, e-Geos announced on 19 November that it had secured a contract from the European Space Agency (ESA) to provide radar and optical images to the EU Global Monitoring for Environment and Security project (GMES). The €3.5 million deal included providing radar data from Italy's Cosmo-Skymed constellation and optical data from U.S. commercial operators GeoEye and DigitalGlobe.[234]

On 20 July, ThalesAleniaSpace secured a €17.9 million contract from ESA to build the Experimental Re-Entry Test Bed (EXPERT). This will be a 440 kg bullet-shaped re-entry capsule that will be launched for a sub-orbital flight onboard a Russian submarine launched Volna rocket, as early as October 2010. The capsule is expected to offer valuable data for the development of ESA's Advanced Re-entry Vehicle (ARV). ARV will be an enhanced, atmosphere re-entry capable design of ESA's Automated Transfer Vehicle (ATV) that carries supplies to the International Space Station (ISS). ARV first flight is scheduled for 2016.[235]

In October, NATO announced it would be conducting an open competition to acquire additional satellite communication services for its troops in Afghanistan. Since 2004, NATO's Consultation, Command and Control Agency (NC3A) has had a $659 million agreement with a consortium using bandwidth on Skynet, Syracuse-3 and Sicral satellites to provide SHF and Ultra-high frequency communications. Extra bandwidth is indispensable, however, as Afghanistan communication infrastructures are very limited. Due to security reasons, the competition would be limited to NATO Member States only. In addition to current providers, Germany, Greece, Spain, Turkey and the United States all have satellites that could be used to fill the gap.[236]

On 30 November, satellite fleet operator SES Astra announced its intention to order four direct broadcast television spacecrafts from EADS Astrium Satellites, at a total cost of approximately €500 million. This contract would constitute the biggest single satellite order ever made by SES and it would account for more than

15% of 2009's commercial satellite sales worldwide. The spacecrafts would be delivered at 6 month intervals starting in 2012. Apart from featuring more than 60 Ku-band transponders for direct broadcast services each, the spacecrafts would also have 2 to 4 Ka-band payloads. This would be a step forward in the company's effort to develop next-generation broadband communication services in Europe. Furthermore, the series' fourth satellite was expected to carry a navigation payload for the European Commission's Egnos programme, designed to enhance GPS signal reliability.[237]

In a parallel development, SES announced that it was also negotiating with Astrium Services the sale of its German-based ND SatCom subsidiary. The company held a 25% participation in MilSat Services, the satellite communication provider contracted by the German military to operate its two SatComBw communication satellites. EADS Astrium Services, an Astrium Satellites sister company, held the remaining 75%.[238]

On 21 December 2009 Avanti Communications of London announced it had secured a $309 million in loans from U.S. and French export credit agencies (the Export-Import Bank and Coface respectively) to build its next generation Hylas 2 Ka-band broadband services satellite. The spacecraft, which was scheduled for launch in 2012, would weight 3.1 tons and provide an 8.28 gigahertz capacity to up to 1 million subscribers, representing a significant capabilities increase from its predecessor Hylas 1. According to the package's terms, Avanti would sell 21.5 million shares in order to raise £86 million on its own to finance the project.[239]

In a related development, commercial satellite fleet operator SES also announced on 21 December 2009 that it had secured a €522.89 million loan, backed by the French export-credit agency Coface, to pay for the construction of 4 new satellites by EADS Astrium. The spacecrafts, named Astra 2E, 2F, 2 G and 5B were scheduled for launch between 2012 and 2014. SES officials claimed that the company, which had a €4 billion accumulated dept, could find credit in the open market and did not necessarily need Coface's backing. However, they added that its support was welcome as it allowed them to borrow on lower interest rates and to spread the repayment period onto a longer time period throughout 2022.[240]

On 26 January 2010, OHB Technologies chief executive Berry Smutny confirmed that although EADS Astrium did not obtain the prime contract for building the first phase of the Galileo NPT constellation, it would still secure up to 50% of the contract's work as a sub contractor of OHB. In fact, the official clarified that EADS subsidiary SSTL of Britain would build most of the satellites' electronics payload, which would account for up to 40% of the spacecraft's total value. He also said that OHB would be using for the Galileo project a derivative of the satellite bus developed for the German SAR-Lupe constellation.[241]

On 9 February the French space agency CNES signed a €280 million contract with ThalesAleniaSpace for the construction and launch of the Athena-Fidus satellite. Athena-Fidus will be a 3 ton Geosynchronous Earth Orbit (GEO) telecommunications satellite based on Thales' Spacebus 4000 B2 platform and using EHF and Ka-band frequencies. It is a joint project evenly funded by the French and Italian space agencies. Its mission will be to offer high speed (up to three GB) communications to military and civil-protection agencies. Its technical specifications would allow it to transmit real time video data from unmanned aerial vehicles (UAV). The satellite will be operated by France and it is expected to be launched onboard an Arianespace rocket by 2014 at the latest.[242]

In February 2010, Surrey Satellite Technology U.S. (SST-US), a subsidiary of the British Surrey Satellite Technology Ltd (SSTL), proposed the replacement of the older commercial imaging spacecrafts Ikonos and Quick-Bird by a constellation of small satellites. Ikonos was launched in 1999 and it is operated by GeoEye of Dulles, whereas Quick-Bird flew in 2001 for DigitalGlobe of Colorado. Both companies have been the principal commercial image providers for the U.S. Department of Defence. SSTL officials have been promoting the use of a constellation of 5 SSTL 150 Kg imaging spacecraft instead, for a total price of less than $150 million. SSTL had already built a similar constellation for the German commercial imaging provider RapidEye AG. The ground resolution offered by these small satellites would be approximately 1 m in black and white and 4 m in colour images, which is comparable to Ikonos' and slightly inferior to Quick-Bird's performance. A constellation of small satellites also has the advantage of shorter revisiting times, but on the other hand it offers a much narrower swath path due to its fixed camera. From a military point of view, a constellation of small satellites also shows greater survivability and redundancy to interference than a single spacecraft. Given that the U.S. Pentagon is already developing such formation flying satellite systems for military use, one could argue that private satellite services providers that work with the U.S. military would soon follow suit, offering commercial spacecraft comparable to the dedicated military ones. In other words, private companies seem to incorporate to their new satellite systems technical characteristics that imitate the standards set by government spacecraft, in an attempt to secure contracts.[243]

Eutelsat, the world's third largest satellite fleet operator, reported on 18 February that its 2009 financial results were good beyond all expectation. More specifically, the company's officials announced a 9.6% revenue increase for the 2nd half of 2009, which brought total revenues in the aforementioned period to €508 million. This figure represented a gross revenue margin of 81% (EBIT-DA), which was well above the firm's objective of a 77% annual average for the period

from 2009 to 2012. Thanks to this performance, Eutelsat foresaw to exceed for the first time in its history the €1 billion revenue mark during the 2010 fiscal year. Furthermore, the firm's officials now expected its average growth to surpass the 7% benchmark on an annual basis through 2012. Eutelsat's backlog also exceeded expectations, marking a 19% increase from the previous year and standing at €4.2 billion at the end of 2009. The firm's positive financial performance was attributed to several factors, including an increase to its available satellite transporters from 489 to 532, a raise in satellite lease prices in Europe and, most importantly, Eutelsat's bullish presence in the emerging Russian, Middle East and African markets.[244]

On 23 February Dutch Space of Leiden, Netherlands, announced it was selected to provide solar arrays for the first four GMES Earth observation satellites, of the Sentinel 1 and 2 series. The company was chosen by ThalesAlenia-Space under a € 13.4 million contract to build panels for Sentinels 1A and 1B (equipped with a C-band Radar payload). Simultaneously it was also contracted for the sum of €10.3 million by Astrium Satellites for Sentinels 2A and 2B (equipped with a super-spectral imaging instrument). The company consequently subcontracted Astrium to build the solar cells and Airborne Composites of Hague to provide the carbon-fibre panels.[245]

On 24 February ThalesAleniaSpace announced it was chosen by the French space agency CNES to build the Jason-3 ocean altimetry satellite. The Jason series satellites are a joint effort by the U.S. National Oceanic and Atmospheric Administration (NOAA), Europe's Eumetsat meteorological agency and CNES. The Jason-3 budget was estimated at €252 million, including launching and three years of operation costs. ThalesAleniaSpace would be responsible for providing the spacecraft's Proteus platform, its principal instrument (the Poseidon 3B altimeter), as well as for the system's integration, testing and launch preparations. NOAA would provide secondary payloads and it would be in charge of its launch, which was scheduled for July 2013. The satellite was planned to work in tandem with Jason-2, already in orbit since July 2008.[246]

Due to problems of a Russian mobile gantry, the first launch of the European Soyuz version is scheduled to the end of 2010, not allowing a second flight in 2010. Also this means additional costs for ESA that will be asked for an additional $50 million funding. The delay also led Arianespace to reactivate its Starsem affiliate to launch four Soyuz rockets from Baikonur Cosmodrome in Kazakhstan beginning in September. The first launch of Arianespace's new light-lift rocket is likely to be not before 2011. After successful demonstration flights of the two new rockets, Arianespace expects to launch annually six to seven Ariane 5 rockets, three to four Soyuz and one or two Vega spacecrafts from the European spaceport in French Guiana.[247]

3.3.2. Industrial evolutions in the United States

One of the most noteworthy events in 2009 was the bankruptcy of the commercial launch services provider Sea Launch Co. LLC. Sea Launch was struggling to meet its 22 June deadline of paying back $245 million in maturing bank loans. Efforts to refinance this debt continued throughout June. These included loan guarantees by two of its main shareholders, Boeing Co. and ASA Group of Norway. In the meantime Sea Launch was continuing to lose contracts, as several of its clients (such as SkyTerra) transferred launches to its competitors, Arianespace and International Launch Services, amongst rumours that Sea Launch would not be able to meet its scheduled launch dates.[248]

Unable to refinance its $2 billion debt (half of which was to Boeing, its main stockholder and hardware supplier), Sea Launch had to file for Chapter 11 bankruptcy protection on 22 June. The suspension of its activities for an entire year in 2007 (following an on-pad launch failure) together with a precipitous rise in raw material prices finally took their toll on the company. As U.S. legislation excluded Sea Launch from launching U.S. government payloads, maintaining a stable revenue base in the long-term proved impossible. Sea Launch's bankruptcy weighed heavily on its main shareholder, Boeing, which was facing up to $478 million in pre-tax charges related to the uncollected debt.[249] Sea Launch's bankruptcy also increased fears of a possible escalation in launch prices from the other two major launching services contractors, ILS and Arianespace.[250]

In the face of such fears both Intelsat and SES, the two most important commercial fleet operators, announced in September that they were willing to support Sea Launch's exit from bankruptcy by guaranteeing future launch contracts with it. Intelsat, which had several launch contracts pending with Sea Launch prior to its failure, reiterated its commitment to using Sea Launch services. Boeing and Space Systems/Loral also voiced support for the company. At the same time, Intelsat and SES also asked for the U.S. government to address the space launch services gap that Sea Launch's bankruptcy has created. In their opinion, this should include reconsidering the U.S. ban on satellite exports to China and encouraging the return of the Atlas and Delta rockets to commercial activities.[251]

Soon after Sea Launch's bankruptcy disputes arose among its principal shareholders on sharing payments due to its creditors. Boeing, which prior to the bankruptcy had reimbursed $448 million to Sea Launch creditors, demanded that other shareholders participate in it proportionally. The Norwegian participating company Aker agreed to do this, but Russian and Ukrainian owners declined. On 19 October Boeing filed a request for arbitration on this issue with the Stockholm Chamber of Commerce. In addition to this, Boeing had loaned another $523 million directly to Sea Launch and demanded that the rest of the owners

participate in it as well. The Sea Launch bankruptcy was the main cause for a 13% decline (to a total of $672 million) in profits that Boeing manifested in the first three quarters of 2009.[252]

On 11 June Lockheed Martin, Northrop Grumman and Raytheon were each awarded a $30 million contract from the U.S. Air Force to start development work on the ground-based radar segment of the future USAF space surveillance system, known as Space Fence. Preliminary plans include the construction of three S-band radars, one of which will be located outside the U.S. The system is expected to have higher resolution than the existing one. The contracts awarded included system design review, present trades and analysis data, operating simulations and lifecycle cost estimates. The prime contractor for the project is to be selected in 2012.[253]

On 10 June, Lockheed Martin was awarded a $1.49 billion contract to build the third of a total of six USAF Space Based Infrared System satellites (SBIRS). They are set to replace the existing U.S. ballistic missile launch warning constellation. The system includes the geosynchronous SBIRS satellite, as well as a highly elliptical orbiting payload. The launching of the constellation's second satellite is scheduled for 2011. At the same time, Lockheed Martin also announced the commercialisation of a low cost GPS enabled wireless tracking device that can be monitored across radio frequency identification and satellite communication networks. This product is addressed to civilian as well as military users.[254]

On 19 May 2009, the USAF launched TacSat-3, its first hyper-spectral reconnaissance satellite. TacSat-3's main payload was the Advanced Responsive Tactically Effective Military Imaging Spectrometer (ARTEMIS). The ARTEMIS spectrometer can distinguish the spectral signatures of different materials, enabling it to identify camouflaged objects or to detect freshly dug earth. TacSat-3 is part of the U.S. Defence Department's Operationally Responsive Space (ORS) programme. It has an on-board computer that enables it to process data before transmitting it directly to the battlefield and its tactical response time should be less than ten minutes. The ARTEMIS payload was built by Raytheon within only 15 months and on a $15 million budget. Off-the-self commercial technology was used extensively in its construction. The entire programme's budget was $90 million, including launching costs. Should TacSat-3 prove the reliability and effectiveness of the technologies involved, USAF is planning to launch a constellation of similar satellites, able to cover multiple operational theatres simultaneously.[255]

On 15 June, Northrop Grumman announced that it had delivered the second of a pair of the long-delayed Space Tracking and Surveillance System (STSS) satellites to the U.S. Missile Defence Agency. These were built in 1999, under a cancelled system demonstration project. The programme was resumed in 2002.

When launched, the satellites will enable the USAF to track ballistic missiles in every stage of their flight, something that current space-based assets cannot do. Their payload includes a multi-band infrared tracking sensor that other missile tracking satellites lack. STSS is a technology demonstrator that will determine the usefulness of a constellation of such satellites for U.S. ballistic missile defence. The post-2002 cost of the programme was approximately $1.35 billion.[256]

On 21 June Northrop Grumman and Israel Air Industries concluded a three week technology demonstration test of the Israeli Synthetic Aperture Radar (SAR) reconnaissance satellite TecSAR for the U.S. Defence Department. The test included tasking, downlinking, processing and delivering TecSAR images from a mobile control station inside a van, within less than 15 minutes of their request. The demonstration was conducted in Key West Florida under U.S. Southern Command's Project Thunderstorm, an initiative seeking to utilise next-generation imaging capabilities to counter asymmetric threats.

Intelsat and SES, the world's largest commercial satellite fleet operators, announced on 23 July that they would jointly try to "persuade" Washington to allow them to launch commercial satellites from China and India. The two companies were expected to be joined by Space Systems/Loral, the largest U.S. builder of commercial communications spacecrafts. The two companies noted that ITAR procedures and the Sea Launch bankruptcy had practically reduced launching services providers to only two (Arianespace and ILS). They therefore insisted on lifting the ban on Indian launches of U.S. satellites, which the U.S. department has maintained in spite of the latest U.S.-India bilateral cooperation agreement on defence and technology trade. However, Congressional sources noted that this lobbying initiative could result in effects on the Hill exactly opposite than expected.[257]

In September, the two companies were joined by satellite operators Telesat and Echostar and intensified their lobbying by hiring former U.S. Senate Armed Service Committee Chairman John Warner to address to executive branch officials, although ethics rules forbid ex-Congress members from lobbying. Warner would try to convince top officials that the absence of a U.S. launch provider is harmful to its national security interests, and this should be addressed by lifting the ban on Chinese launchers and facilitating commercial flights on board the Atlas and Delta rockets.[258]

On 11 August, Raytheon Space and Airborne Systems unveiled its new infrared light-wave detector that is four times larger in dimension than the current one. Its 4 k×4 k focal plane array comprises 16 million pixels in 4,096 columns and rows, laid on a 64 square centimetre surface. The new detector promises greater sensitivity and higher frame rates, while at the same time simplifying systems design and lowering construction costs.[259]

On 1 July Terrestar-1, the world's largest commercial spacecraft ever built, was lifted to orbit onboard an Ariane 5 ECA rocket. The 6,910 Kg satellite will provide mobile voice and data communications services in North America, using the 2 GHz and S bands.[260] The satellite's most striking feature is its unfurlable 18-metre-diameter s-band antenna. Concerns about whether the antenna would deploy properly had delayed its launch since early June.[261] The satellite will be operated by TerreStar Networks Inc. of Reston, VA.[262]

On 24 September, Space Exploration Technologies (Space X) Corp. announced it would launch a prototype of its reusable Dragon cargo capsule onboard the maiden flight of the Falcon 9 rocket. Dragon is a reusable capsule under development since 2006 for conducting cargo flights to the International Space Station (ISS). In December 2008 Space X won a $1.6 billion contract from NASA's Commercial Orbital Transportation Services to conduct 12 such flights to ISS by 2016. Dragon's launch has been delayed since 2007 because of problems with the development of the Falcon launcher.[263]

In an important development, Raytheon announced on 26 October that it had been awarded a $3 million contract to study the integration of the new U.S. Missile Defence Agency sensors to USAF's Space Surveillance Network. USAF is already using MDA's fixed radar stations for space surveillance purposes, but it would like to add its new mobile radars (like AN/TPY-2 X-band radar) to the mix. According to Raytheon it was the company itself that came unsolicited to the Air Force with a proposal to develop an open command and control architecture able to merge all available sensors into one dual-purpose system. Full-scale development of the programme could begin in 2012. At the same time, Raytheon has been in contact with MDA and the intelligence community in order to allow the dedicated Space Surveillance sensors to be used for early missile launch warning and intelligence gathering.[264]

In a separate development, representatives of the Israeli Space Agency suggested during a Space Security workshop on 3 November in Tel-Aviv, that Israel's planned Arrow-3 high-altitude ballistic missile defence system could be easily adapted to an Anti-Satellite (ASAT) role as well. According to workshop participants, Arrow-3's agile last stage exoatmospheric hit-to-kill vehicle could be modified to intercept LEO satellites and the system's Green Pine radar could be used for tracking them. During the workshop, Iran's future deployment of earth observation satellites was identified as a possible motive for Israel to acquire an ASAT capability.[265]

In the meantime, the U.S. Operationally Responsive Space (ORS) Office disclosed in November that it was making a capability assessment of the German-built LAPAN-TUBSats. The ORS office could order up to 8 such satellites to complement U.S. tactical imaging capabilities, at an estimated cost of $60 million.

The 50 Kg low-cost spacecrafts are built by the Technical University of Berlin (TUB) and they are equipped with a near real-time remote-controlled digital video camera, with an 8 to 10 metres ground resolution. TUB had already built such satellites for Indonesia and Morocco, among others. The system's main operational advantages were its good price-capability ratio and its remote-controlled camera that allows for shorter re-tasking times.[266]

On 23 November, mobile satellite operator Inmarsat announced the acquisition of the U.S. communications services provider Segovia Inc. for $110 million. In 2008 Segovia had reported a net profit of $18 million on $67 million total revenues. With this purchase, Inmarsat was expected to boost its position in the U.S. government contract market. The company was already a customer of Inmarsat's L-Band services. It also operates a network of Very Small Aperture Satellite (VSAT) satellite Earth stations for the U.S. Defence Department, which is relevant to Inmarsat's involvement in DARPA's "Persistent Broadband Ground Connectivity for Spacecraft in Low Earth Orbit Effort" programme. According to Segovia's Chief Executive M. Wheeler, 80% of the company's business was with the Pentagon. Prior to its acquisition, Segovia had also begun to provide services from Inmarsat's competitor, Iridium Communications. With this acquisition, Inmarsat could expand its BGAN broadband service to new distributors.[267]

In a related event, on 23 November Cisco Systems Inc. saw its first space-based internet router launched aboard a commercial communications satellite. The router was built for the U.S. Defence Department's Internet Routing in Space (IRIS) technology demonstrator, launched aboard the Intelsat 14 satellite. IRIS was the first dedicated U.S. military payload to reach orbit on a commercial satellite. In 2008, SES Americom had also signed a contract with USAF to host an experimental missile warning sensor aboard a communications satellite scheduled for launch in 2011. Although the experiment is funded by the Pentagon, Cisco has property rights over the router that it hopes to commercialise with satellite communications service providers. Intelsat also had expressed its interest in adding internet routers to its future spacecrafts. The demonstration acquired renewed interest since the cancellation of USAF Transformational Communications Satellite (T-Sat), which was also set to feature space-based routers.[268]

On 7 December Virgin Galactic unveiled its passenger carrying SpaceShipTwo suborbital space-plane, during a gala presentation at the Mojave Air and Space Port in California. The vehicle is designed to carry 6 passengers and a 2 member crew. The company's officials expected commercial operation to begin in 2011 from the Space Port America field, currently under construction in N. Mexico. Until then the space-plane was scheduled to contact extensive flight testing.[269]

In January 2010 the Denver-based United Launch Alliance (ULA), a Lockheed Martin-Boeing joint venture operating the Atlas 5 and Delta 4 rockets, announced

it had posted a strong campaign in 2009. The year ended with a total of 8 successful launches, whereas 10 more were scheduled for 2010 for the two vehicles combined. ULA is the principal space launch services provider for the U.S. Department of Defence and civil agencies and it was created in 2006. Both the rockets it uses were developed under the USAF's Evolved Expendable Launch Vehicle (EELV) programme. In spite of the high launching rate maintained in 2009, ULA has a backlog full of government launches that would not leave room for commercial payloads before 2012 at the earliest. This queuing up of payloads was caused by launch stagnation in 2008, when both rockets were grounded for technical reasons. This situation had prompted ULA to take measures such as reducing launch intervals by 20–25%, developing a dual payload adapter for its rockets and delaying the assignment of payloads to 6 months prior to each launch.[270]

In the mean time, a series of legislative and administration delays within the U.S. Department of Defence has caused a considerable revenue decrease in 2009 for U.S. commercial satellite image providers. On the one hand, Pentagon's existing contracting vehicle called NextView was only renewed in December 2009, three months later than expected. As a result, the U.S. National Geospatial Agency (NGA) that is the contracting authority on behalf of the U.S. government could not procure any images from commercial companies in the aforementioned period. Furthermore, this situation was not expected to change in the first half of 2010, as a new contracting vehicle called EnhancedView was not yet put into place, in spite of the fact that the existing one was set to expire in June 2010. Although NGA assured commercial providers that it would renew it on a monthly basis until the new one came into force, it was clear that they could not expect any increase in revenues from U.S. government contracts in 2010.[271]

In the face of these events DigitalGlobe, one of the country's major commercial satellite image providers, announced it would have to count on foreign customers to support its growth in 2010. DigitalGlobe projected a 22% total revenue increase in 2010, even assuming that U.S. government contracts would remain in 2009 levels. The additional income necessary to boost the company's growth rate was expected to come from sales to commercial and foreign government customers. Commercial sales income in particular was thought to increase by 15% in 2010, in spite of its 3.6% decline in 2009 (amounting to approximately $50.9 million). Given that U.S. government contracts account for almost 75% of the firm's revenues, the bulk of its growth would have to come from foreign government customers. To increase that source of income, DigitalGlobe had set up a mechanism known as the Direct Access Programme (DAP). Under this scheme, foreign countries approved by the U.S. government could downstream images from DigitalGlobe's satellites directly to ground stations in their territory for an annual fee of roughly $35 million. DigitalGlobe planned that 25% of its spacecrafts'

operational time would be used by foreign governments under this short of lent-lease agreement. The company announced that it had already secured five such customers and it was negotiating with another two, the identity of which it did not disclose.[272]

Should this development materialised, it would bring about a significant change in the company's revenue sources. Overtime DigitalGlobe expected these customers to pay on average $50 million for its services. Given that the firm's total revenues in 2009 amounted to $281.9 million, it becomes obvious that in the future DigitalGlobe would rely solely on these clients for its growth. Even at a $35 million annual fee, the seven foreign government clients would provide the company with $245 million in revenues per year, which would be over 60% more than the $150 million that it is currently receiving from its U.S. government. In this sense, one could argue that the DAP programme signifies a change in the U.S. commercial satellite image providers business model, obliging them to rely more on their foreign customers than on their domestic ones. It is also worth noticing that all DAP clients would have access to DigitalGlobe's latest and more accurate WorlView-2 satellite, while the U.S. government usually purchases products from the older Quickbird and WorldView-1 spacecraft.[273]

3.3.3. Industrial evolutions in Russia

In September, Roskosmos was obliged to postpone its Phobos-Grunt mission to the largest of Mars's two moons. The mission, which is Russia's first interplanetary mission since its failed Mars orbiter and lander mission in 1996, was originally scheduled for October. However it was postponed until the next launch window in 2011, due to delays in the final testing of the spacecraft. The Phobos-Grunt mission consists of an unmanned lander and a sample-return craft.[274]

In September, the French export-credit agency Coface announced it would guarantee the necessary loans for the construction of two Yamal-400 communication satellites from ThalesAleniaSpace on behalf of the Russian operator Gazprom Space Systems. Both spacecrafts would be launched aboard an Ariane 5 rocket. However, the programme was criticised by Russian authorities that are currently reviewing the country's satellite communication sector, because of its lack of Russian technology content.[275]

On 17 October, Roskosmos published a summary of its planned Yasny spaceport in the Russian Far East. The document stated that development of the site would require building an entire 30,000 people city almost from scratch. The Russian federal government has estimated that total construction costs might reach as high as $13.9 billion. At the same time, the site still faced long launch

delays because of rocket-debris cleanup disputes with Uzbekistan. In October, the launch of two Swedish Prisma satellites and the French Picard were delayed for the same reason. Apparently, the new launching site could face the same availability issues as the Baikonur Cosmodrome has faced because of similar disputes with Kazakhstan.[276]

On 2 March 2010 Russia successfully launched three Glonass-M navigation and positioning satellites. All three were lifted to orbit onboard a Proton M rocket launched from the Baikonur Cosmodrome. The launch was postponed from the previous October due to the need to inspect a critical component suspected of malfunction. Russia is currently running a programme to replenish and modernise its Glonass satellite constellation. Another three space craft were launched in late 2009 and three more were expected to follow in August 2010. After that, the initially planned 24 satellite constellation would be fully operational.[277]

3.3.4. Industrial evolutions in Japan

HTV-1 was successfully launched on September 10 from the Tanegashima Space Centre and arrived at the ISS on 17 September. Apart from carrying various provisions for the ISS crew, HTV-1's payload included two highly sophisticated earth observation instruments on behalf of the U.S. Navy. These were the Hyperspectral Imager for the Coastal Ocean (HICO) and the Remote Atmospheric and Ionospheric Detection System (RAIDS). Both instruments are experimental. They were developed by the U.S. Naval Research Lab and were mounted on the external payload platform of the ISS's Japanese Experiment Module Kibo. Both instruments are intended for military and civilian purposes alike. HICO will provide high resolution real-time imaging of coastal areas and RAIDS will monitor the earth's Ionosphere and Atmosphere in order to provide space weather data. These are the first high-performance observation instruments mounted on the ISS.[278] On 2 November, HTV successfully completed its 59-day mission and was destroyed as planned by re-entering the atmosphere above the Pacific Ocean.[279]

In September, the U.S. headquartered company BB Sat acquired a licence to provide satellite broadband services in Japan. The company has concluded agreements to use Ka-band capacity onboard a Japanese satellite already in orbit and to cooperate with Japan's Internet Service Providers (ISP) in handling sales and customer services.

On 28 November, Japan successfully launched the first of its new generation earth observation satellites aboard an H-2A rocket. The space craft, called the Information Gathering Satellite (IGS) Optical-3, would provide optical imagery

of 60 cm ground resolution, a considerable improvement on Japan's current 1 metre capability. The $562 million satellite was the first of a total of four reconnaissance satellites, two optical and two radar, scheduled for launch through 2012. Further spacecrafts with even higher resolution capability are planned for 2014.[280]

3.3.5. Industrial evolutions in China

The Chinese launch-service provider China Great Wall Industry Corp. (CGWIC) is expecting to be responsible for more than ten launches per year during the next two years. An aim of the company is to attract Western Business. Helpful could also be the low insurance rates of the well-proven Long March Series that are not far from Ariane 5 or Proton rockets. CGWIC is pretending that customer satellite teams have the full control over the facility – including access-permissions. Due to the U.S. International Traffic in Arms Regulations (ITAR), it remains nearly impossible to bring U.S. satellite components to Chinese launch bases.[281]

3.4. Industrial overview

In order to get a more detailed overview of the main developments of the space industry in 2009, a segmental appraisal will be undertaken in the following section. Three main activity areas will be presented: the launch sector, the satellite manufacturing sector and the satellite operators. These three segments make up the two main components of the overall space industrial business, namely the launch sector and the satellite industry. The two strands of the business are closely interrelated, as none of these industry branches can prosper without the other. Indeed, satellite manufacturers and satellite operators need a guaranteed and stable access to space, whereas launch providers rely on orders from the satellite industry to sustain their activities.

It is important to clarify some central concepts which will be at the centre of the analysis in the following sections, in particular the notions of commercial launch and commercial payload. Indeed, since the commercial space industry is growing in significance and progressively replacing the traditional forms of government-operated space activities, it has become more difficult to define and interpret what commercial launches and commercial payloads encompass. In the following section, a launch classification differentiating commercial and non-commercial launches and payloads will be used. A commercial payload is described as having one or both of the following characteristics:[282]

3.4.1. Launch sector

Despite its crucial importance for the satellite industry, the launch sector is an enabler rather than a significant economic activity. The revenues it generates are far less important than the ones originating from the satellite manufacturing and satellite services business.

The year 2009 was an even more active year for the launch sector than 2008, with a total of 78 launches conducted by launch providers from Russia, the United States, Europe, China, India, Japan, North Korea, South Korea, Iran and the multinational consortium Sea Launch. Three non-commercial launches failed: a Taurus XL launch in February 2009, a North Korean Taepodong 2 launch in April 2009 and a South Korean KSLV-1 launch.[283]

The main events for the rocket industry in 2009 were the successful launch of RazakSAT on the Falcon-1 vehicle by the privately-funded Space Exploration Technologies Corporation (SpaceX) from the company's Kwajalein pad, and the collision of the Iridium satellite and Cosmos 2251 spacecraft in February 2009. Furthermore, the Sea Launch Company's bankruptcy and the following protection actions had a major influence on the launch industry sector. Additionally, 2009 was marked by Iran's first orbital launch in February, successfully deploying its payload into LEO on a Safir three-stage rocket. As mentioned above, South Korea also performed its first orbital launch. However, the deployment of the satellite named STSAT 2 A in August 2009 failed. In 2009 North Korea also conducted its first launch since 1998, albeit an unsuccessful one.[284]

When looking into specific countries, Russia was again the world leader in the launch sector, representing approximately 37% of the total number of launches. It was followed by the United States (app. 31% of the total), Europe (app. 9%), China (app. 8%), Sea Launch (app. 5%), Japan (app. 4%), India (app. 3%) and South Korea, North Korea and Iran which launched one vehicle each, or approximately 1% of the total launch figure (Figure 5.5).[285]

Russia launched 29 vehicles in 2009, using eight different systems (as much as in 2008) whereas the United States conducted 24 launches with eight different launch systems as well (three more than in 2008). China used five different systems for six launches, Japan two systems for three launches, Europe one system for seven launches, Sea Launch one system for 4 launches, India one system for two launches and North Korea, South Korea and Iran each used one system for their respective launches. A total of 29 different launch systems were used in 2008, eight more than in 2008 (Table 5.1).[286]

Regarding the share of payload launched in 2009, Russia, the United States, Europe and India launched more than 80% of the total payload units launched in space in 2008. When considered in detail, Russia launched 37.8% of the total,

while performing 37.2% of the launches. The United States accounted for 30.8% of launches and 25.2% of payloads. Europe launched 12.6% of the payloads with a share of only 9% of the total launches. China accounted for 7.7% of the launches, but carried only 8.1% of total payloads in orbit (Figure 5.6). The difference between the share of launches and the share of payloads carried by Europe is attributed to the fact that continent's main contractor Arianespace concentrated on the launch of heavier payloads. Indeed, the Ariane-5 vehicle can carry two GTO satellites at a time, thus sending heavier payloads in orbit with fewer launches.[287]

In total, 111 payloads were launched in orbit in 2009, five more than in 2008. Russia was the world leader again, as it launched 42 payloads. It was followed by the United States, which launched 28 payloads and by Europe which launched 14 payloads. India launched nine and China seven. The remaining Sea Launch consortium, Japan, North Korea, South Korea and Iran accounted for 11 payloads. In 2009, Russia took the lead in terms of commercial payloads as well (12 payloads), followed by Europe and Sea Launch (eight and three payloads), the United States (two payloads) and China (one payload – Figure 5.7).[288]

There is a fairly equal distribution of payloads among the different mass classes. In the period from April 2009 to March 2010, micro, small, intermediate and large payloads were roughly equally distributed, as each class made up around 20% of the total number of payloads launched. Large spacecrafts represented around 13% of the total number of payloads, and heavy ones accounted for only around 10% (Figure 5.8).[289]

Micro payloads are mainly science satellites, technological demonstrators or small communications satellites, like the Orbcomm series. Small payloads are very often Earth Observation satellites, such as SAR-Lupe, Jason or the RapidEye series. Medium payloads feature the most diverse set of satellites, including small satcoms in geostationary orbit, Earth Observation satellites, and most of the Russian military satellites from the Kosmos series. Intermediate payloads encompass medium satcoms and big scientific satellites. Large payloads refer to big satcoms, as well as to the Soyuz and Progress spacecrafts flying to the ISS. Lastly, heavy payloads are all linked to the ISS: the modules Kibo and Columbus, as well as the cargo spacecrafts ATV and Leonardo.[290]

Of the total launches conducted in 2009, 69% were non-commercial, representing 54 launches, and 31% were commercial, representing 24 launches. Only five actors performed commercial launches, whereas five actors performed non-commercial launches. As a whole, there was a decrease of commercial launches from 28 in 2008 to 24 in 2009, after an increase in 2008 by comparison to the previous year.

As in 2008, GEO launches were again the top commercial activity, and the whole space transportation market was largely driven by the demand for GEO satcoms. This trend is likely to continue in the near term. Commercial launches were particularly important for Europe and Sea Launch. U.S. launch services in contrast, continued to rely heavily on the governmental market, with only four out of 24 U.S. American launches being of a commercial nature. This was the case in Russia as well, where the relatively important domestic institutional demand continued to support the launch sector as ten out of 19 payloads related to government activities. India and Japan focused on non-commercial launches, as well as the newcomers North Korea, South Korea and Iran. Russian launchers conducted ten commercial launches, followed by the European Ariane-5 with five commercial launches. Sea Launch and the U.S. conducted four commercial flights each and China one.[291]

Regarding the launch service providers, Arianespace again dominated the market, as its Ariane-5 vehicle (ECA and GS versions) flew seven times in 2009.[292] Arianespace has won more than 50% of the commercial launch contracts worldwide in the last two years.[293] In 2009 it placed 14 payloads into orbit in seven launches, totalling 35 successes in seven years and confirming its technological maturity.[294] A core feature of the company is the ability to carry two satellites at a time, a characteristic which maximises the benefits of using Ariane-5, but which also makes the company more vulnerable to satellite schedule slips.[295] In 2009, the company's sales are estimated at €1 billion. At the beginning of this year, Arianespace announced that 6 to 7 launches are scheduled for 2010.[296]

As for the U.S. American launch providers, Boeing Launch Services (BLS) conducted two commercial launches. The first one was used to orbit the weather satellite GEOS into GEO in June and the second to place the WorldView 2 satellite into LEO. Lockheed Martin Commercial Launch Services (LMCLS) launched one Intelsat satellite into GEO.[297] The two companies traditionally do not compete in the commercial launch market, as their launch vehicles would not be cost-competitive for such an endeavour and as they can count on steady revenues from governmental demand.[298] SpaceX carried out its second successful commercial flight of the Falcon 1, transporting the Malaysian RazakSat satellite into LEO. Orbital Sciences Corporation (OSC) performed two non-commercial launches in 2009, one of which failed in February 2009.[299] United Launch Alliance (ULA) and United Space Alliance (USA) carried exclusively non-commercial launches.[300]

The Sea Launch Company launched only one single satellite from its sea-based platform in 2009. This mission was carried out for the Italian army, deploying a communication satellite in GEO. Additionally, the company conducted three Land Launch missions from Baikonur. All in all, Sea Launch launched only four

rockets in 2009 compared to six launches in 2008. This was due to the company's bankruptcy in June and the resulting effort to restructure its finances.[301] During the first quarter of 2010, the company planned to submit a reorganization concept as a step toward emerging from bankruptcy status.[302]

As far as the Russian launch service providers are concerned, International Launch Services (ILS), International Space Company Kosmotras (ISC Kosmotras) and Eurockot Launch Services carried the ten commercial launches in 2009. ILS launched seven commercial Proton rockets in 2007, carrying mostly communication satellites. Additionally, ILS conducted three launches for its prime contractor Khrunichev, for example taking three GLONASS navigation satellites into their orbits in December 2009.[303] ISC Kosmotras launched one Dnepr-1 rocket and Eurockot one Rockot.[304]

Total commercial launch revenues in 2009 amounted to roughly $2.5 billion, about $500 million more than in 2008. Not surprisingly according to its market share in commercial space flights, Europe takes the lead accounting for approximately $1 billion in revenues, followed by Russia (app. $750 million) and the U.S. (app. $300 million).[305]

An estimated 29 satellite launch contracts were signed in 2009 for geostationary spacecrafts. The two main actors in the sector were the same as in 2008, namely Arianespace and ILS, followed by China Aerospace Corporation and Mitsubishi Heavy Industries as minor actors (Figure 5.9).[306]

Arianespace had a very solid year again in terms of contracts signed, winning more than half of the open competition commercial contracts. These "Services and Solutions" contracts include for instance the launches for satellite owners Hispasat, Arabsat, Intelsat, Inmarsat and Avanti Communication.[307] Furthermore, Arianespace signed a contract with the ESA in June 2008 for two Soyuz launch vehicles in order to orbit the first four operational Galileo satellites from Europe's Spaceport in French Guiana.[308] The company plans to continue its steady launch rate in the near term.[309] Arianespace also signed a contract with Astrium for the production of 35 Ariane-5ECA rockets in February 2009, at an estimated €4 billion value. With this contract, Arianespace has a total of 49 Ariane-5 in its backlog.[310]

ILS also signed 13 launch contracts for GEO satcoms in 2009, 6 more than in 2009 and as much as Arianespace. The contract partners include satellite owners AsiaSat, Intelsat, SES World Skies, Intelsat and Eutelsat, among others.

Sea Launch signed six launch contracts in 2008. Due to its mid-2009 bankruptcy, the company lost its status and the ability to sign contracts for future launches. The loss of Sea Launch as a main provider resulted in a market duopoly of Arianespace and ILS, a situation about which commercial satellite fleet operators expressed great concern. Sea Launch might emerge from bankruptcy by the end of this year.[311]

Among the remaining actors in the launch sectors, the China Great Wall Aerospace Corporation won a contract for the Nigerian Nigcomsat-2 satellite and the Apstar 7 of APT Satellite Holdings. Mitsubishi Heavy Industries on the other hand, signed a contract with the Korea Aerospace Research Institute for the launch of the Kompsat-3 satellite.[312]

The main feature of the launch industry in 2009 was the more or less unexpected bankruptcy of Sea Launch and its side effects. The two remaining principal launch services providers Arianespace and ILS had to fill in the gap for former Sea Launch customers, which led to the creation of a duopoly market. The reaction among satellite operators led by Intelsat and SES was to increase pressure for loosening U.S. export controls on spacecraft launched in China. Arianespace and ILS however claim that they did not see much growth in 2009, in spite of the elimination of Sea Launch as a competitor.[313] Nevertheless, launch prices worldwide have been increasing in the past two years. This process continued in 2009, especially due to the bankruptcy of Sea Launch.[314] Therefore, satellite operators have become increasingly worried by the launch market's diminishingly competitive nature.

3.4.2. Satellite manufacturing sector

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

In 2009 111 payloads were launched. Only 23% of the payloads were commercial, significantly less than in 2008, when they represented 40%. 38% of the launched payloads were manufactured by Russia, 25% by the U.S. and 6% by China. Europe accounted for 13% of the payloads launched (Figures 5.6 and 5.7).[315] Ninety-eight satellites were launched in 2009, nine more than in 2008. Most of them were manufactured by U.S. companies with 39 of the satellites launched (40% of the total figure), followed by Europe (24 satellites representing 24.5% of the total), Russia (15 satellites or 15.3%) and China (13 satellites or 14.5%).[316] When looking at the performances by the bigger satellite manufacturing companies, ThalesAlenia had a very active year as 11 of its satellites were launched in orbit in 2009. Other European manufacturers such as Surrey and EADS Astrium accounted for two and four satellites respectively. The two top U.S. satellite manufacturers were Space Systems/Loral (SSL) and Lockheed

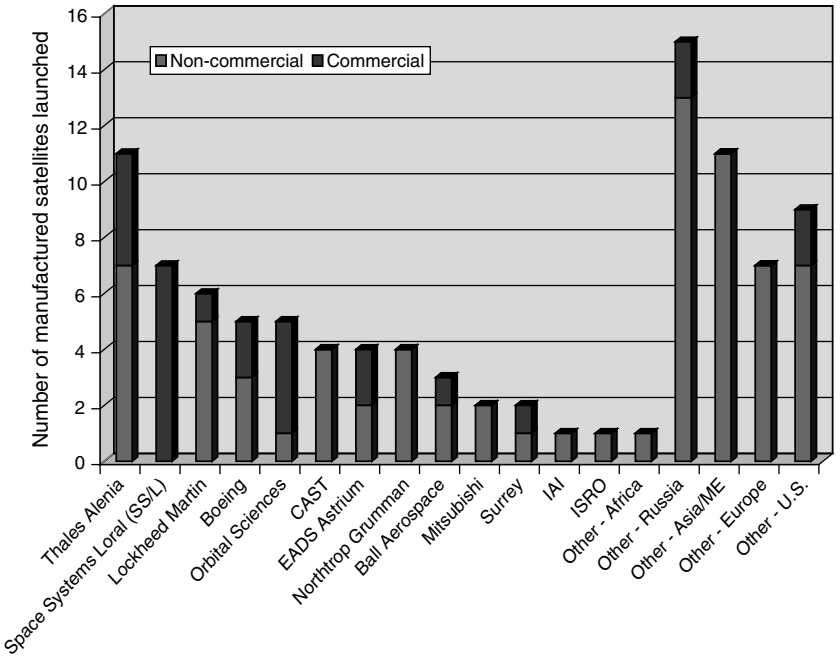

Fig. 8: *Satellites launched in 2009 by manufacturer and commercial status (source: Futron).*

Martin with seven and six satellites respectively, followed by Boeing and Orbital, with five spacecraft each (Figures 5.10 and 5.11).[317]

Of the 98 satellites launched, 26 were commercial. The main part of the commercial satellites launched were European or U.S. built: seven of the commercial satellites were European, representing only 27% of the total number of commercial satellites launched, whereas 17 commercial satellites were manufactured in the U.S., accounting for 65% of the total. Twenty-eight satellites were launched to GEO and 70 into other orbits. When looking at GEO satellites, Europe lost the lead it held in 2009: 25% of the GEO satellites launched in 2009 were European (three made by EADS Astrium and four by ThalesAlenia). In contrast, 61% of the GEO satellites launched were U.S. built, whereas Russian ones accounted for 11% of the total figure.[318]

2009 was an extremely successful year in terms of satellite contracts awarded. 41 commercial GEO satellites were ordered, nearly twice as many as the 23 orders in 2008. Manufacturers from the U.S. won 19 contracts, whereas European manufacturers signed 12 and Russian manufacturers 5. There were also satellite orders with two co-prime contractors: The two Arabsat 5C and 6B satellites will be built by ThalesAlenia and EADS Astrium, and the OverHorizon satellite of OverHorizon AB by Orbital and ThalesAlenia (Figure 5.12).[319]

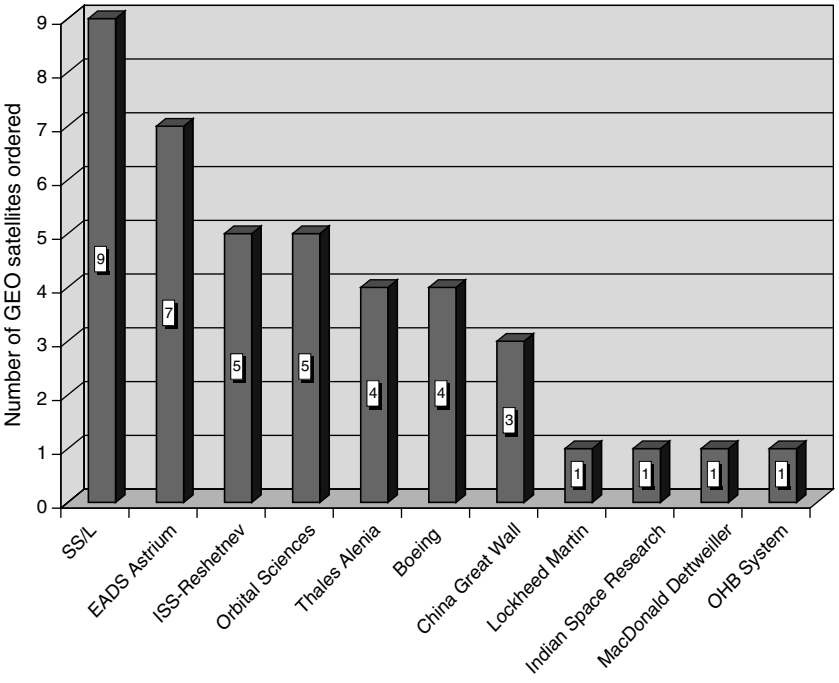

Fig. 9: *GEO satellite orders in 2009 by manufacturer.*

As for market trends compared to the previous year, in 2009 the sector witnessed the entry of two new actors in the commercial export business. The German-based OHB System AG won a contract for its first Small-GEO mission. The building contract for the Spanish Hispasat AG-1 communication satellite has a value of €48 million.[320] Additionally, OHB attracted the industry's attention by winning the contract to build 14 Galileo-satellites for €566 million.[321] The second newcomer was the Canadian MacDonald Dettweiller and Associates Company, chosen to build a communication satellite system for the National Space Agency of Ukraine, which also includes a GEO communication satellite. This satellite will support direct broadcast television and high-speed Internet access in Ukraine.[322]

The Russian manufacturer ISS-Reshetnev won, among others, a contract with the Russian Radio Research and Development Institute for developing the Express AM5 and AM6 satellites in May 2009. For this project, ISS-Reshetnev cooperates with ThalesAlenia. Additionally, the company negotiated a contract on a TELKOM-3 telecommunication satellite for PT Telekomunikasi Indonesia.[323] The rising number of contracts and the international involvement of Russian companies are indicators of the increasing integration of Russia's satcom industry into the global market.

In 2009 China's presence in the satellite market was also confirmed by contracts attributed to Chinese companies from Nigerian satellite services providers, the Asia-Pacific Mobile Communications Satellite Company Limited and the Laos National Authority for Science and Technology.[324] However, there is still some uncertainty regarding the long term sustainability of the Chinese market presence, due to a Long March 3B rocket failure in August. The rocket's malfunction did not allow it to place the Indonesian commercial communications satellite Palapa-D into GTO.[325]

Despite the emergence of the new actors, the traditional satellite manufacturers from Europe and the U.S. had a very good year. As a whole, the business stayed stable despite the crisis, and the main buyers of satellites remained the major satellite fleet operators: SES and Intelsat alone accounted for more than a third of the orders. If the growth of the sector continues at this pace, one could expect a stable rate of replacement satellite orders, at around 20 spacecrafts per year. The growing commercial capabilities in Japan, South Korea, India and elsewhere could have further positive effects. However, the main commercial satellite providers such as SES, Intelsat and Eutelsat have already promised to subside investing now that they have completed their hardware replacement expansion cycle.[326]

Looking at the European satellite manufacturers in more detail, EADS won seven contracts in 2009, whereas ThalesAlenia had four orders, excluding the co-orders with EADS Astrium and Orbital Sciences. Newcomer OHB System AG won one contract with Hispasat. As for the U.S. satellite manufacturers, Boeing was contracted by Intelsat to build four new 702B satellites, which could give the company a chance to rapidly re-enter the commercial market within the course of this year. Orbital Sciences won five contracts, including orders from Intelsat and OverHorizon. Loral Space and Communications has invested $350 million in the past few years into its SSL division. This enabled the company to sign nine contracts in 2009. Loral is the only satellite manufacturer which depends entirely on commercial contracts. Consequently, it is also more vulnerable to market fluctuations than other manufacturers.[327]

With the exception of Loral, no satellite manufacturer relies on commercial orders alone. Therefore, institutional orders constitute an important segment for the satellite manufacturing sector, particularly in the United States. For example, Orbitel announced that its advanced space programme division increased revenue by 15.6 percent in 2009 and will continue to grow in 2010, mainly thanks to manufacturing classified and unclassified satellites for the U.S. government.[328] In Europe, the biggest non-commercial order was that of the 14 Galileo satellites to the German OHB company, leaving behind the main competitor, EADS Astrium. In 2009, only a little more than 25% of all launched satellites was commercial. Consequently, the government related satellite

manufacturing business still represents the greatest revenue source for the sector's companies.

In terms of future perspectives, 20 to 25 satellites are expected to be launched annually in the next few years. Rising technologies e.g. HDTV are keeping up the demand for new satellites.[329] However, the current "high cycle" of the manufacturing market should last until 2013 and corresponds to replacement of older satellites.

3.4.3. Satellite operators sector

In 2009 Satellite services remained the single largest satellite industry segment[330] led by satellite TV growth for a global increase of 10.7% of revenues. This year saw a global increase of revenues and some falls are also noticeable for certain of them. Other consequences should be expected after the financial crisis which had at this time not yet hit the sector. The podium stays globally the same with a steady and quite similar growth of the revenues for Intelsat and SES (6%) while Eutelsat experienced a significant increase of 10% especially boosted by the growing market in South America. Telesat confirmed its fourth place with an impressive augmentation of 28.9% of its revenue. The rest of the ranking knew a certain upheaval with the fall of the Russian satellite communication from the sixth to the

Tab. 1: *Top 10 FSS operators in 2009.*[331]

Rank	Company	Country	2009 revenues in million $	Satellite in Orbit	Satellites on order
1	Intelsat	Luxembourg	2500	52	8
2	SES	Luxembourg	2440	44	11
3	Eutelsat	France	1410	26	6
4	Telesat	Canada	750	12	3
5	Jsat Corp.	Japan	362.7	13	2
6	SingTel Optus	Australia	236.6	5	0
7	Hispasat	Spain	216.4	4	3
8	Russian Satellite Communications	Russia	200	11	4
9	Star One	Brazil	193	7	1
10	Arabsat	Saudi Arabia	189	4	3

eight one, with a significant drop of his revenues of 14%. A phenomenon that would be explainable with the fall of the rubble in 2009 and the expansive renewal of the fleet. A significant effect affected Gazprom system.

In the same way Jsat Corp saw its revenues drop of 11% but keeps its place followed SingTel Opus and Hispasat both in progression. At the bottom of the ranking, Star One and especially Arabsat with 20% had a significant increase in their revenues on this period.[332] Just behind the top list, the Norwegian Telenor Satellite Broadcasting could next year join the club with an increase of its revenues from $125 million to 177 in 2009. The Satcom market was so on the roll between 2009 and 2010 and saw a fierce competition within it with candidate to access to the ten first places while the five leaders consolidated their positions.

4. The security dimension

4.1. The global space military context

The following chapter briefly presents key developments in the field of military related space activities. These include the 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. Nevertheless, one should take into account that studying military space activities based on open sources is always a difficult task, given the confidentiality clauses that usually apply to them. Consequently, all the verifiable facts and figures given below cannot provide a fully detailed picture of all related developments. They do however put them in perspective by providing an overall estimate of the general trends in this field.

Space-related military spending remained generally stable from mid 2009 to mid 2010. While the worldwide military spending on space rose slightly by 7% from $29.4 billion in 2008 to $31.8 billion in 2009, the share nearly remained the same. Again, the United States led by far with a share of 90% of worldwide space-related defence expenditures, but the sum of the other countries now occupy a bigger share of 10% compared to 5% in 2008. However, the European space spending dedicated to military use decreased in 2009 by 32% to approximately $752 million.[333]

It has to be stated that money spent on dual-use programmes or research is not included in this overview. It should also be kept in mind that spending is not always clearly allocable, because some budget positions can be assigned to various categories. The standard confidentiality and secrecy along with potential

opaqueness can further complicate matters. Different purchasing powers and work force costs add another degree of ambiguity, calling for relativisation of numerical budget values

4.2. Europe

4.2.1. National initiatives

Although European cooperation in dual-use space technologies is increasing, military space activities in 2009 and 2010 remain predominantly within the national government's field of competences. Consequently, European cooperation in such matters remained into the sphere of bilateral or at best multilateral arrangements among the major European space-faring nations.

The domain of Space Situational Awareness in particular has been one of the areas that attracted particular attention in the last 12 months. The German Armed Forces for example, proceeded to the creation of a separate military command to coordinate space surveillance activities, known as the German Space Situational Awareness Centre (GSSAC). The command's facility was inaugurated in 2009 and it was projected to reach the planned staffing ceiling already within 2010. The centre's creation was deemed necessary not only to facilitate German military participation in the future European space-monitoring capability, but also to develop the country's national competencies in this field.[334]

Furthermore, Germany and France are the only EU members that have a limited space surveillance capability through the use of two nationally operated Radars. These are the German TIRA, which is capable of tracking objects in orbit and determining their nature, and the French Graves, which is more suitable for wide area surveillance. Given the complementarity of the two systems there has been a strong incentive for bilateral cooperation on their use. Therefore, the two countries have initiated in 2009 an exchange of surveillance data programme, enabling them to coordinate the use of both systems and to multiply their operational usefulness. Nevertheless, even the combined systems' accuracy is not always sufficient for the accurate identification and tracking of objects in orbit. Therefore, both countries still have to rely on USAF's space monitoring network for more accurate measurements in order to avoid losing their military space assets to collisions with space debris.[335]

However, since military space still remains predominantly under strict national jurisdiction, European cooperation does not proceed at the same pace in all areas of activity. Contrary to the dual-use SSA where cooperation has been increasing, negotiations on the MUSIS system stagnated throughout the reporting period.

MUSIS is a six-nation European effort to build a common ground segment for its members' Earth observation satellites. Some participating countries would contribute their optical reconnaissance satellites to the common system, others their Radar satellites and others would only share its operating financial burden. This complicated arrangement however has made it difficult to quantify each participating country's contribution to and expected returns from MUSIS. Consequently, negotiations among the participants have been fruitless for the past 12 months and the programme's future was threatened as certain participant countries could be inclined to proceed independently with their national projects.[336]

In spite of the difficulties that the multilateral MUSIS programme has encountered, the bilateral cooperation between Germany and France in the field of Earth observation (EO) satellite data exchange moved forward in the second half of 2009 and the first half of 2010. On 4 May, satellite manufacturer OHB of Bremen announced it had secured a €14 million contract in order to provide ground stations to both countries permitting access to data from each other's EO spacecraft. Under this Franco-German bilateral agreement known as the Europeanisation of Satellite-Based Reconnaissance programme (E-SGA), France would be granted access to data from the German radar EO SAR-Lupe satellites and Germany from the French Helios 2 optical EO satellites. Ground stations in both countries were already under construction and they were expected to become operational by July 2010.[337]

The increasing importance attributed to military space activities in Europe was also reflected in their increasing budgets, which showed remarkable resilience to the past 12 months' adverse financial conditions. On 25 November 2009 for example, French Defence Ministry officials announced they were on track to increase military space spending by 8% annually through 2014, in accordance with the defence policy announced by President N. Sarkozy in 2008, before the financial crisis's consequences were fully felt. This would mean that French military space budget would rise to €600 million by that year, from €380 million in 2008. An additional €200 million would be channelled to the French space agency CNES for dual-use technologies development. At the same time, the country's joint defence staffs was set to create a Joint Space Command by July 2010 in order to coordinate military space assets use better. At the same time, France was actively seeking participation from other EU countries in its future optical and electronic surveillance satellites.[338]

At the same time in the UK, Defence Ministry officials announced they were considering a revision to the Skynet 5 contract with Paradigm, an EADS Astrium Services subsidiary, to allow for the addition of a forth satellite to the Skynet 5 constellation. According to the same sources, tactical imagery transmission demand from UK forces in Afghanistan has brought the existing three satellite

constellation to its capacity limits. Furthermore, demand was expected to double in the next 5 years, or quadruple by comparison to the initial bandwidth demand models made back in 1998, on the basis of which the contract with Paradigm was concluded. For the time being, UK officials said they were dealing with the situation by scrutinising transmission demands and using the Skynet 5C spacecraft, which was originally planned as a back-up spare satellite. Military satellite communications providers in France and other NATO countries admitted facing the same problem as well.[339]

Finally, the decision to deploy a fourth Skynet 5 satellite was officially announced on 9 March 2010. The original Skynet 5 contract with Paradigm was valued at £3.5 billion through 2020 for the lease of three communications satellites and related services. This contract was extended through 2022 for an additional cost of £400 million, allowing Paradigm to launch a fourth satellite by 2013 in order to meet the increased demand. Since the Skynet 5 contract was originally set up as a public-private partnership (PPP), with Paradigm maintaining the ownership of the spacecrafts and leasing their services to the military, the extension costs would only burden the UK government towards the end of its duration. Thus, British armed forces would be able to use the fourth satellite and only pay for it in 2020. This outcome clearly demonstrated the advantage of PPP's adaptability to changing operational needs, especially at a time of budgetary difficulties for the UK.[340]

The satellite manufacturer ThalesAlenia Space and the ground-services provider Telespazio are to build the Sicral 2 military telecommunications satellite, going to be launched in 2013. The satellite will be used by both the Italian and the French defence ministries, containing separate UHF- and SHF-frequency payloads for both countries. However, this joint military satellite project marks a clear break to previous European politics where countries have their own military communications satellite systems. Noteworthy is the fact that both contracting companies are in a joint French-Italian ownership. The satellite is to be included in France's Syracuse 3 system and will enforce Italy's capacities to contribute UHF bandwidth to NATO.[341]

4.2.2. European Union level

Between July 2009 and June 2010, the European Union has been increasing its involvement in dual-use military applications that could potentially have a military usefulness. EU security related space activities are mostly managed through the European Commission, the European Defence Agency and the European Union Satellite Centre. The European Space Agency also acts as a

programme coordinator and procurement authority for most of these projects. The EU's principal security related programmes include the Galileo navigation and positioning satellite constellation, the Global Monitoring for Environment and Security (GMES) Earth observation programme and the Space Situational Awareness (SSA) project. As all of the aforementioned programmes are of potentially dual civil-military usefulness, they were already presented in details in chapter 3 of this report. However, a brief analysis of developments related more closely to their space security aspects would be pertinent in this chapter.

4.2.3. European Space Agency

One of the principal trends during the period in question has been the increasing involvement of the European Space Agency (ESA) to the development of dual-use space capabilities for Europe. This tendency has led to an increased level of cooperation with the European Defence Agency (EDA), which is the only other European institution tackling this issue.

This trend was especially evident in the development of the future European Space Situational Awareness (SSA) system. Both agencies were scheduled to start official discussions in 2010 on the subject of how the European dual-use SSA should be created and managed. Although the SSA started as an ESA programme, EDA became quickly involved, mostly upon the insistence of European governments. In fact, the past 12 months have witnessed increasing pressure in favour of the active participation of EU military personnel in SSA's development and operational use, with certain voices even calling for the complete militarisation of the system's operating concept. This trend has been also induced by the rising number of European military space assets in use, as well the growing realisation of their vulnerability to space debris collisions described above.[342]

Another example of ESA-EDA coordination appeared in February 2010, when they both issued parallel contracts of a €400,000 value and 6 month duration each for the realisation of two preliminary concept studies investigating the use of Unmanned Aerial Vehicles (UAVs) for domestic and maritime security purposes in Europe. Although the two agencies demanded separate studies, they nevertheless issued a common request for proposals. This fact undoubtedly illustrates the gradual expansion of ESA's mandate into the field of security-related activities. Although it is forbidden for UAVs to fly over European civilian airspace in order to avoid accidents, it is anticipated that this regulation will change as UAVs demonstrate an increasing degree of operational reliability. The future UAV system envisaged would use satellite communications to downstream surveillance

data and it is expected to operate complementary to Earth observation satellites, offering shorter revisit periods than space assets.[343]

Finally, ESA involvement into space security applications became greater in May 2010, when the agency began the concept development of a system of systems focused on utilising existing and future European space capabilities for security purposes. The programme, known as the Global Integrated Architecture for Innovative Utilisation of Space for Security (or Gianus), intends to integrate all existing European Earth observation, communications and navigation satellites into a single interface. By creating a unified operational system from all European space assets, Gianus would facilitate its use for security purposes and eventually make it more adaptable to specific military operational needs. At a time when military budgets across Europe are strained by the ongoing financial crisis, dual-use space systems developed could be a viable option for the majority of its member-states.[344]

4.3. The United States

As the Operationally Responsive Space concept is maturing in the United States, more and more major U.S. space contractors, such as Boeing or Lockheed Martin, are becoming interested in it. Boeing's Phantom Work's Advanced Network and Space Systems are currently working on small satellites that they qualify as "disruptive technology". Analysts in the U.S. expect 17 more small satellites to be built within the next decade, for a projected total value of $1.4 billion (a 40% increase from current levels). The Pentagon is moving forward with purchasing smaller, simpler and cheaper satellites to cover ORS needs for a number of reasons, including their affordability, survivability and launch-on-demand capability.[345]

In a related development, the U.S. National Reconnaissance Office (NRO) has started a new program to use tiny satellites, known as "cubesats", as in-space test platforms for future satellite technologies. "Cubesats" satellite buses, which typically measure $10\times10\times10$ cm, are relatively cheap, they can be purchased in bulk and be ready on demand to serve as test platforms. They could help NRO to validate new instruments, missions and capabilities, such as hyperspectral sensors, attitude control systems, or radio-frequency modules. NRO has reportedly asked for acquiring approximately 20 to 50 "cubesats" at a $250,000 unit cost, over a two-year period beginning in 2010. One more advantage of using "cubesats" would be that they could be launched in a timely fashion aboard the first available launcher. NRO was even considering placing them on top of NASA's boosters.[346]

In a parallel development, U.S.A.F. Space and Missile Systems Centre (SMC) issued on 13 November a Request for Information (RfI) on the possible develop-

ment of its first cubesat demonstrator mission. SMC was particularly interesting in validating the operational utility of a cubesat constellation. The demonstrator would be used to collect space weather data, it should have an operational life span of 1 year at a 400 km altitude and it should de-orbit within 5.[347]

Furthermore, the U.S. Missile Defence Agency (MDA) was also reported to seek complementing its future Space Tracking and Surveillance System (STSS) with a constellation of small satellites, known as the Precision Tracking and Surveillance System (PTSS). MDA has been persistently asking the Congress to fund a 1,125 Kilogram demonstration satellite for several years now.[348]

On the other side, the U.S. Senate Armed Services Committee's 2010 defence authorisation bill more than doubled the budget for ORS that the Pentagon had requested. In fact, Senators appropriated an additional $170 million to the Air Force's $112.9 million request for the ORS Office in 2010. Extra funding included a program to build prototype, low-cost, half-metre ground resolution imaging satellites within 36 months. The ultimate goal would be to field a large constellation of such satellites and to acquire them on a fixed-price basis for no more than $100 million a piece, including launching costs.[349]

In another development, the U.S. House of Representatives approved on 30 July an $80 million funding for Northrop Grumman to continue development of its Kinetic Energy Interceptor (KEI), in spite of the Defence Department's repeated attempts to cancel the project.[350]

On 18 August, U.S.A.F. announced the results of the Schreiver War Games 5 space defence exercise, held at Nellis Air Force base in April 2009. During the exercise it became clear that a sophisticated space-faring nation could deny key U.S. military space capabilities in case of conflict. The exercise scenario also established the need for improved space surveillance capabilities, especially as far as tracking small satellites is concerned. In fact, U.S.A.F. admitted that during the exercise they were often unable to determine the nature and source of events involving small satellites.[351]

On 11 August the U.S. National Geospatial-Intelligence Agency (NGA) announced its plans to issue up to four $85 million and 5 year duration contracts to commercial providers of radar satellite images. The request included Synthetic Aperture Radar (SAR) images both in the X and the C band. Since the U.S. lack commercial radar satellites, demand will have to be met by European (Cosmos Skymed and TerraSAR-X) and Israeli (TecSAR) satellites. The request represents a considerable budget increase from the $10 million that NGA has been paying annually to the Canadian Radarsat-2 operator for similar services over the past ten years. Its broad requirements would also indicate that contracts will be most likely split among several operators.[352]

EnhancedView is part of a wider satellite imagery strategy for national security purposes announced by Director of national Intelligence Dennis Blair, on 7 April 2009 and approved by President B. Obama. The concept, known as "two-plus-two", has two piers. One is the purchase of two highly sophisticated imaging satellites by the National Reconnaissance Office (NRO) for strategic intelligence purposes, scheduled to be build by Lockheed Martin Space Systems. The other is the contractual purchase of lower resolution images from two less capable commercial satellites by the NGA, for geospatial and tactical military use. This approach was adopted in the U.S. House of Representatives' 2010 Defence Appropriations Bill.

On the contrary, the Senate's Defence and Intelligence Authorisation Bills asked for the deployment of a larger constellation of cheaper and less technically advanced satellites.[353] On 16 September the Senate's Defence Authorisation Bill upheld this option and effectively turned down the version of the Bill preferred by the Obama Administration. NRO's Director Bruce Carlson his opposition to the Senate's proposed plan, which he deemed technologically riskier. Low technological risk was the primary driver behind Lockheed Martin's selection, after Boeing's failure to develop a more advanced system under NRO's Future Imaging Architecture (FIA) in 2005. According to press reports, the two companies' struggle for the contract could be behind the Senate's decision, as the two Senators that opposed NRO's plans the most have important Boeing facilities in their constituencies.[354]

On 17 September the U.S. Defence Advanced Research Projects Agency (DARPA) proceeded to an open call for new concepts for removing space debris from Low Earth Orbits (LEO).[355] The announcement was made as DARPA and NASA were preparing to host o joint conference on this subject later that year. According to NASA's Office of Safety and Mission Assurance, coming up with innovative and inexpensive solutions could prove difficult. They were particularly concerned by the threat to space environment posed by increasing numbers of tiny satellites, such as cubesats. Since cubesats are currently almost undetectable, their proliferation creates uncontrolled space debris and increases the danger of cascade collisions. However, finding ways to remove debris from LEO could also run into diplomatic disagreements, as any such system would inherently also be capable of working as an orbital Anti Satellite weapon (ASAT).[356]

On 9 October U.S.A.F. issued a request for information for the development of its next generation of space-weather monitoring satellites. U.S.A.F. is currently using sensors onboard its Defence Meteorological Satellite Program spacecrafts. Nevertheless, similar payloads have been eliminated from its successor, the civil-military National Polar-Orbiting Operational Satellite System, because of budget cuts. This request for information would be a first step in exploring alternatives for a space-weather monitoring system that could involve payloads onboard

commercial satellites, or small dedicated satellites. The program has secured an initial $15 million budget and launch is expected in 2015.[357]

On 22 October U.S. Defence Secretary R. Gates announced during an official visit to the Republic of Korea (RoK) that the U.S. would extend its missile defence shield over that country. Under this doctrine of "extended deterrence", he said, the U.S. would use the full range of its military capabilities (conventional, nuclear and missile defence) to defend RoK against any incursion from the North. The announcement was made as RoK is moving forward with its own autonomous ballistic missile defence system, based on Aegis destroyers and Patriot Advanced Capability-2 interceptors.[358]

In an interesting technology development, the U.S. Defence Advanced Research Projects Agency (DARPA) issued a Request for Information (RfI) on 22 October for a system that could provide internet connectivity to Low Earth Orbit (LEO) satellites. The Request, issued by DARPA's Tactical Technology Office, called for a 100 Kilobit per second broadband connexion to all LEO satellites flying at a 500 km altitude and in any orbit. The RfI also asked for 95% operational availability and the capacity to be used not only for downloading data, but also for telemetry and controlling the satellite. Information from government laboratories, universities and private companies were due in 5 November.[359]

Following on this RfI, DARPA issued on 3 February 2010 a Notice of Intent to award a sole source contract to develop and build the necessary hardware to Inmarsat plc of United Kingdom. The contract, under a program called the "Persistent Broadband Ground Connectivity for Spacecraft in Low Earth Orbit Effort", solicited the Broadband Global Area Network (BGAN) service provided by Inmarsat's I-4 communications satellite. The project's objective would be to provide near-24/7, very low latency, on-demand ground-to-spacecraft connectivity for LEO satellites. From an operational perspective this would greatly enhance Operationally Responsive Space capabilities, allowing performing of missions such as time-sensitive satellite control directly from the theatre of operations, rapid data transfer and direct-to-theatre data delivery on small portable devices.[360]

For this purpose, a space-based version of Inmarsat's BGAN airborne terminal would be developed, tested, certified and integrated into the planned F6 fractionated spacecraft demonstration cluster, scheduled for launch in 2013. According to the same announcement, Inmarsat has been selected as the sole source contractor for this program because of its considerable expertise in the field of end-to-end satellite broadband services.[361] Inmarsat itself had sought to boost its business with U.S. government agencies, when it acquired the U.S. based communication services provider Segovia Inc. on 23 November 2009.[362]

On 10 October Lockheed Martin Aerospace launched the scaled prototype of a rocket plane from Space Port America in New Mexico, U.S. The self-propelled

90 Kg winged vehicle was launched on a vertical ramp provided by UP Aerospace of Denver and it reached the altitude of 915 metres. The test was the third since 2007 and the second successful. The vehicle is considered a demonstration of an advanced reusable launcher, under the U.S. Department of Defence Operationally Responsive Space concept. Further details on its development were restricted.[363]

On 19 December 2009 U.S. President B. Obama signed the 2010 Defence Appropriations Act that included funding for military space programmes. This Bill, approved by Congress, called for the formulation of a long-term space investment strategy through 2025, which should be delivered to its defence committees by 1 May 2010. Accompanying documents of the legislation particularly demanded that the U.S. maintains a robust space launch capability, by ensuring the Evolved Expendable Launch Vehicle's (EELV) utilisation through 2030. This effort would also include the development of a common upper stage for both of EELV's variants, notable the Delta 4 and Atlas 5 rockets. Other major space programmes that secured funding were the civil-military National Polar-orbiting Operational Environmental Satellite System (NPOESS) and USAF's Third Generation Infrared Surveillance system. On the contrary, the Bill did not foresee budgeting of the seventh Wideband Global Satcom communications satellite.[364]

On 29 December 2009 the U.S. National Geospatial-Intelligence Agency (NGA) awarded three contracts to commercial radar satellite imaging companies. These included EADS North America, Lockheed martin Space Systems and MDA Geospatial Services of Canada. The first two would provide imaging from European commercial spacecraft, notably the German TerraSAR-X and the Italian Cosmo-Skymed (through its commercial brunch e-Geos) spacecrafts respectively. The third would use imaging from Canada's Radarsat-1 and -2 satellites. The total value of the contracts was estimated to reach $85 million over a period of 5 years. Commercial images would act complementary to data acquired through more sophisticated U.S. military radar observation satellites.[365]

In an interview on 14 December 2009, the U.S. Defence Information Systems Agency (DISA) Director Mr Bruce Bennett announced that DISA had plans to lease the Netted Iridium Service on behalf of the U.S. Navy. This service would allow ground military operators in Afghanistan not only to communicate from point to point as before, but also to transmit voice and data broadcasts to several recipients simultaneously and at much faster speeds. Netted Iridium is a retooled variant of the standard Iridium service using special radios built by NexGen Communications LLC of Dulles, an ITT subsidiary. DISA spent approximately $70 million in 2009 acquiring bandwidth for military purposes on the 66 LEO satellite constellation owned by Maryland based Iridium Communications. This figure was expected to rise to $80 million in 2010. The Netted Iridium Service

became the U.S. Navy's only option for obtaining narrow-band communications capacity after continued delays in the development of its new generation communications satellites, known as the Mobile User Objective System (MUOS).[366]

In the same interview, DISA's Director announced that his agency had spent over $400 million to acquire commercial satellite communications services in 2009, $50 million more than the year before. In fact he admitted that commercial operators contribute the bulk of U.S. Armed Forces satellite connectivity worldwide. In the mean time satellite operators increasingly deploy Ka- and X-band capacity to complement their standard Ku-band transponders and DISA is expected to triple its demand of X-band capacity in 2010. Finally, DISA Director announced the implementation of a new contracting vehicle for communications satellite capacity called the Future Comsatcom Services Acquisition. Under this new contracting scheme, DISA would be able to acquire bandwidth directly from commercial operators, without having to pass through intermediate private companies, as it is the case today.[367]

At the same time, back in the United States commercial satcom operators were asking of the Defence Department to adopt a more comprehensive and long term approach in commercial bandwidth acquisition. At present the Pentagon is funding these acquisitions, which account for nearly 80% of its global satellite connectivity demand, through supplemental war funds that are approved by Congress on an annual basis along with each year's defence budget. This would mean that no long term acquisition planning would be possible under the current purchasing scheme. To complicate things further, supplemental war funding, which represents roughly 20% of U.S. defence spending, is expected to be curtailed over the next few years.

At the same time, USAF's plans to develop its next generation military communications satellite were set back by the cancellation of the Transformational Satellite system in 2009. In response to this situation, commercial operators have asked in January 2010 for the creation of a dedicated regular line in the U.S. defence budget to cover satcom services procurement on a longer term and not on the current year to year basis. Such a decision, they said, would enable them to make the necessary investments to respond to the Pentagon's growing commercial satcom use, as well to offer services that are more adapted to specific military needs. However, according to industry officials the problem remained that commercial capacity demand was highly unpredictable, as it depended mostly upon unforeseen geopolitical events and contingent operations.[368]

On 13 January 2010, the California based telecommunications company Cisco announced it had completed a successful in-orbit test of its space internet router component onboard Intelsat's IS-14 satellite. The router was part of the U.S. Defence Department's technology demonstration project on Internet Routing in

Space (IRIS). Although the Pentagon was funding the experiment, the router itself was owned by Cisco, which planned on commercialising the devise immediately after the conclusion of its testing period in April 2010.[369]

On 26 January 2010, the U.S. Defence Department announced that a consortium led by satellite operator Intelsat had secured a five year $542.7 million contract to provide end-to-end satellite communication services to the U.S, Navy. The project, known as Commercial Broadband Satellite Program (CBSP) called for the procurement of 449 megahertz of Ku-band, 329 megahertz of C-band and 82 megahertz of X-band capacity, which should be accessible to 95% of the Earth's populated regions. For that reason, the consortium included no less than 17 companies (including major providers such as SES), in order to achieve constant global coverage. Intelsat's proposal included as many as 20 satellites and 8 teleports. This contract is expected to replace the U.S. navy's existing one for the procurement of L-band mobile services from Inmarsat of London.[370]

The U.S. Missile Defence Agency (MDA) successfully launched two new generation Space Tracking and Surveillance System (STSS) demonstration satellites on 25 September 2009. The spacecrafts included considerable improvements form previous systems, including the capability to track cold bodies in space for the first time. However, their initial testing period run into serious delays due to numerous technical problems. In fact, officials of Northrop Grumman Aerospace Systems of Los Angeles, the satellites' manufacturer, confirmed only on 21 January 2010 that the system's testing and sensor calibration had resumed. By then, the entire programme came under scrutiny by the Congress for budget overruns and poor programme management, which resulted in the curtailing of several scheduled tests of the system. As a result, MDA's medium term Integrated Master Test Plan that was completed in mid-2010 did not include even a single test related to STSS. It should be noted that although MDA estimated the programme's total cost since 2002 at $1.35 billion, the U.S. Government Accountability Office (GAO) raised it in its own project assessment to $ 3.1 billion. According to MDA sources, development of an operational version of the system would not begin before the completion of current demonstrator testing.[371]

On 1 February 2010 the U.S. Air Force announced its budget appropriation request for 2011. Although the overall USAF budget request was up 3% from 2010 (at $170.8 billion), space procurement and development expenses were curtailed by more than 8% (to approximately $8 billion). This development ended the upward trend in USAF space activities spending over the last few years. In fact, the proposed budget focuses on capitalising on the operational use of existing space systems and foresees only limited funding for new development projects. Even transformation programmes that were given priority until now, such as these run by USAF's Operational Responsive Space (ORS) Office for example, suffered

budget cuts. The disproportionate decrease in defence space appropriations was attributed by government officials to the general trend of limiting R&D spending in the 2011 defence budget. Since R&D related expenses are proportionately higher in space activities than in other USAF programmes, the same officials claimed, the resulting budget cuts were also greater. Among the most important defence budget cuts, one can single out the termination of the $26 billion Transformational Satellite communications system, the scaling down of the Third Generation Infrared Surveillance (TGIRS) programme and the 25% decrease in funding for ORS projects ($94 million in 2011 from %124.3 million in 2010).[372]

As it seems, operational programmes already in use or in their final development stages represent the bulk of the requested appropriations. These include $426.5 million for space situational awareness projects ($188.1 million more than in 2010) and the purchase of additional spacecraft for a number of USAF programmes, like the fourth SBRS satellite, the seventh Wideband Global Satcom and the fifth Mobile User Objective System narrowband communications one. The USAF space surveillance system stands out among the programmes with the greatest increase in spending. Funds are mostly diverted to upgrading the system's ground-based radar network known as Space Fence, as well as developing follow-on to the Space Based Space Surveillance satellite due for launch in June 2010.[373]

At the same time the Obama administration requested on behalf of the U.S. Missile Defence Agency (MDA) $8.4 billion for Ballistic Missile Defence (BMD) in 2011, representing a $500 million increase from the previous year. The planned budget was heavily influenced by the new BMD posture announced on 1 February 2010 through the Ballistic Missile Defence Review Report published by the Pentagon. This new BMD orientation adheres to the deployment of SM-3 interceptor equipped warships in European waters, in order to compensate for the cancellation in September 2009 of the more capable ballistic missile interceptors that would be installed in Poland. At a later stage, the new planning also calls for the development of a land based version of SM-3 (with an initial $281 million budget for 2011). Furthermore, the new doctrine calls for longer development and operational evaluation periods for the new ABM systems, as well as for increased international cooperation in this field. This new policy document also gives considerable attention to developing new ballistic missile warning sensors, both airborne and in space. The space component under development is known as the Precision Tracking Space System, for which MDA has requested $67 million. The programme should benefit from initial work done over the Space Tracking and Surveillance System demonstration satellites, three of which are in orbit since 2009. In an effort to limit development costs and streamline the required system tests, MDA has thoroughly reviewed its testing programme in late 2009 and it has requested increased funding for such activities in 2011 ($1.11 billion compared to

$823.3 million in 2010). Finally, funding for the development of the experimental high-power chemical Airborne Laser is terminated. The budget only foresees $99 million for the transformation of the system into a ground based test bed for directed energy weapons.[374]

In the U.S., the Department of Defence disclosed that it was experiencing mounting problems related to poor hardware manufacturing and quality control. Space and missile defence programmes in particular suffered from repeated delays and failures caused by deficient components. For example, a failed Missile Defence Agency (MDA) test of the Ground-based Midcourse Defence system on 31 January 2010 may have been caused by faulty components. In February, Pentagon officials confirmed that USAF increasingly discovers hardware and software flaws in satellite and launcher components during their final assembly and testing. According to the same sources, deficient parts included crucial pieces of hardware, such as gyroscope and reaction wheels on satellites. These manufacturing flaws were attributed by government officials to the retirement of older generations of space industry skilled workers and the low rate of their replacement. At the end of this process, the U.S. space industry could be facing a permanent loss of space systems manufacturing know-how. On the other hand, this situation could partially explain the resistance that the new US space policy has met within certain department of Defence circles.[375]

On 11 February 2010 the U.S. Missile Defence Agency (MDA) announced a successful test of the Airborne Laser system. A Boeing 747 aircraft carrying a high power chemical laser tracked down and destroyed its intended target, a short-range liquid-fuelled ballistic missile. However, in a second test later the same day the weapon malfunctioned and failed to destroy a sounding rocket that simulated a solid-fuelled ballistic missile. Nevertheless, MDA qualified the test as a success, since ABL had reportedly achieved to intercept a similar solid-fuelled target in a separate test on 3 February. In spite of its success as a system demonstrator, ABL has been deemed as an operationally non-viable and logistically expensive weapons platform. Therefore, MDA had apparently decided to terminate all funding for the programme in 2011 and to invest in other directed-energy technology research projects. As for ABL itself, it would be transferred to the Pentagon's Office of Defence Research to serve as a test bed for laser technologies.[376]

On 17 February, the satellite platform for USAF's first non experimental operationally responsive satellite was delivered by ATK Space Systems of Maryland. The spacecraft, known as ORS-1, was built in 16 months and it was transported to Goodrich ISR Systems of Connecticut, the programme's prime contractor, where the integration of its Earth observation payload would take place. Its launch was scheduled for the second half of 2010. ORS-1 is the first operational satellite developed under the Operationally Responsive Space (ORS)

concept, a USAF project aimed at developing small satellites cheaper, faster and ready to launch on demand. The programme's objective is to achieve a quick launch capability for Earth observation satellites, as a response to urgent intelligence demands from units engaged in military operations. Although the satellite's exact cost had not been disclosed, government official's confirmed that the project had met its budget and timetable objectives. ATK announced that the platform's cost was approximately $34 million, whereas the Pentagon's Operationally Responsive Space Office, which is the programme's contracting authority, had previously announced that the total budget could reach as high as $162 million. The satellite bus of ORS-1 was based on the one manufactured by ATK for TacSat-3, Pentagon's latest experimental operationally responsive satellite launched in May 2009. In spite of the programme's proclaimed success, the question of its exact cost remains pertinent, as the affordability of the satellites used is undoubtedly one of the most crucial parameters of the ORS concept.[377]

Although the budget for science and technology development programmes at the U.S. National Reconnaissance Office (NRO) was cut off half during the last five years, it intends to reverse the trend and come to the historical budget amount, according to NRO Director Bruce Carlson. Due to the classified character of the NRO's budget he didn't disclose any concrete figures on his speech of 14 April 2010. Nevertheless, the NRO will conduct its most aggressive launch campaign of the last 25 years until late 2011.[378]

Finally on 22 April 2010 USAF launched the X-37B Orbital Test Vehicle, a winged unmanned spaceplane demonstrator. The vehicle was expected to perform evaluation manoeuvres for as long as nine months, before re-entering the atmosphere and landing as a conventional airplane. The 8.9 metres long spacecraft built by Boeing's Phantom Works of California was lifted in its maiden flight by an Atlas 5 rocket. It has a cargo bay similar to the space shuttle but of smaller dimensions, capable nevertheless of accommodating two small satellites. USAF hopes that when the spacecraft becomes operational it will add a quick and affordable satellite launch capability to its inventory. The programme was originally started by NASA in 1999, before it was passed on to DARPA in 2004 and finally to USAF's Rapid Capabilities Office, which currently has overall supervision of the project. A second test flight was scheduled for 2011.[379]

4.4. Russia

The Russian military space programme remains highly classified and all available open source information regarding it is scarce. Consequently any attempt to analyse it should be considered by definition only indicative. Nevertheless, the

available information does permit us to draw some conclusions on its overall nature and strategic orientation.

The basic lines of the Russian military space strategic plan follow in broad terms the orientation of its civil space programme. These are the following: to re-establish Russia as a major military space power on a global scale, limiting its capabilities gap with the U.S.; to revitalise the country's space industrial base in order to make it competitive on an international level and even export-oriented; and to use space related technologies' research and development as a pivotal point for the overall growth of the Russian scientific research and economy, especially in the field of electronics.[380] In spite of its long military space tradition, the Russian military space programme has been increasingly utilising dual-use systems, marking a possible change in its operating concept. For example, one should not forget that the Glonass satellite navigation constellation was initially meant to be a military system, whereas today the Russian authorities put more emphasis to its commercial use as well. As another example, Russian officials announced on 15 April 2010 that they were developing a meteorological satellite scheduled for launch in 2011, disclosing at the same time that it would also be of military use, as it would be capable of detecting submarines as well.[381]

Nevertheless, the Glonass satellite navigation constellation remains a militarily crucial space asset and its expected full operational deployment by the end of this year should be considered a major evolution step for the Russian military space capabilities. Apart from this project, the Russian armed forces proceeded to the launch of at least two publicised military satellite launches in the past 12 months, the mission of which was kept classified. In total, Russian military authorities publicly admit to operate a fleet of over 60 spacecraft dedicated to military missions, the bulk of which is used for Earth observation purposes.[382]

In addition to this, another system of inherent dual-use nature that should greatly upgrade Russian military space capabilities is the development of the Angara heavy launcher, capable of lifting up to 24.5 tons into orbit. The rocket is scheduled to replace both the Rockot and Proton vehicles, thus improving the Russian fleet's homogeneity. It also encompasses the new dual-use oriented approach in space systems' development, as it would not only greatly improve the country's capacity to lift military payloads, but it is also expected to have a broader commercial launch services use as well. The rocket was planned to use the Plesetsk space centre instead of the Baikonur Cosmodrome in an attempt to reduce Russian space transport dependence on third countries and its first launch was expected in 2011. However, the vehicle's debut could be postponed for a year due to a cut in its 2009 budget expenses that were allocated to the construction of additional launching facilities at Plesetsk. Finally, in a related development the Khrunichev State Research and Production Space Centre that manufactures the

launcher announced it had requested additional funds of 10 billion Rubbles ($290 million) over the next three years in order to complete the project.[383]

Finally, in 2009 and 2010 the Russian armed forces have continued to develop the country's Earth-based counter space capabilities under their long-term air defence modernisation programme. This project, which treats air and space as an operating continuum for the purposes of air defence, aims at creating an integrated weapons system consisting of ground-to-air missile systems with anti-aircraft and anti-missile capabilities, as well as modernised MIG-31 supersonic interceptors.[384] In addition to these, the system is expected to include some kind of Earth-based anti-satellite (ASAT) capability as well, although this has not been officially confirmed. Nevertheless, there have been official statements to the effect that the Russian armed forces are in fact developing a new type of ASAT based on what was described as a "fundamentally new weapon [technology]".[385] At the same time however, the Russian government also declared that it was continuing to oppose the development of co-orbital ASATs or any other form of space weaponisation, insisting that any such future systems would be exclusively Earth-based.[386]

4.5. Japan

The Japanese national security strategy is evolving rapidly since the creation of a Defence Ministry in 2007 and space systems have a pivotal role in this transformation process. Japan is bound by its Constitution to pursuit only the "peaceful" use of space. Nevertheless, the country is now in the middle of a policy shift that seeks to define "peaceful" not as "non-military", as it was the case until now, but as "non-aggressive". This will enable the regularisation of the use of dual-purpose satellites by Japan's armed forces and it will reinforce the cooperation between the country's space agency JAXA and the Ministry of Defence. The further development of space systems for national security purposes is one of the pillars of the new Japanese security strategy published in August 2009. The defence against ballistic missile attacks and the improvement of the country's intelligence gathering apparatus through the use of Earth observation satellites are among the conditions identified as crucial for the realisation of the new strategy.[387]

For that purpose, Japanese space activities have been increasingly focusing on the development of their space applications segment. Japan is actively pursuing the development of dual-use space assets across all fields of applications. These include a new generation of Information Gathering Satellites (IGS) with greatly improved ground resolution, a satellite positioning system of regional coverage known as the Quasi-Zenith Satellite System (QZSS), an early warning system to cooperate with

its ballistic missile defences and a space situational awareness system similar to the one currently used by the U.S.

The IGS programme is the most mature of these projects, both technologically and operationally. Japan currently operates four of these spacecraft, two equipped with optical and two with radar Earth observation apertures. Although their constellation was only completed in 2007, a new generation of improved IGS spacecrafts is at the final stages of development and they were scheduled for launch between 2009 and 2014. The first of these satellites was successfully launched on 28 November 2009. The IGS programme's total budget from 1998 to 2014 is estimated to reach approximately ¥1 trillion, with an expected average spending of ¥60 billion annually through 2014.[388]

The flight testing of the Quasi-Zenith Satellite System (QZSS) is also expected to begin in the summer of 2010 with the launch of the programme's first demonstrator spacecraft, QZS-1 (nicknamed "Michibiki"). Upon the successful conclusion of the testing schedule, QZS-1 should be joined by two more satellites to form the system's complete operational constellation. It should be noted that QZSS is not indented to be an autonomous satellite navigation system; its mission would rather be to enhance the accuracy and redundancy of the GPS signal over Japan. Nevertheless, from a technological point of view QZSS's development will greatly enhance Japanese know-how on building such systems, possibly allowing it to pursuit the development of its own independent system in the future.[389]

In general, Japan's ambitions in developing a full range space security apparatus are adequately backed by sufficient budget resources. Out of the ¥348.8 billion reserved for space activities in the 2009 budget, ¥213billion (or almost 40% of the total) was related to dual-use space applications. The IGS programme received the most funding (¥66 billion), followed closely by BMD related systems (¥58 billion), QZSS (¥14 billion) and GX rocket development (¥11 billion).[390] The latter's development was however cancelled on 16 December 2009 by the Japanese government, due to its continued budget overrides and unsure commercial prospects.[391] It is highly likely that Japan's early warning satellite programme, which appears to be the nation's next priority in military space capabilities development, would be funded from the BMD related budget line.

4.6. China

As it is the case with Russia, the Chinese military space programme is also classified. Very little and always unofficial information exits the country regarding

these projects. What it should be noted is that the Chinese military space programme also evolves around a dual-use concept. This means that all space assets are conceived from their very beginning as military use compatible. These include the country's communications satellites and the Beidou satellite navigation system, which will emit a government-only signal alongside its commercial one. However, the great difference with other space-faring powers is that the Chinese dual-use space assets are mostly run directly or indirectly by the Chinese Army, due to that country's unique political and administrative structure. The Shenzhou manned spaceflight and the Long march launcher programmes are among the most significant examples.

The Shenzhou manned spacecraft programme, also known as Project 921, did not see any significant changes in the past 12 months. After the spacecraft's successful 3rd flight in the September of 2008, the programme's focus has shifted to improving Extra Vehicular Activities know-how and testing in-orbit docking technologies for use in the future Chinese space station. This seems to be the next step in the Chinese human space flight programme. CAST has already three space docking stations under construction, with the first (Tiangong-1, meaning a palace in Heaven in Chinese) scheduled for launch in 2011.[392] The next two space stations are scheduled for launch before 2015. Each one will have an expected life span of only two years. They should be primarily used to demonstrate docking technologies, in cooperation with the three Shenzhou space craft also scheduled for the same period.[393]

4.7. India

India does not have a dedicated military space programme. However, future dual use satellites will have an inherent military utility and ISRO does not place any restrictions on their use. Nevertheless, an important new dimension for the country's nascent military space capabilities emerged earlier this year. During a press conference on 3 January 2010, the Director-General of India's Defence Research and Development Organisation (DRDO) V.K. Saraswat disclosed that his country had begun development of an Anti-Satellite weapon system (ASAT). Mr. Saraswat said that the system had just entered its initial development phase and that it would not be made operational unless his country decided that it "needed" it. He predicted that the ASAT would consist of two components, a laser used for tracking targets and a direct ascent interceptor missile of a 120–140 km range, equipped with an exoatmospheric direct impact kill vehicle. Initial testing of the missile was expected to begin in September 2010, while the full system should be developed by 2014.[394]

4.8. Other selected space actors

The spatial sector has seen over the past years the emergence of a new series of actors in a world ever more globalized. The growing importance of these protagonists can be easily assessed through their often ambitious space programmes. Canada in addition to be an associate member of ESA has thus seen its involvement to space activities gradually augment. Firstly, this movement is noticeable by the regular rise of its budget to reach approximately €395 millions in 2010.[395] Major programmes are under development such as the Radarsat Constellation Mission (RCM). RCM has become a key strategic mission for the Canadian government, costing between or in military initiative, the Remote-sensing Situational Awareness (URSA) component will focus on mission planning, tactical reconnaissance, target acquisition and battle damage assessment. The Canada's next-generation radar Earth observation system, suggesting that the budget delays that have slowed the project's development are a thing of the past. A fresh cash infusion has been made in 2010 of 397 million Canadian dollars. The three-satellite Radarsat constellation missions, should ensure that Canada maintain its role as a world leader in aerospace technology. It is also a key asset to defend their Arctic sovereignty. The first of the three satellites could be launched in mid-2014, with the two others launched in 2015 knowing that the total cost of the system is around 600 million Canadian dollars. The European Space Agency (ESA), of which Canada is an associate member, is in negotiations with Canadian officials on providing user interoperability of the three Radarsat Constellation spacecraft with ESA's Sentinel-1 C-band radar satellite, set for launch in 2012.[396] Concerning Space exploration, in the framework of future international space exploration effort. Canada's MDA Corp.awarded a contract to design and build two lunar rover prototypes for yet-undetermined missions under a contract with the Canadian Space Agency.[397]

Iran tries to join the concert of space faring powers by testing its home made rocket. A capsule containing live animals and featuring a camera mounted on the vehicle that provided a live video stream of the rocket's ascent has been successfully launched, in February 2010. This follows the launch of the telecommunications satellite in 2009 which has according to the head of the Iranian Aerospace Organization re-entered Earth's atmosphere. Further more ambitious programmes might be announced in the coming months after these victorious attempts.[398]

South Korea also tempts to take part in the space venture with more and less success after the Korea's Naro-1 satellite launcher blew up after lifting off from the Naro Space Center June 10, marking the second failure in as many tries for the

vehicle, whose first stage was built by Russia. The Korean authorities have blamed the Russian part for the accident. Korea's prime objective is still to the use of Earth observation through two major programs, namely, the Kompsat and COMS-1 (Communication, Ocean and Meteorology) Two more satellites Kompsat-6 (radar) and Kompsat-7 (optical)are expected to be launched in 2016 and 2019.[399] South Korea should first of all fix its problem of launcher in order to fulfil its expectations concerning space activities.[400]

Israel launched with success its newest spy satellite in June which confirms the maturity of the Shavit rocket. After only three days the Ofeq-9 satellite began transmitting its first high-resolution imagery to military intelligence users. This satellite is going to be a key element of the intelligence network of Israel. The satellite would be capable of capturing black-and-white images at resolutions of 50 centimeters or better. A satellite's imaging resolution corresponds roughly to the size of ground objects or features it can distinguish. This reinforces the previous one TecSAR which had been previously launched. The successful launcher is due to be an integrant part of the nuclear capacity of the country.[401]

Turkey has also steadily increased its investments essentially destined to reinforce its Earth Observation capabilities. The country's space defense spending is gauged around $93 in 2010.[402] Turkey appears firmly decided to develop its own independent satellite system to protect national. This will symbolised by the GÖKTÜRK satellite. A €250 million contract had been already awarded in2009 to ThalesAleniaSpace and Telespazio preceded the construction kick-off in 2010 for the 80-cm resolution optical imaging satellite GÖKTÜRK satellite. The project is mainly due to provide image over borders nations. It is a quite critical topic given the tensions which has been recently developed with Israel, but also the development of the Kurd resistance. Launch of the satellite is scheduled for 2012/2013 timeframe.

4.9. Threats to the space environment

Volatile solar activity can seriously affect the functioning of satellite and others high tech materials. An insight of the effects was observed in 1989 while Quebec suffered an electrical power blackout due to a massive solar storm.[403] Numerous of studies are undergoing or planned to better undertand the composition and cycles of the Sun in order to anticipate the dramatic potential damages on Earth and its orbit. A longer description of this worldwide effort is provided in the chapter concerning Space exploration.

Space debris is a growing subject of concern while the most powerful nations seem to be helpless in face of this challenge, The chapter concerning new

technologies describes the will of Russia and the U.S. to develop revolutionary systems to tackle this crucial issue[404]

The collision between an Iridium mobile communications satellite with a retired Russian spacecraft in February 2009, creating a new debris field in low Earth orbit, has accelerated talks on collaboration on space surveillance.[405] The new diplomatically strategy of the U.S. should be thus more axed on international cooperation, a cornerstone announced by the Obama's administration. A crucial step given that the U.S. maintains the world's most sophisticated space-surveillance network of ground-based sensors but it has been unclear in the past how willing the U.S. Air Force.[406] The European code of conduct might have oriented the protagonists in the right way to mitigate as much as possible the creation of debris.

The International Telecommunication Union (ITU) was seized by the french regulators to intervene with the Iranian government to persuade Tehran to stop jamming satellite signals from the BBC World Service's Persian-language broadcasts into Iran. The request come after that many complains had been already done to Iran to stop the jamming. The BBC Persian programming carried on the Eutelsat Hot Bird 6 satellite. The jamming had started last spring during Iran's elections and has continued intermittently.[407]

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