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ASSESSING RUSSIA'S SPACE COOPERATION WITH CHINA AND INDIA

Opportunities and Challenges for Europe

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Assessing Russia's Space Cooperation with China and India - Opportunities and Challenges for Europe

EXECUTIVE SUMMARY

Russia is historically and technologically a world leader in space. It is also a strategic partner for Europe. Since the nineties, Russia has changed and its partnerships have evolved. This transformation strongly impacts the space field and the country's space cooperation. Russia and Europe have structured and increased their cooperation in the last decade, and some Europeans are advocating closer cooperation with Russia and even a joint strategy for the development of their space activities. At the same time, Russia has reinforced its cooperation with the two fastest growing space-faring nations, India and China. The question therefore arises: to which extent could Russia's stronger cooperation with India and China affect future Europe-Russia cooperation?

This study first reviews the current situation of Russia and the evolution of the country's space activities and cooperation. It then investigates the relations between Russia and the two largest Asian countries, India and China, the overall context of those relations as well as their space cooperation. It examines the possible consequences of the evolution of those relations for Europe, and in particular, evaluates the potential impact on its space activities and on its cooperation with the Russian partner. Finally it concludes with recommended actions to be taken by European decision-makers in order to maximise opportunities and minimise risks in this changing environment.

Russia in 2008

Russia is recovering from the severe crisis it suffered after the end of the Soviet Union and is regaining its political clout. After its collapse in the nineties, the economy has now returned to its 1990 level and its financial position has dramatically improved. This economic resurgence, based on its energy sector, was made possible by the renewed political stability as well as by political and economic reforms. However the Russian economy has to overcome several challenges to sustain its current growth including demographic issues and its strong dependence on oil and gas exports, which requires a diversification of the economy. With the improvement of the overall situation of the country, the Russian leadership has gradually adopted a more confident posture on the international scene. Moscow is using economic and political means to increase Russia's influence and is at the same time building up an image of a committed and responsible international power. This new attitude is coupled with an evolution of Russia's foreign policy towards a multidirectional, more balanced and pragmatic strategy, with, in particular, an active promotion of cooperation with its Asian neighbours.

Russia and Space

These general trends are reflected in the space field. After a golden age, the space sector severely suffered from a lack of interest and funding during the nineties. Today, Russia has to re-build its space capabilities and to transform its space sector. The space sector has recently got a new impetus from the Russian leadership which has the will and means to further develop and diversify Russian space activities. Space is now back on Moscow's strategic agenda for political and economic reasons, and is supported at the highest political level. The Russian leadership wants to fully use this key industrial asset and regain control over it. Ambitious programmes that cover the whole spectrum of space activities have been adopted, the funding has been increased and the industry is being reorganized to improve its competitiveness. However, there are many challenges to be addressed in this sector, including human resources, regulatory, financial, organizational and technological challenges. This new situation led to an evolution of Russia's space cooperation. Russia remains open to

cooperation, but wants its partnerships to better reflect its interests and to serve its technological needs. The recent shift towards a more balanced foreign policy also led to the diversification of its partnerships in the space domain. Russia's attitude to its traditional partners has changed and it is now looking for new partners for strategic and commercial reasons. Another major development is the strengthening of its cooperation with the quickly-rising space-faring nations, in particular China and India.

Cooperation in the triangle Russia-India-China

Closer space cooperation between Russia, India and China does indeed have the potential to impact Europe and the rest of the world. Taken together, the three great EurAsian powers actually have a significant and growing influence in the world. China, India and Russia jointly have formidable human and natural resources, as well as economic and political weight in the world. In addition, they are developing closer relations with each other. These two trends are, in fact, being observed in the space field. The three countries' space activities are developing and gaining importance, reflecting their expanding economies and the growing interest in space of their decision-makers. In these three countries, space expenditures are increasing and space programmes are quickly developing, i.e., the volume of activities is increasing and the spectrum of activities is broadening. Moreover, the reliability of the Chinese and Indian systems has increased. This evolution creates more opportunities for cooperation, especially as partnerships might be necessary for those countries to overcome some technological barriers.

Russia has gradually strengthened its relations with India and China. Strategic cooperation between them takes place mainly in two fields: energy and defence. Russia is a major energy provider to those two countries with growing energy needs as well as their main provider of weapons and defence equipment. Russia's respective bilateral relations with India and China are however very different.

Sino-Russian relations

After being suspended for almost three decades, Sino-Soviet relations resumed in the late nineties and have gradually normalized. Those relations are complex and cautious. In the past years, both countries have focused less on their differences than on pragmatic rationales for their cooperation. Trade is developing but asymmetrically, and Russia remains very wary because it perceives China as a potential threat to its interests. Both countries have very different rationale for cooperating, but share some similar views and concerns. Their space cooperation has been central to the development of the Chinese space programme. After Russia helped China building its first missile, cooperation was suspended after the Sino-Soviet split of 1956 until the late nineties. After the collapse of the Soviet Union, China needed technology to sustain its progress, and cooperation was resumed mainly in manned spaceflight. Within the framework of a bilateral commission on space cooperation, joint activities have been undertaken, mainly in the field of science and exploration. The two countries have also taken a common position regarding the non-weaponisation of space.

Indo-Russian relations

Cooperation between the Soviet Union and India started in the sixties and for more than four decades, their relationship has been one of mutual trust and confidence. The quality and stability of their relations stems from the compatibility of their geopolitical and strategic interests. However, outside of the fields of energy and defence, their relations still remain limited, as demonstrated by the low level of trade, but still have the potential to grow. India remains a far more acceptable partner for Russia than China. In the two main fields of cooperation, i.e., defence and energy, Russia tends to go further with India than with China, as illustrated by the joint Indo-Russian development of the BrahMos missiles. Nevertheless, Indo-Russian relations, unlike Sino-Russian ones, are likely to be significantly affected by the evolution of the US-Russia and US-India relations. In fact, the US is trying to strengthen its ties with India, as exemplified by the controversial US-India civil nuclear cooperation agreement. Russia and India started cooperating in the space field in the seventies with the launch of the first Indian satellites on Soviet launchers and the flight of the only Indian cosmonaut in 1984. The three main areas of cooperation are launchers, navigation, and science and exploration. In the future, India and Russia might cooperate in manned spaceflight as India turns towards more "prestige-related" activities. Indo-Russian cooperation however tends to be hindered by Western constraints.

No real strategic triangle

The concept of a strategic triangle Russia-India-China was put forward by the former Russian Prime Minister Y.M. Primakov in the late nineties, as a way to challenge US hegemony, but this idea was never really supported by the two other countries. The three countries do share common interests and the vision of a multi-polar world, and this triangle has actually become a reality in the sense that the leaders of those three countries are meeting more often since their first trilateral meeting in 2001. Nevertheless, this triangle tends to be used mainly as a diplomatic tool when needed and is unlikely to develop into a real alliance. The main reason being that none of the three countries wants an alliance that could be detrimental to both independence and bilateral relations with the US. The relations are likely to remain bilateral between the three countries. The main challenge to this strategic triangle will remain relations between India and China, as there are significant issues of trust between the two largest countries in the world that are trying to define their roles at regional and international levels and perceive each other as a threat to their own interests and ambitions. Their cooperation is developing, but is likely to remain limited. A tripartite cooperation in the space field is therefore unlikely as India and China are developing their programmes in parallel.

Consequences for Europe

Despite limitations, these new developments have the potential to impact European-Russian relations and space cooperation.
The relationship between Russia and Europe has evolved from one of reciprocal hostility during the Cold War into a partnership. The long-lasting relations have experienced ups and downs, but each has become a priority partner of the other today. Russia has established well-structured relations with the EU, in addition to its long-lasting relations with some of the EU member States. Russia and Europe are key economic partners and have become very interdependent, but there are still several political challenges to their relations. The diversification of Russia's partnerships could certainly be beneficial to European-Russian relations, as Moscow has not shown less interest for Europe and its foreign policy has become more balanced and less exclusive.

Europe and Russia have a long history of space cooperation. Cooperation today takes place at various levels, in different frameworks and - thematically - mainly in four fields: satellite telecommunications, launchers and launch services, manned spaceflight, and science and exploration. Some of Russia's new partnerships can be beneficial to Europe, while others can negatively impact Europe's markets and attractiveness. Cooperation with Europe in some fields, like telecommunications or launch services, can be expected to remain quite stable. However , there are fields in which Russia today has alternatives to Europe.

Russia remains very interested in cooperating with Europe. However, if Europe is not interested or is not acting decisively, Russia has now new alternatives, among which are India and China. Russia is launching ambitious programmes and upgrading its space capabilities. Those new activities create many great opportunities for Europe at a time when the conditions for intensifying Russian-European space cooperation are favourable despite the overall political context that is not so positive. Nevertheless, if Europe is interested, it should act in a timely manner. Many challenges also need to be addressed, which include political ones associated with building a political Europe, defining a common foreign policy, as well as fully using the potential of space as a political tool. Then, there are challenges that stems from the current European organization and mechanisms used to implement space cooperation with Russia. Lastly, there are also difficulties in implementing cooperation in areas that range from technology transfer issues to differences in business and engineering practices.

Europe has today new opportunities to cooperate with Russia, and if it does not seize them, others will. In particular new development activities, needed by the European industry, could be jointly undertaken with Russia. In the field of launchers, Europe should make the best of the existing synergies in future developments and should seriously take into account in its future decisions the difference in the timeframe of the future European and Russian developments. For launch services, Europe and Russia are now interdependent and will be similarly affected by new competitors. In the long-term, the only viable option for Europe is to design incentives to encourage at least European companies to "buy European". In the field of navigation, Europe could take the lead in political initiatives to further coordination among

providers and cooperation with users in specific sectors. In science and exploration, Europe should position itself as an attractive partner and should use its advantage of having good relations with all the main players to become a bridge between them for future joint endeavours. Then, if Europe wants to move forward with its manned activities, it should include in its portfolio the only missing element, i.e. a manned transportation system. To achieve that goal, it has mainly two options, an independent system or an autonomous system jointly developed with the Russians, each of them with its own set of advantages and challenges.

Europe has today the possibility to further its interests by establishing cooperation with Russia to the benefits of both sides and addressing the challenges posed by the closer relations between Russia, India and China. But it would require a more comprehensive and longer term approach of its international relations.

Assessing Russia's Space Cooperation with China and India - Opportunities and Challenges for Europe

Introduction

Russia is one of the two main strategic partners for Europe in its space endeavour. Long-standing cooperation has developed between European and Russian partners in various areas, from science to launchers to manned spaceflight. However, in the past years significant changes have been observed in Russia's attitude. Strengthened by a better economic situation, Russia is now reasserting strong ambitions, and its leadership aims to reaffirm the country's position on the international scene. The space sector suffered acutely from the overall crisis the country underwent after the fall of the Soviet Union, but it has again become a priority for the Russian leadership, which is firmly determined to make the most of such a strategic asset. This trend is reflected in the evolution of Russia's international partnerships in the field. One of the most striking features of this evolution is that Russia, which has leaned westward towards Europe and the United States since the end of the Soviet Union, is diversifying its partnerships and is turning now more and more to the East to Asia-Pacific. Russia has recently intensified relationships with two major countries, China and India, which have accelerated the development of their space activities over the same period. If Russia intensifies work with those two rapidly developing space-faring nations, this development has the potential to strongly impact Europe and its space activities as well as the relations between all those actors.

This report investigates the overall context of the relations between Russia, India and China and focuses on the space field. It reviews past and current cooperation and analyses the rationale, drivers, limitations and possible evolution of such relations, from cooperation to competition in the different space-related areas. It then examines the possible consequences of the evolution of the relations in the triangle Russia-India-China for Europe in terms of opportunities and risks. In particular, it evaluates the potential impact on its space activities and on its cooperation with the Russian partner. Finally, it concludes with recommended actions to be taken by European decision-makers in order to maximise opportunities and minimise risks in this changing environment. The present report does not include military space activities, except when relevant, as international cooperation remains limited in this field.

1. Russia in 2008

In the past decade, Russia has benefited from political stability and a stronger economy.

1.1. A stronger economy

After the collapse of the Soviet Union, Russia underwent a transition from a planned to a market economy and experienced severe economic difficulties, further complicated by the financial crisis of August 1998 that followed the Asian 1997 crisis. During the 1998 "ruble crisis", the Russian stock market collapsed and the government devaluated the ruble, defaulted on its domestic debt and declared a moratorium on payments by commercial banks to foreign creditors to prevent mass bank default. In a month, the ruble lost two-thirds of its value. In 1998 Russian inflation reached more than 85% and major banks went bankrupt. The economic crisis also led to a political crisis and to the dismissal of the Prime Minister, Sergei V. Kiriyenko.[1,2] In 1998, Russia's Gross Domestic Product (GDP) was almost half the country's 1989 GDP, as presented in Figure 1. After the "ruble crisis" the economy made an impressive rebound thanks to the energy sector, and since 1999, the Russian economy has steadily improved. In 2007, Russia's GDP got close to the 1989 level.

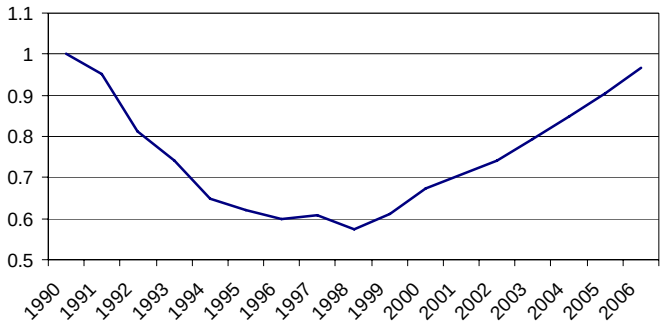


Figure 1: Russia's GDP relative to its 1989 level (in real terms)[3]

Russia's financial position has also dramatically improved since 1999. As illustrated in Figure 2, its total external debt was reduced from 90% of the GDP in 1999 down to 25% of the GDP in 2006. Today its public external debt is low and still decreasing, but private sector debt is rising, which in 2007 led to the first year of increase of the debt-to-GDP ratio since 1999, up to more than 30%.

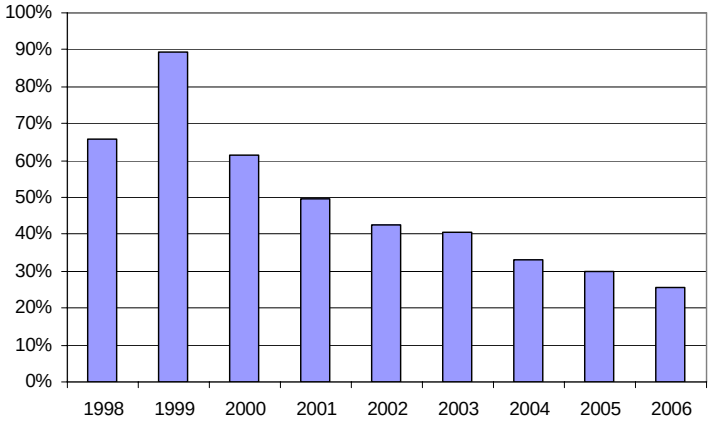


Figure 2: Russia's total external debt (as a percentage of the GDP)[4]

Moreover oil exports have fuelled an increase in foreign currency reserves. After China and Japan, Russia holds the third-largest gold and foreign reserves with more than 500 billion dollars in April 2008.[5]

1.2. An economy very dependent on the energy sector

The recovery of the economy has been supported by improved economic policies, but above all by the country's energy exports. Today, Russia is in a position of an "energy superpower" thanks to its oil and gas reserves. Russia has the largest gas reserves in the world estimated at almost 30% of the proven reserves and is the largest exporter of natural gas. It has the eighth proven oil reserves and is the second oil producer in the world. [6] Since 1999, the Russian economy has benefited from both an increase of Russia's oil production and high oil and gas prices, as illustrated in Figure 3 and Figure 4.

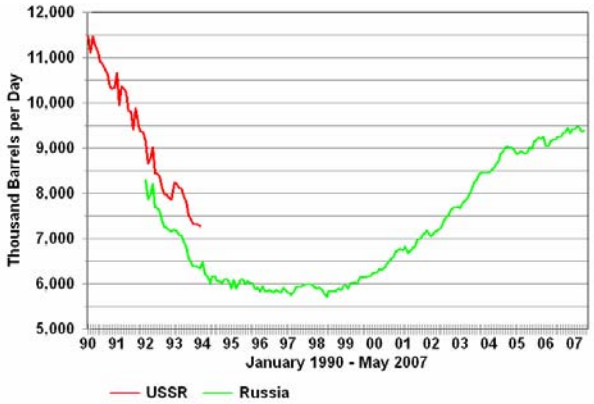


Figure 3: Crude Oil and Condensate Production from 1990 until 2007 in the USSR and Russia[7]

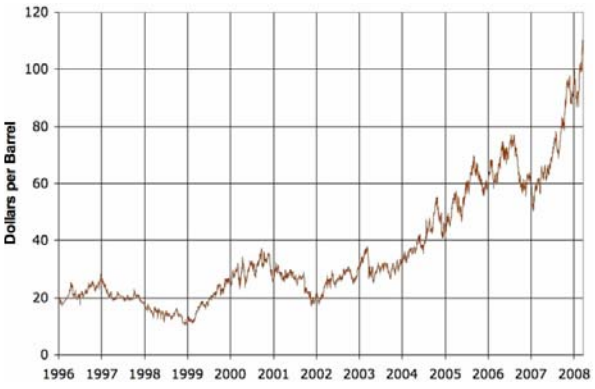


Figure 4: Oil Prices from 1996 until 2008[8]

The importance of energy for Russia's economic revival also means that the overall economy is very dependent on this sector. In 2005, the oil and gas sector represented about 20% of the country's GDP and in 2007 it generated 64% of the export revenues.[9] This dependence is a chief concern of the Russian leadership. First, during President Putin's second mandate Moscow has re-nationalised the energy sector and has exerted tighter control on it, as illustrated by the Yukos affair in the oil sector. Second, the Russian leadership is trying to control foreign investments in its energy sector, in particular, investments in deposits identified as "strategic". To put it into perspective, extraction of mineral resources amounted to more than 70% of the Foreign Direct Investment (FDI) in Russia in 2007.[10] In order to limit this dependence, Moscow tries to use the energy income to diversify the economy and invest in other sectors of the industry. The Stabilization Fund, established in 2004 and fed by tax revenues from high oil prices, is a major tool aimed at limiting this dependence. In early 2008, the Fund amounted to more than 150 billion dollars.

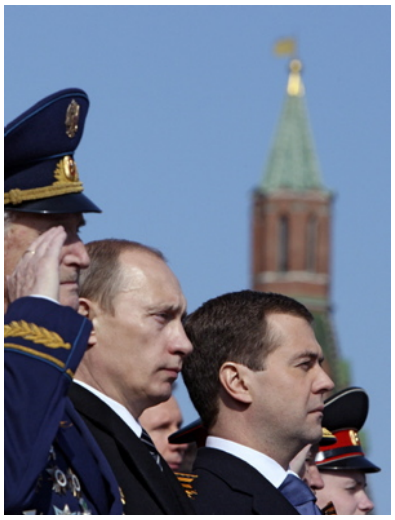
Gazprom holds one third of the world's natural gas reserves, produces more than eighty percents of Russia' natural gas and controls almost all Russian gas exports (Credit: RussiaBlog)

The economy has to overcome several challenges in the medium to long term. The first weakness of the economy is its lack of diversification. Several programmes are underway to increase innovation and boost investments in non-traditional industries. For instance, the Investment Fund, established in 2006, aims to support investment projects that improve the diversification of the economy. This Fund is financed from the government budget from oil export revenues and the savings made by the early repayment of the country's foreign debt. However, the results of these diversification efforts might be slow to come. A second concern is of demographic nature, as the country's population is decreasing markedly and ageing. This demographic trend will constrain the country's economic potential. In addition, Russia's economy has been critically affected by waves of "brain drain". Last, but not least, Russia is strongly dependent on the energy sector, but today it is not sufficiently investing in the future, i.e., in the modernisation of the infrastructure and in the development of new fields.[11]

1.3. Political stability

The country and its economy have also benefited from internal political stability, experienced since the first election of President Vladimir V. Putin in 2000. In May 2008, after two presidential mandates, President Putin had to hand over the presidency to Dmitry A. Medvedev - whom he personally picked. However, he became Prime Minister and a few weeks before he was elected leader of "United Russia", the majority party in the Duma that holds 315 of the 450 seats. Putin's election as its leader has reinforced the influence of "United Russia" and has put Putin in a strategic position to pass laws at the Duma.[12] It could also set the stage for Putin's return as President in 2012.[13,14]

The new leadership tandem, Medvedev-Putin, might secure political and economic stability, but political power is increasingly concentrating within the Kremlin, which makes Western observers concerned about the risks of authoritarianism. Furthermore, uncertainty remains regarding the future evolution of the country that might be darkened by structural issues. Structural reforms and appropriate policies still have to be implemented for the country to sustain its economic growth. Those include a sound management of the revenues from natural resources, the diversification of the economy, the reforms of the state administration, the creation of an environment more favourable to business development and foreign investments, the promotion of innovation, and the reform of the healthcare system.[2,15]



V.V. Putin and President D. A. Medvedev during the military parade on 9 May 2008 (Credit: Mikhail Klimentyev, Presidential Press Service, AP Photo/RIA Novosti)

1.4. A new posture and the evolution towards a more balanced foreign policy

As a result of the improvement of the economic and political situation, Putin and his successor have gradually adopted a more confident posture and reasserted

G8 Leaders at the St Petersburg Summit in 2006 (Credit: G8russia)

Russia's status of superpower on the international scene. This attitude was clearly demonstrated during President Putin's speech before the 43rd Conference on Security Policy in Munich in 2007, when he bluntly criticized the US and the North Atlantic Treaty Organization's (NATO) expansion.[16] The Russian leadership wants to show that it has regained independence in its foreign policy, which will now be mainly driven by Russian national interests. This tendency is for instance reflected in Moscow's decision to sell armaments to countries considered as sensitive by Western countries, like Iran or Syria.[17] In addition, Putin has clearly tried to limit the country's dependence on Western loans.[18] Moreover, Russia is using economic means, especially its energy revenues, to strengthen and assert its political clout in the world. Since 1997, Russia has been the eighth member of the club of leading industrialized nations (G8) which contributes to building its image of a committed and responsible international power. Furthermore, Russia's future accession to the World Trade Organisation (WTO) and negotiations to join the Organisation for Economic Cooperation and Development (OECD) demonstrates its willingness to integrate into the world economy and normalise its situation.

This new attitude of Russia on the international scene is also associated with a shift in its foreign policy from a pro-Western line towards a multidirectional, balanced and pragmatic strategy.[18] This redefinition of Russia's foreign policy led to the active promotion of cooperation with its Asian neighbours, as well as with its neighbours in Africa or the Middle East. This trend does not correspond to a real reorientation of Russia's foreign policy, but rather contributes its balance.[18]

2. Russia and Space

2.1. Space as a strategic asset

The Soviet Union pioneered in space and has a long list of achievements, covering the whole spectrum of space activities. From the 50ies to the 90ies, it has gained considerable expertise and developed unique capabilities. A major asset of the Soviet Union in the field was its remarkable human resources. With the collapse of the Soviet Union, the space sector went through a severe crisis like other sectors, but suffered particularly from a sudden lack of interest after a "golden age". Such a neglected heritage quickly attracted foreigners, in particular, Europeans and Americans interested in buying hardware and expertise, especially in the field of launchers. At the time, there were only very few space-faring nations and the former Soviet launchers combined the advantages of demonstrated robustness and lower costs. This appeal of Russian products was an acknowledgement of Russian know-how and a way to prevent proliferation and the dissemination of critical technologies to "rogue" States. In need of money and activities, the Russian space sector opened rapidly and widely to foreign partners without much concern for technology transfer. In the early 90ies, several joint ventures were established with Western partners to commercialise the former Soviet launchers and ICBMs. Those joint ventures enabled the sector to maintain a level of activity necessary for its survival. At the same time, the lower priority given to space and limited funding for more than a decade led to the decay of the Russian space systems, in particular civil satellite systems. As a result, in 2000 the GLONASS navigation constellation had only eight of the nominal 24 satellites, and in 2007, Russia no longer had a single meteorological satellite.

After a decade-long crisis, space is now back on Moscow's strategic agenda. Space has regained the status of a strategic sector, with the major difference from the Soviet era being that technological prowess is no longer a political or ideological end in itself. There are both political and economic reasons for such a renewed interest in both space assets and the space sector.
Space is an attribute of sovereignty and independence and space capacities are associated with power. Moreover space systems contribute in a unique way to national security. The Russian leadership wants to use such assets to support its regained credibility, and even prestige, on the international scene.
The space sector is also expected to contribute to the country's sustained economic growth and to the diversification of the economy in high-tech fields. Space is a decisive asset of Russia's industry. Moscow is fully aware that Russia remains a key actor in space, especially in manned spaceflight and launchers, and is trying to make the most of this unique heritage. Given the importance of space, significant investments are being made in the space sector and the State has regained control over it. Furthermore, the Russian leadership wants to improve the sector's competitiveness in order to increase the valorisation of the country's technical capabilities and the benefits derived from capacities and expertise.

It is quite clear that President Putin has a strong interest in the field. On the international scene, he was among the leaders who gave great support to its space sector and domestically, he has been a very strong advocate for Russian space activities, in particular, the redeployment of GLONASS. In 2007, he has made the space sector one of the main priorities in the development of Russia's industry, with aeronautics and shipbuilding.[19]

At the same time, the Government is becoming more interventionist and is trying to regain tight control over space activities, as it has been doing in other strategic fields.

The renewed interest in space is combined with a restored funding capacity, as the

sector benefits from the improved overall economic situation and is becoming less dependent on commercial activities. The combination of these two factors has given a real new impetus to the Russian space sector. Moscow wants to, and is now able, to further develop and diversify both civil and military space activities.

The main stakeholders in the Russian space activities are shown in Figure 5.

according to the *Strategy for Development of the Space Industry up to 2015*. The Federal Space Agency oversees 112 companies.

The strategy for the sector will establish a new organisational structure by creating 10 or 11 horizontally and vertically-integrated structures by 2010 and setting up three to four space corporations that would encompass most of the main enterprises of the field before 2015. The consolidation will

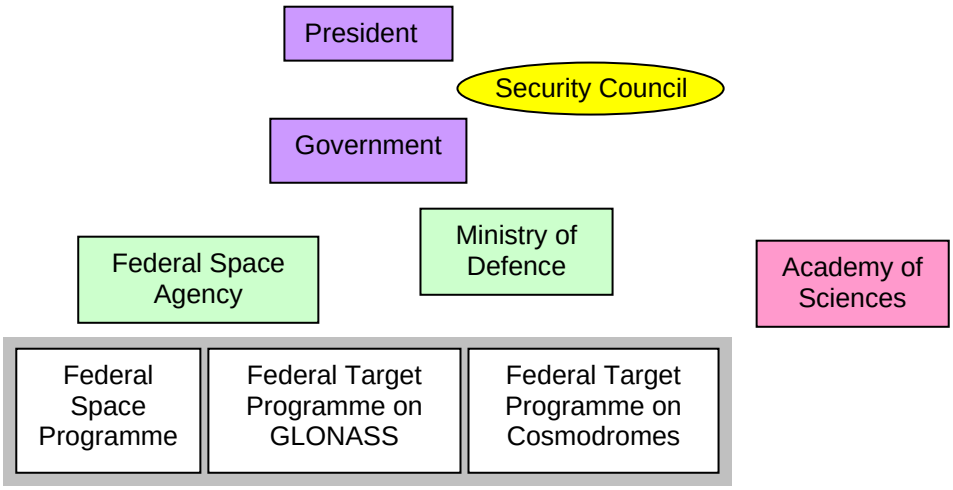


Figure 5: Main stakeholders in Russia's space activities and the main federal programmes

Several major programmes have been adopted and budgets are increasing. Russia is currently conducting three large civil space programmes:

- the Federal Space Programme 2006-2015, adopted in 2005;
- the Federal Target Programme on the Development of Russia's cosmodromes 2006-2015, adopted in 2005; and
- the Federal Target Programme on GLONASS 2002-2011, adopted in 2001, which received a new impetus when President Putin stated it as a priority programme in 2005.[20]

In addition, after 2007, the civil space budget allocated to the Federal Space Agency is planned to increase by 6% a year. In addition to new programmes and more funding, the spectrum of activities has been widened. In particular, there is a new focus on space-based applications.

Furthermore, the industry is being restructured to increase competitiveness with a stronger involvement of the State create national champions in each major branch (propulsion, launchers, etc.). The plans are ambitious and there are doubts if the sector is actually ready for such a change. The plans had to take into account the 250 000 people employed by all those companies who might be affected by any rationalisation scheme. In addition, structural issues in the sector might not be solved with the planned restructuring, especially if the holding activities are exclusively space-related and not diversified into other fields.[20]

Reality might prevent the Russian leadership from achieving its ambitious goals, at least in the short to medium term. Despite the rising tendency, the Russian space budget remains low in a country where, like in many others, the sector strongly depends on public money.
As detailed in Table 1, Roscosmos' budget is more than 13 times lower than NASA's budget and one-third of ESA's budget in value at current exchange rates. However, Roscosmos has a quite significant budget as a percentage of the GDP, comparable to the one of NASA.

Country – Space Agency	2007 Budget of the Agency (in billion €)	Budget (in % of GDP)
USA - NASA	12	0.12%
Europe - ESA	2.9	0,02%
France - CNES	1.8*	0.09%
Japan - JAXA	1.1	0.05%
Germany - DLR	1*	0.04%
Russia - Roscosmos	0.9	0.12%
Italy - ASI	0.8*	0.05%

** including contribution to ESA*

Table 1: Budget of the main space agencies

The Russian space sector also lacks state-of-the-art technologies in critical fields, including payloads for Earth Observation (EO) and telecommunications satellites, electronics, avionics and computers. As a result, Russian companies are not as important suppliers on the satellite commercial market as they are for instance on the launchers market.[20] Finally, a major challenge to Russia's future space activities is human resources. First, a whole generation of experts of the early space age has retired. In addition, the "brain drain" - internal and external - has led to a lack of experts in their forties to fifties who would be needed to train the next generation and the younger generations are no longer attracted by space science and engineering careers.

2.2. Impact of Russia's evolution on its space cooperation

The new situation of the space field in Russia has led to an evolution of its cooperation with foreign partners.

Russia remains very open to international cooperation in its space programmes. Russia has demonstrated the importance it gives to meeting its international commitments, even during difficult times, as shown by the example of the International Space Station (ISS). Cooperation enables partners to share costs, but in Russia's case, a key element is that it makes its programmes more stable and ensures national funding and a certain degree of continuity in activities.

The role of space agencies is essential to the development of such cooperation, especially in Russia, where international cooperation generally takes place within the framework of intergovernmental agreements and is always overseen by the Federal Space Agency. The Federal Space Agency also implements some cooperation activities itself.

Moscow's eagerness to reaffirm sovereignty in its foreign policy[18] can also be seen in the space field. As the space sector regains credibility, the Russian leadership wants international partnerships to better reflect Russia's national interests and priorities. It also uses space as a foreign policy tool, especially to affirm the country's regained power and influence.
Moscow wants to use its new position to derive more benefits from its partnerships and expects the terms of its cooperation to be better balanced than in the past. Russia wants to move away from the "buyer-seller" type of relations adopted in the nineties. For instance, the era of "space tourists" onboard the stations seems to be over and joint research programmes with foreign partners are being established instead. The Russians clearly want to have more control over the terms of their cooperation and to have a real say in the decisions, if not to the leadership. They also want to increase their control on over their original technologies. [21]
Moreover the country's foreign policy is used to serve the objectives of economic and industrial development and modernisation.[18] Cooperation is a way to gain expertise and acquire technologies it lacks today. Russia's technological needs are likely to drive the choice of its international partnerships. New cooperation could also be an impulse for the further development of the space industry and a way to maximise the benefits of investments in the industry.
Last, but not least, as explained in 1.4., Russia is diversifying its international partnerships and this recent move towards multivectoral foreign policy is reflected in its space cooperation as its list of partner in the field grows longer.[20]

Russia's attitude towards its traditional partners in the space field has changed. The United States remains a priority partner, considered as the only one of similar size. However, Russo-American relations have

become mainly commercial and apart from ISS-related experiments, little work is jointly undertaken, especially when compared to the large spectrum of both countries' activities. Europe remains a key partner in space for Russia.

Russia is interested in further developing cooperation with the West, but wants to do it on a more equal footing.[18] As a result, Russian companies have tried to renegotiate commercial agreements made in the nineties with their Western partners.
With the Commonwealth of Independent States (CIS), the relations in the space field are being more clearly defined. On the one hand, Russia is trying to limit its dependence on Ukraine in the overall aerospace and defence field. On the other hand, it has initiated programmes under Russian leadership with Belarus and Kazakhstan.

Russia is looking for new partners for its programmes and markets for its products.[17] For instance, Russia built and launched Iran's first satellite in 2005, the Sina-1 Earth observation satellite. It is helping the Republic of Korea to develop its space programme and, in particular, its own KSLV launcher and launch facilities in Naro. Moreover, the first South Korean astronaut was sent to the ISS in April 2008. Russia is also building and will launch Angola's first telecommunication satellite in 2011. Other cooperation projects include Air Launch: the aircraft from which a rocket will be launched will take off from the Indonesian island of Biak.

South Korea's First Astronaut Yi So-yeon and Russian Cosmonauts Sergei Volkov and Oleg Kononenko before their flight in April 2008 (Credit: Xinhuanet)

A key development is the strengthening of Russia's cooperation with the quickly-rising and emerging space-faring nations, i.e. China and India, and Brazil and South Africa. These countries are likely to develop their space activities quickly and in a sustainable manner and need cooperation to acquire technologies and expertise. Russia transfers technologies and know-how to these partners and does joint work. However, cooperation between Russia and these countries is considered as potentially sensitive in some cases both by domestically and internationally, and issues of technological transfer tend to hinder it.

President V.V. Putin and South African President T.M. Mbeki during the official visit to South Africa of September 2006 (Credit: Kremlin)

3. Cooperation in the triangle Russia-India-China

3.1. What is at stake?

Taken together, the three great EurAsian powers have significant and growing influence in the world. In addition they are developing closer relations with each other. Both tendencies are reflected in the space field.

3.1.1. The significance and rising influence of the three great EurAsian powers

China, India and Russia have formidable human and natural resources together, as well as economic and political weight in the world. Jointly, they represent almost 40% of the global population and will contribute to more than 20% of population growth in the next half century.[22] This last number must be explained though, as the populations of India and China will grow significantly, while Russia's is expected to decrease. They account for more than 25% of the world's GDP[23] and are expected to contribute to more than 40% to global economic growth over the 2006-2020 period. As detailed in Figure 6, Russia, India and China have achieved impressive growth rates over the past years. Even if they are obviously starting from different levels, while Europe and the US are expected to attain an average real GDP growth rate of less than 2.5% and less than 3%, respectively, over the 2006-2020 period, Russia is estimated to post a rate of 3.3%, India 5.9% and China 6%.[24]
In addition, the three countries are nuclear powers and Russia and China are permanent members of the UN Security Council.

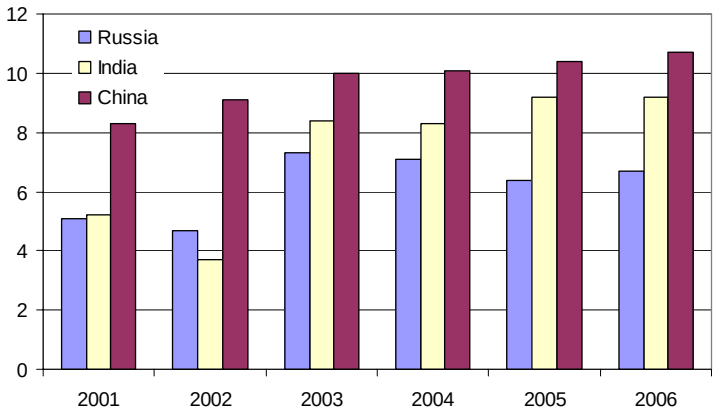


Figure 6: Real GDP growth rates of Russia, India and China (in %) (Source: World Bank)

3.1.2. Growing weight in the space field

The three countries' space activities are gaining importance, reflecting expanding economies and a growing - or reaffirmed - interest in space from their decision-makers, who are aware that space is a strategic asset. Russia has remained a major space power and is gradually recovering after more than a decade of severe crisis. India and China are the fastest growing space-faring nations, both in terms of budgets and activities.

In terms of civil space expenditures, India ranks eighth in civil space budgets with some 600 million euros in 2007, Russia sixth with about 900 million euros and, depending on the estimates, China between second and fourth place with a budget of 1 to 2 billion euros. However, these figures at current prices do not reflect the significant difference in purchasing power to the other countries of these top eight rankings, i.e., the USA, Japan, France, Germany and Italy. Moreover, the Chinese, Indian and Russian budgets are significantly increasing. The Indian budget has risen by 20% in real terms from 2007/2008 to 2008/2009 in comparison to the rather stable budgets of Western countries. In terms of launch activities, Russia, India and China together accounted for 54% of the launches and 57% of the satellite launched in 2007.[25] They also jointly accounted for 38% of the commercial launches in 2007 when India performed its first commercial launch.

The Indian and Chinese space programmes are developing fast. The volume and spectrum of their space activities have significantly increased over the past few years and this tendency is likely to be maintained in the coming decade given their ambitious plans. In 2005, China became the third country to put a man into space. In addition to its "space for development" approach focusing on applications, the Indian programme now includes more "prestige-related" programmes such as exploration and manned spaceflight as

well as "sovereignty-related" programmes that comprise high-resolution Earth Observation (EO) satellites and a satellite navigation system.

Besides raising their budgets and activities, China and India have increased the reliability of their systems, as illustrated by the increasing launch success rates.

The development of the three countries' space programmes means more potential opportunities for cooperation with foreign partners in some areas. In particular, international cooperation could be necessary for them to overcome some technological barriers.

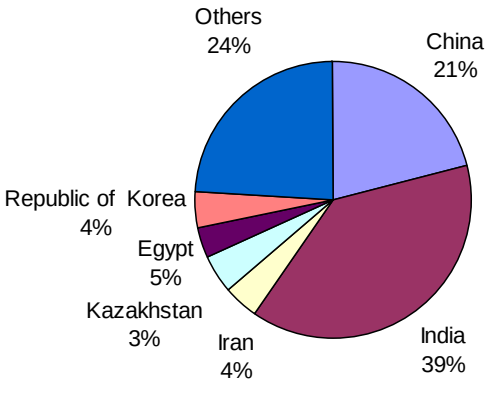
3.1.3. Relations between Russia and the two great rising Asian powers

Russia, which tended to lean westward, is balancing its foreign policy by looking more towards Asia. Moscow's priorities in Asia include national security concerns, the development of trade and Russia's economic and political influence in the region. The relations between Russia and the two great rising Asian powers have become firmer in the past decade, but these are still of very different natures. Russia wants to strengthen its relations with both India and China in order to develop a counterbalance to US hegemony. At the same time Russia shares concerns with India about China's rise.[26]
Strategic cooperation between Russia and its two Asian partners takes place in mainly two fields: energy and defence. Russia is a major energy provider to India and China which needs are growing quickly in order to sustain development. Russia is providing large quantities of oil and gas to India and China and is building nuclear plants in India. Russia is also a major arms and defence equipment provider to India and China. Together India and China have been the two main Russian arms importers, together accounting for 60% of Russia's arms exports in 1997, as illustrated in Figure 7. In 2007, Russia still exported about 50% of its arms to India and China, but China's share has increased while India's has decreased. In 2007, India still imported almost 70% of its arms from Russia and China more than 90%.[27] Today, more than 2/3 of the Indian and Chinese military equipment are of Russian origins.[28] When the Soviet Union collapsed, Moscow starting looking for markets to sustain the massive Soviet military-industrial complex[29] and turned to China and India for economic and national security reasons, at a time when American sanctions prevented arms sales to India and China.[26]

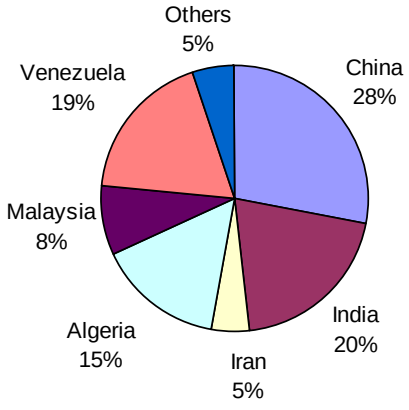
3.2. Russia and China: complex and cautious relations

3.2.1. The broader context of cooperation between Russia and China

In the past twenty years, the complex relations between Russia and China were resumed and have gradually normalised. The Sino-Soviet relations were suspended for more than a quarter of a century after the split of 1960 and until the visit of President M.S. Gorbachev in May 1989, which symbolised a new start in their relations. In



1997
Total amount ~3 billion constant dollars 1990



2007
Total amount ~4.6 billion constant dollars 1990

Figure 7: Russian arms importers in 1997 and 2007[27]

1991, the two countries started addressing their border dispute by signing the Sino-Russian Border Agreement. Their relations gradually evolved from a "constructive partnership", as declared in 1994, to a "strategic partnership" in 1996. However, the actual definition of such partnerships has remained vague and their contents limited.[30] Their improved relations have led to the creation of the Shanghai Cooperation Organisation in 1996 - in replacement of the Shanghai Five[31] - and to the signature of a "Treaty of Good Neighbourliness, Friendship and Cooperation" in July 2001. In August 2005, they held their first joint military exercises in the Yellow Sea.

In the past few years, both countries have focused less on their differences than on pragmatic rationales for cooperation.[32] As regards the economy, trade between Russia and China has significantly grown in the last decade and this tendency has accelerated in the past years. Their foreign trade turnover expanded fivefold from 1995 until 2005 and by twofold between 2005 and 2007.[33] Today, China is the third trade partner of Russia and Russia is the sixth trade partner of China.[34] The trade balance is in favour of China, which exports 60% more to Russia in value than Russia exports to China. Russia exports mainly natural resources and arms to China. In the defence field, however, Russia remains very cautious as it perceives China to be a potential threat. As a consequence, Russia tries to keep a technological lead despite China's demand for more advanced technology transfers.[32]

The two countries have similar views on the need for a multipolar world and share concerns over NATO's eastward expansion, the US pre-emptive strike strategy and the possible deployment of the US missile defence system in Asia.[35] In this context, cooperation can enhance the international standing of both countries.[28] China's cooperation with Russia today is driven mainly both by its willingness to become integrated politically and economically at the international level and by the sanctions it experiences with American policies, for instance, on arms sales or on launch services. On the other hand, Russia wants to develop cooperation with China further, because of great economic opportunities of the Chinese market with today's limited competition and as a way to mitigate the influence of the US in the region. Nevertheless, as mentioned above, Russia remains careful in its relations with China, as it perceives in it a real threat to its economic and political interests. Another issue of concern for Russia is its sparsely-populated, resource-rich region in the Far-East, where Moscow has lost a great deal of control and the Chinese influence is growing and could challenge this control.[36]

3.2.2. China and space [37,38]

China started its missile programme with the help of the Soviet Union in the 50ies and launched its first DF-1 missile in 1960. In 1970, China became the fifth country to put a satellite into orbit, with the launch of its first satellite, the DFH-1. Since then, China has developed its own launchers, in particular, the Long March series, which has yielded more than a dozen versions thus far. Between 1970 and 2007, China has launched 104 Long March, with no launcher failure since August 1996 except from a partial failure in August 1997. This represents 62 successive successful launches between August 1996 and December 2007.[39,40] China is also working on new launchers, especially on the small launch vehicle KT (KaiTuozhe).
The US has had a tremendous impact on Chinese commercial launch services. After the Loral/Hugues affair and the Cox report in 1999, the US basically prevented China from launching foreign satellites, because since then, it has not granted any export license that would allow satellites carrying US components to be launched from China. The only exceptions were ITAR-free satellites built by Thales Alenia Space.

China has three main launching sites in Jiuquan (Gansu province) for all kind of missions including manned missions, Xichang (Sichuan province) for launches to GEO and Taiyuan (Shanxi province) for launches to polar orbit. A fourth and southernmost launch site will be built in Wenchang (Hainan province).
China has developed and launched about a hundred civil satellites in six main series: FSH (Fanhui Shi Wexing) recoverable remote-sensing satellites, DFH (DongFangHong) telecommunications satellites, FY (FengYun) meteorological satellites, SJ (ShiJian) scientific satellites, and ZY (ZiYuan) Earth resources satellites and Haiyang oceanographic satellites. The dual-purpose Beidou navigation satellites must also be added.
China has a manned spaceflight programme and was the third country to launch a man on the Shenzhou spacecraft in October 2003. It also has an exploration programme, including its first mission to the Moon Change'1, launched in 2007.
China's space activities are characterised by the multiplicity of stakeholders and their limited and uncertain coordination, which also impacts its cooperation in the field.

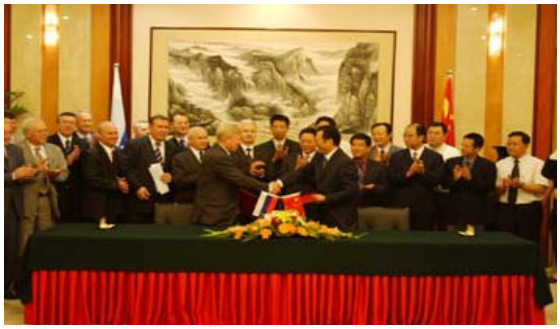
According to the 2006 White Paper[41], China has ambitious plans for the future development of its space activities, which in the medium-term include the development of a new launcher, a high-resolution EO system (including work on small satellites) and a satellite telecommunications system, and the completion of its Beidou/Compass navigation system. China will also continue investing in manned spaceflight with EVA operations - a first spacewalk is planned for late 2008 - and research on space laboratories, and it will pursue its Moon and Mars exploration effort, with the Change'2 mission planned for 2009.[41] Lastly, China is developing its military space activities, and even if its achievements are limited thus far, they have caught serious attention, as demonstrated with the ASAT test of January 2007.

The rationales for China's space activities are economic, scientific, technological and social, i.e., the cohesive dimension of space. Space is also associated with national prestige and address national security concerns. China applies its policy independence and self-reliance to its space activities, but wants to actively engage in international cooperation.[41] Such cooperation is driven by its technological needs and financial issues.
China cooperates with Russia and Europe: with ESA on Double Star for magnetospheric research and Dragon Earth Observation application programme; with the EC on Galileo. The main purpose is to develop the spectrum of its activities and learn. China also created the Asia-Pacific Space Cooperation Organisation (APSCO) and cooperates with its members. Lastly, China also cooperates with developing countries under its leadership for commercial and strategic reasons, as it does with Brazil on the remote-sensing CBERS satellites programme.

Signing ceremony of the APSCO Convention in Beijing in October 2005 (Credit: APSCO)

3.2.3. Cooperation in space

Sino-Russian cooperation has been central to the development of China's space programme. Cooperation between the Soviet Union and China started in the 50ies, at a very early stage of the space age. The Soviet Union delivered missiles and technical documents to the Chinese from 1956 on. It allowed China to develop its own version of the R-2 missile, the DF-1 whose maiden flight took place in November 1960. After the Sino-Soviet split in August 1960, cooperation was suspended until the early 90ies.
It was restored on the collapse of the Soviet Union. At the time, China needed technology to sustain its progress and had gained self-confidence in its capabilities.[42] Since then, cooperation has taken place in the field of manned spaceflight which led to the 2005 first "taikonaut" flight. But the relations in this field were mainly of a buyer-seller nature. It is remarkable to note that the Chinese received training at Star City to become or train taikonauts, but no Chinese ever flew with the Russians as "passenger". Further cooperation might take place in manned spaceflight but still on a similar type of approach.
A joint sub-committee on space cooperation of the committee for the regular meeting between the Chinese and Russian Prime Ministers was established in 2000 and has met regularly ever since. Within the framework of this sub-committee, two multiannual cooperation agreements were adopted, a first five-year one from 2001 until 2006 and a second ten-year one running from 2007 until 2016. From 2005 on, plans for cooperation on Moon and Mars missions were announced, in particular, for the Russian mission Phobos-Grunt (with a Chinese lander onboard) as well as on deep space exploration missions with the Russian missions Spektr-UF (now also known as WSO/UV) and Radioastron. In the field of science, cooperation evolves and shows a tendency towards joint missions, a qualitative evolution compared to cooperation in the field of manned spaceflight and launchers.
In addition, Roscosmos opened a representation office in Beijing in April 2008 and the CNSA is setting up an office in Moscow.
The main field of future cooperation is exploration, whether of Moon and Mars or of the deep space.



CNSA Administrator Sun Laiyan and A.N. Perminov during the 6th meeting of the Russo-Chinese subcommittee on space in June 2005 (Credit: CNSA)

Moreover, Russia and China have taken a common position on the non-weaponisation of space, and after a first joint proposal in 2002, they jointly submitted a draft Treaty on the Prevention of the Placement of Weapons in Outer Space to the Conference on Disarmament in Geneva in February 2008.[43] This action is an example of how Russia and China work together to promote their international positions and to oppose the US.

China's Ambassador to the United Nations Li Baodong and Russia's Minister of Foreign Affairs Sergei Lavrov during the Conference on Disarmament in February 2008 (Credit: News Hour Extra)

Thus far, both countries remain unwilling to talk openly about their cooperation, which is likely to remain limited especially as Russia want to keep its technological lead with respect to China. Russian concerns with China are highlighted by the prominent example of Igor Reshetin's prosecution for transferring classified space-related information to China.[44] Today, all cooperation activities with China go through a special internal procedure in order to be approved by different authorities.

3.3. Russia and India: enduring but non-exclusive relations

3.3.1. The broader context of cooperation between Russia and India

Cooperation between the Soviet Union and India formally started in 1962. For more than 40 years, their relation has been one of mutual trust and confidence[31] and has developed into a "strategic partnership" in 2000.[45] Their good and stable relations stems from the compatibility of their geopolitical and strategic interests, both at regional and international levels.[31,46] Russia's strategic interests are consistent with a stronger India, which could offer markets opportunities for its industrial complex and offset the growing power of China.[47] Strengthened relations with India could help Russia increasing its influence in Asia. On the other hand, India recalls that it received from the Soviet Union, and then Russia, extremely valuable political and diplomatic support on key issues. Russia is crucial in India's diversified international partnerships and sources of energy. India remains interested in Russian military equipment and looks for Russian support to get a permanent seat at the UN Security Council.[48] Still, India wants to keep its independence and its relations with Russia are not exclusive.

India's Prime Minister Manmohan Singh and President A.P.J. Abdul Kalam and Russian President Vladimir V. Putin during an official visit in New Delhi in January 2007 (Credit: GettyImages)

Cooperation between Russia and India takes place mainly in the fields of energy and defence.[49,48] In the energy field, Russia has provided India with nuclear reactors and fuel when India was denied technologies and sanctioned by the West because of its refusal in 1968 to sign the Nuclear Non-Proliferation Treaty (NPT).[50] Russian companies are currently building a nuclear power plant in Kudankulam (Tamil Nadu state). In addition, today India imports 60% to 70% of its oil and gas from Russia and is expected to become the third-largest importer of energy by 2025, with 90% of its supply being imported.[51] Those needs have therefore become a major driver of India's foreign policy. In Russia, India is investing heavily in the Sakhalin Island oil and gas deposits. In the defence field, the Indo-Russian relations have qualitatively evolved from buyer-seller relations to technology transfers and joint developments of defence systems (i.a. the BrahMos missile system)[52] and in December 1998, they extended their long-term agreement on military technical cooperation until 2010.[49]

Apart from these two strategic fields, the scope of cooperation remains limited though. The level of trade between Russia and India is still low with a turnover of 5.3 billion dollars in 2007 - to be compared with 40.3 billion dollars between Russia and China or 52 billion dollars between Russia and

Germany -, but in 2006 they defined a bilateral trade target together of 10 billion dollars by 2010.[53]

India remains a far more acceptable partner for Russia than China, as it is not perceived as a potential threat and it currently enjoys from a better image on the international scene and appears more advanced technologically.[54] Thus, Russia tends to go further in its cooperation with India, as illustrated in the defence field. Russia has actually played a critical role in the military technology balance between India and China.[54] Nevertheless, the Russian-Indian relations, unlike the Sino-Russian relations, are likely to be strongly influenced by the evolution of the US-India and US-Russia relations.[26,30] In recent years, in the aftermath of 9/11, the US has actually moved to strengthen military, economic and diplomatic ties with India after a freeze in their relations following the Indian nuclear tests in 1998.[31] This tendency is illustrated by the visit to India of President G.W. Bush in March 2006 and by the controversial US-India civil nuclear cooperation agreement.

3.3.2. India and space

The Indian space programme started in the 60ies with the establishment of the Thumba Equatorial Sounding Rocket Launching Station (TERLS) by the Indian Committee for Space Research (INCOSPAR). The first sounding rocket, an American Nike-Apache, was launched from Thumba in November 1963. The first Indian Rohini sounding rocket was launched from there in 1967. In 1969, the India Space Research Organisation (ISRO) was created under the Department of Atomic Energy and given the responsibility to conduct the country's space research. The Department of Space was then created in 1972 to manage all Indian space activities and ISRO was brought under its responsibility. India subsequently developed its own launch vehicles: the SLV-3 first launched in August 1979 and last launched in April 1983; the ASLV first launched in March 1987 and last launched in May 1994; currently in use, the PSLV first launched in September 1993 and the GSLV first launched in April 2001. Since 1999, India has launched on PSLV foreign satellites including satellites from Germany, the Republic of Korea, Belgium, Indonesia, Argentina and Italy.
The first space activities developed in India corresponded to the vision of Dr. Vikram Sarabhai. India was to be second to none in bringing the benefits of space to citizens. India has therefore initially focused on the development of space-based applications that would address its citizens' needs.

India launched its first satellite, Aryabhata on a Soviet Cosmos rocket in April 1975. About 50 Indian satellites have been launched since then. Today, the Indian space programme includes a strong Earth observation programme with a recent transition from multi-purpose satellites to dedicated satellites like Oceansat or Cartosat. India also has a telecommunications programme with the satellites of the INSAT and GSAT series. Meteorological instruments used to be onboard the INSAT telecom satellites, but dedicated meteorological missions are now being undertaken since Kalpana 1 in 2002.
India is leader in the use of space-based capabilities for development and has developed many application programmes. It uses satellite communications for unique programmes in tele-education, tele-medicine, and for its village resource centres.

In the navigation field, India has implemented its GPS augmentation system, GAGAN, and is developing its own regional navigation system in addition to future cooperation on the GLONASS system and the interest it demonstrated for the Galileo system.

The Indian space programme has now transitioned from its initial "space for development approach" to more prestige-related programmes. Those include exploration missions, like the Moon probes Chandrayaan-1 and -2, and manned space flight activities like the Space Recovery Experiment (SRE).

In India, all space activities are managed by a unique organisation ISRO and commercialised by a single company, Antrix Corporation.

3.3.3. Cooperation in space

Russia and India started cooperating in the 70ies when the Soviet Union launched the first Indian satellites. In 1984 the first, and so far only, Indian cosmonaut, Rakesh Sharma, flew onboard the Salyut 7 station as part of the Intercosmos programme. One should bear in mind that India has been quite unique in the development of its space activities based on Russian, US and European technologies since the 60ies.[17]

India and Russia have cooperated in the field of launchers. In 1993, Russia agreed to transfer the technology of the KVD-1 cryo-engine to India, to be later flown as the GSLV upper stage. However the Russians pulled out of the deal under US pressures at a time when the negotiations for the ISS were ongoing. A new agreement was signed in

1994 in which Russia agreed to sell three, later renegotiated to seven, KVD-1 engines without the technology, but the problem gave Russia the image of unreliable partner. Since then, 4 GSLV launches took place in 2001, 2003, 2004 and 2006 with the engines built in Russia. In the meantime, India has developed its own cryo-engine which will be flown on the GSLV Mark III for the first time in 2008. Russia and India are still working together on launchers but since India started commercial flights with its PSLV launcher in 1999 and is progressing on the commercial launch services market with its indigenous capacities, future cooperation on commercial launchers is likely to remain limited. Both countries will become competitors in that market.

A second area of cooperation is navigation, with several cooperation agreements on GLONASS being signed since 2005. These include Indian launches of GLONASS-M satellites onboard GSLV, joint development of the future GLONASS-K satellites and of users' equipment. India is thus far the unique foreign partner in GLONASS at this level. For Russia, cooperating on GLONASS demonstrates its openness and interest in the Indian market. At the same time, India is also developing its own regional navigation system, the 7-satellite constellation Indian Regional Navigational Satellite System (IRNSS) approved by the Indian government in May 2006, and is participating in the Galileo programme.

A third, and more recent, area of cooperation is science, and especially Moon exploration, with an Indian payload onboard the Russian Coronas-Photon mission and Russian participation in the Indian second lunar mission, Chandrayaan 2.

India is also using Russian ground stations. For instance, India contributed to the refurbishment of the 64-meter antenna in Bearslake, Russia, to support its Chandrayaan-1 mission.[55]

Finally, India joined the international telecommunication satellite operator Intersputnik in 2000.

India and Russia are likely to further cooperate on manned spaceflight and exploration, as India turns to more prestige-related activities. India is starting its manned spaceflight programme and has approached Russia for help with training an astronaut and sending him/her into space onboard a Soyuz spacecraft.[56,57] It has also expressed an interest in participating in the development of a new Russian manned spacecraft.[55] Russia does not really need to cooperate on those programmes to achieve its own objectives; the reasons for cooperation might therefore be of a political and strategic nature.

Indo-Russian cooperation has been and remains hindered by Western constraints. As mentioned above, political pressures from the US prevented the initial KVD-1 transaction. More recently, export control restrictions put on Indian satellites integrating US and European licensed components prevent them from being launched by Russia and hinder cooperation on joint missions.[21]

3.4. A strategic triangle Russia-India-China?

3.4.1. The broader context of a strategic triangle

Since the late 90ies, Russia has pushed for establishment of a Russia-India-China alliance. During a visit to India in 1998, the Russian former Prime Minister Y.M. Primakov put forward the concept of a strategic triangle to ensure regional peace and stability, but this idea was not supported by the two others.[31,29,58] The Russian interest in a strong trilateral cooperation was further stated in an official foreign policy document of the Russian Ministry of Foreign Affairs in March 2007 that recommended to "keep on developing the dialogue and the interactions in the triangle Russia-India-China".[59]

Presidents Hu Jintao and Vladimir V. Putin and Prime Minister Manmohan Signh during a tripartite meeting within the G8 Summit in 2006 (Credit: G8russia)

The three countries have clear common interests and share a vision of a more just and fair international order.[60] Together they promote the concept of a multi-polar world, but deny that it is directed against any third state, i.e. without targeting the United States.[61] This concept of a more balanced world order supported by the three countries is particularly attractive to developing countries, in particular in Africa. Given their combined political, economic and

demographic weights, such an alliance could obviously counterbalance the US influence in the region and its hegemony since the collapse of the Soviet Union, but India and China are clearly not as keen as Russia to challenge this hegemony and antagonize the US.[62] This triangle has become a reality in the sense that the three countries meet more and more frequently. The first trilateral meeting took place in Moscow in September 2001[46], and since 2002, trilateral meetings of foreign ministers have been taking place annually. However, this triangle concept has become a diplomatic tool used by Russia and China when necessary, but is unlikely to materialise as a real alliance.[63] In particular, this united front cannot become a substitute to their bilateral relations with the United States. Until now, the three countries have developed stronger ties with the US than any of them has with one of the others.[64] In addition, India is unlikely to develop alliances at the expense of its relations with other partners. In line with the country's tradition of non-alignment, Indian leaders want to avoid alliances that can be detrimental to its relations with other partners and to its strategic independence.

The main challenge to this strategic alliance is the relations between India and China.[65] Even though their relations have recently normalised and steadily improved, there are still important issues of trust between India and China and a lack of knowledge of each other. After India's defeat during the 1962 border war, Sino-Indian relations were unfriendly. After the mid-70ies, there have been ups and downs in their relations, which remain tense. The tension between the two countries reached new heights in the late 90ies with India's concern over the Chinese transfer of nuclear and weapon technologies to Pakistan and the Indian nuclear tests in 1998. Since then, their relations have gradually normalised as demonstrated by the joint declarations of the countries' Prime Ministers since 2003 – the one in 2003 was the first ever – and more recently with the joint military exercises in Kunming (Yunnan province) in 2007. The two countries have common interests that will gradually lead them to improve their relations. From a political and diplomatic perspective, both countries support the idea of a multi-polar world in which their independence and sovereignty are respected. Social and economic factors come then into play. Both countries have their own development as ultimate priority and want to develop their economy in today's globalised environment, which includes accessing foreign markets. Reaching those objectives requires a stable and peaceful environment and the avoidance of conflicts with their neighbours.[66] As stated by the Indian Minister of External Affairs Shri Pranab Mukherjee in 2006, India has "to promote an environment of peace and security in the region and beyond, which indeed is a pre-requisite for development."[67]

The two largest developing countries are trying to define their role in Asia and in the world given their growing influence in the global economy and affairs[32] and perceive each other as a potential threat to their interests and ambitions. The situation is first of all asymmetric, both in economic terms, as India's GDP is less than half of China's, and in military terms, as China's strategic assets, i.e. ICBMs and nuclear warheads, are unequalled by India's.[68] Both countries compete to attract foreign investments, but in 2007 China still attracted almost twice the volume of FDI that India attracted. As a result, until recently China has demonstrated a relative lack of interest for India.[63] However, India's economic and technological development as well as its population, which will overtake China's before 2050, but will be also be much younger than China's, are becoming sources of concern for China. To China, India is becoming too assertive and too pro-Western, especially as it improves its relations with the United States.[68] On the other hand, India is still concerned about China's support to Pakistan in the area of strategic weapons since 2002 and perceives China as a serious threat, as it tries to expand its influence in South Asia. Two other key issues in their relations are Tibet and their border dispute for which today there is no momentum for any solution.[63] Their economic ties are strengthening and cooperation is increasing.[32] However, their cooperation is likely to remain limited, especially as it is less of a priority than their cooperation with major powers,[69] and competition will durably underpin their relations.[65,70] This duality is reflected in the energy area in which they sometimes cooperate on commercial projects on foreign grounds, including Central Asia and Africa, but in which they also fiercely compete for contracts.[71]

3.4.2. Cooperation in space

A triangular cooperation in space seems unlikely in the near future, as the Indian and Chinese programmes are developing in parallel along similar avenues. India and China have neither particular needs nor real opportunities to work together on space projects. Furthermore, it might not be in Russia's interest to promote cooperation between those two countries. Russia greatly benefits from its current bilateral relations

with India and China and might not be eager to bring its two partners closer.

4. Consequences for Europe and its cooperation with Russia

Since the nineties, the Russian partner has changed and is still changing. It has diversified its partnerships and strengthened its ties with old and new partners. At the same time, cooperation with both Europe and some European countries has intensified. This changing context is reflected in the space field, in which Europe and Russia have further structured and increased their cooperation, while Russia has developed -or re-developped - cooperation with the two fastest-growing space-faring nations, India and China. In this context, some Europeans are advocating closer cooperation[72] with Russia and even for a joint strategy for the future of their space activities. To which extent will Russia's stronger cooperation with the two great rising Asian powers affect cooperation between Europe and Russia?

4.1. Russia and Europe: long-lasting relations with ups and downs

4.1.1. The broader context of cooperation between Russia and Europe

Russia is Europe's largest neighbour and one of its main partners. In the past decades, the relationship between Europe and Russia evolved from one of reciprocal hostility during the Cold War to a partnership. Each side is working towards strengthening the partnership, even though their relations have not met each partner's expectations and Russia's recent evolution is transforming them. Each has become a priority partner for the other and their relations are well-developed and well-structured today.

In addition to the well-developed bilateral relations with some of the European Union (EU) Member States, Russia has developed strong relations with the EU. The basis for EU-Russia relations is the Partnership and Cooperation Agreement (PCA) that came into force in December 1997 for an initial duration of 10 years, which will be automatically extended beyond 2007 on an annual basis (see current issues below). It establishes the framework for regular consultations between both parties, including bi-annual summits of heads of states and governments, including the European Commission (EC) President, the Head of the EU Presidency and the Russian President.
In May 2003, during the Saint Petersburg Summit, both partners decided to reinforce their partnership in the framework of the PCA by creating four "common spaces":

- a Common Economic Space – to establish an open and integrated market between the EU and Russia;
- a Common Space of Freedom, Security and Justice – to facilitate ease of movement between EU and Russia within a context free of terrorist threat, organised crime and corruption;
- a Common Space of External Security - to cooperate on security and crisis management in order to address global and regional challenges;
- a Common Space of Research and Education – to create and reinforce bonds between the EU and Russian research and education communities.

In May 2005, the Moscow Summit adopted objectives and roadmaps for the implementation of those common spaces. In these roadmaps, space is mentioned several times as detailed in the Annex E.

José Manuel Barroso, President of the European Commission, Vladimir V. Putin, and José Socrates, President of the European Council, during the EU-Russia Summit in Portugal in 2007 (Credit: Portuguese Presidency of the EU)

In addition, Russia is a member of the Council of Europe and of the Organisation for Security and Cooperation in Europe (OSCE).

Russia and the EU are also key economic partners and have become very interdependent. Trade between Russia and the EU has significantly increased over the past decade. Between 2000 and 2006, in a gradual way, EU's exports to Russia more than tripled and imports from Russia more than doubled.[73] But trade figures show a clear asymmetry. In 2007, the EU27 represented more than 55% of Russia's exports and 44% of Russia's imports.[74] On the other hand, in 2006 Russia represented 10% of the EU25 imports and 6.2% of its exports. Then, while Russia mainly imports manufactured products from the EU, which accounted for more than 70% of Russia's imports from the EU in 2006, the EU imports mainly energy from Russia, which represents more than 65% of EU's imports in 2006, a percentage that has increased over the past years. Last, but not least, one should also bear in mind that the GDP of the EU27 is 15 times higher than Russia's GDP for a population that is three and a half times larger.

The EU dependence on Russian energy products has to be put into perspective. Russian oil and gas represent 30% and 44% of the EU27 total imports, respectively. But the level of dependence varies greatly within Europe. For instance, Russian gas imports represent the entire Estonian and Finnish gas consumption, but less than 25% of France's one. On the other hand, the EU market is crucial for Russia as it exports more than half of its energy products to Europe.

The main EU interests in Russia include fostering the political and economic stability of the country and maintaining a stable supply of energy.

From 1991 until 2006, some 2.7 billion euros in assistance were provided to Russia within the framework of the programme of Technical Assistance to the Commonwealth of Independent States (TACIS), which was designed to enhance the transition process towards market economy and democracy in countries of Eastern Europe and Central Asia. TACIS has been the biggest programme of assistance to the Russian Federation.[75] TACIS ended in 2006 and an EU-Russia programme of financial cooperation, to be funded by both parties is currently being put in place to strengthen the strategic partnership, focusing mainly on the four common spaces, and funded by the Union through the European Neighbourhood and Partnership Instrument (ENPI), even though Russia is not part of the European Neighbourhood Policy (ENP).

A key determinant in the development of the relations between the EU and Russia will be the position of some of new EU Member States, especially Poland and Lithuania, which have been quite critical towards Russia and EU-Russia cooperation.[76] It was clearly illustrated by their blocking of the talks on the replacement of the initial PCA.[77]

4.1.2. Consequences for Europe of Russia's more balanced foreign policy

The Russian leadership has adopted a more confident posture on the international scene and openly criticised the West and Europe, for instance on NATO's expansion or on the establishment of US missile defence infrastructure in Europe. This willingness to defend national interests even if it goes against European ones has alarmed some Europeans and led to an unfavourable political context to develop space cooperation. At the same time, Moscow has reinforced its relations with other partners, in the Middle East, Africa and in particular Asia, where it is trying to regain a leading position. The diversification of Russia's partnerships could be beneficial to European-Russian relations and give them a sounder basis, as Moscow has not shown less interest in Europe while balancing its foreign policy.[17]

4.2. Cooperation in space

4.2.1. Europe-Russia cooperation in space

Europe and Russia have a long history of cooperation in space. European countries and the Soviet Union - then Russia - have cooperated in space for more than 40 years, first at the national level and later at the European level. From the sixties on, the German Democratic Republic and some of the new EU member States participated in the Intercosmos and Intersputnik programmes. Despite the Cold War, scientific cooperation started between Russia and France with a first agreement in 1966. At the European level, cooperation between ESA and Russia started in the nineties and since then it has developed into a strategic partnership. Cooperation started in space science, was then extended to manned spaceflight and more recently to launchers.

Space cooperation between Europe and Russia takes place at various levels and in different frameworks.
At national levels, Russia has intergovernmental and interagency agreements, as well as joint working groups and specific activities with many EU member states. At the European level, cooperation takes place between Russia, ESA and the EC. Cooperation between ESA and Russia started in 1991 with a first Framework Agreement on Cooperation. It enabled joint activities, in particular, in manned spaceflight. ESA established a permanent mission in Russia in 1995. The first cooperation agreement was followed in February 2003 by the signing of an Agreement on Cooperation and Partnership in the Exploration and Use of Outer Space for Peaceful Purposes. The Russian Federation has become one of ESA's major partners.

The European Commission's involvement in space cooperation with Russia started in the late nineties. In December 2001, the EC, ESA and Rosaviacosmos signed a joint memorandum "New Opportunities for a Euro-Russian Space Partnership" proposing the establishment of a long-term partnership between Russia and Europe in the fields of launchers, satellite navigation and GMES. It was followed by an EU-Russia joint statement[78] on space cooperation in May 2002 and by a joint workshop in January 2003 to promote it.[79] Within the framework of the Common Economic Space, a tripartite dialogue on space cooperation between ESA, the EC and Roscosmos was established in March 2006 to strengthen cooperation in the fields of Earth observation, satellite navigation, satellite telecommunications, access to space, space science, and space technology developments. Seven joint working groups were created to work on common initiatives which are to take place mainly through ESA programmes, the EU Framework Programmes and Russia's space programme.[80]
Those intergovernmental and interagency agreements at the national and European levels give a framework to the cooperation between European and Russian companies and research institutes.

Russia and Europe cooperate today mainly in four fields:[81]

- Launchers and launch services

Cooperation takes place for the commercialisation of Russian launchers through Euro-Russian joint ventures. In addition, Europe launches some of its missions on Russian launchers. Russia and Europe also cooperate on the development of new launchers. For instance Russia is involved in the development of a third stage booster for Vega.

- Satellite telecommunications

The cooperation on telecommunications takes place directly between companies. European companies typically provide their Russian counterpart with payloads and systems for the platform of satellites intended for the Russian market and to be launched on Russian launchers. Thales Alenia Space has been working with NPO PM for 15 years and with Khrunichev. Astrium is also working with Khrunichev in this field.

- Manned spaceflight

Cooperation in manned spaceflight started in 1994 with EuroMir and missions of European astronauts onboard Mir. Russia and Europe have then cooperated on missions of European astronauts onboard the ISS for the launch to, return from and use of the Russian ISS segment. Those missions included a complete programme of scientific and technological experiments conducted in the ISS Russian segment. Russia contributed to the development of the ATV, in particular, to the design of the docking system. Europe provided the central data management system of the ISS Russian Service Module and should provide the European Robotic Arm to be used in the assembly and servicing of the ISS Russian segment. In addition, joint research is conducted on microgravity with Foton spacecraft and on biology and medicine with Bion missions, which might resume in the close future.[82]

- Science and exploration missions

Cooperation is ongoing on the European missions Integral, Mars Express and Venus Express and on the future mission BepiColombo.

Cooperating with Europe in the field of telecommunication satellites illustrates the fact that Russians are lacking state-of-the-art technologies for satellites and in order to get them they are buying them abroad and developing cooperation with European partners. In addition, cooperation is particularly developed in the field of telecommunications compared to other fields where Russians might need state-of-the-art technologies as it tends to be less problematic than in the field of remote sensing satellites, where export restrictions hinder cooperation with some European countries. On the other hand, launchers and manned spaceflight are the strongest assets of Russia's space activities and cooperation in those fields is crucial to Europe and is set up as a win-win situation.

4.2.2. Impact of the evolution of Russia's relations with India and China

Russia's cooperation in space is driven by several rationales including:

- Foreign policy objectives

Space is being used as a foreign policy tool for political and strategic purposes

- Domestic policy objectives

International cooperation helps secure national funding for space programmes and increases the stability and continuity of national space activities.

- Funding needs

Russia's ability to fund its space activities has drastically improved, but its plans are also very ambitious. Therefore cooperation is also an important source of funding for joint activities.

- Technological needs

Russia can improve the performance of its systems and access state-of-the-art technologies by buying from - but also - by further cooperating with foreign partners.

Russia's various partnerships are driven by different rationales among the ones listed above.
Russia is diversifying its partnerships in the space field, but thus far without showing less interest in Europe. Its new partnerships might be complementary or substitutive to existing or future ones with Europe
Some of Russia's partnerships are complementary to the ones with Europe and beneficial to Europe. These include ISS activities or scientific missions with other partners.
Other partnerships are dissociated from the ones with Europe, but do impact Europe's market and attractiveness. For instance, Russia's cooperation with African countries, like South Africa or Angola, are examples of cooperation which tend to limit the interest of those countries in working with Europe. Furthermore, the establishment of joint ventures with the US and Russia's cooperation with China, and then India, on launchers have clearly impacted the launch services market and will do so even more in the future.
Europe will remain a valuable source of technology, capital and management know-how for Russia[18] as well as a market and an access to other markets. One can therefore expect cooperation in some fields like telecommunication satellites or launch services to be quite stable over the medium term.

However, in some areas, Russia today has - and shows it has - other alternatives than Europe. Discussions with other partners, like Chinese or Indians, offers Russia more options and demonstrates to Europe that it has other possibilities for them as well. This is the case in manned spaceflight, for instance, where joint work with the Indians is being discussed and in the area of electronics which could be provided to Russia by the Republic of Korea or India.
One should also bear in mind that cooperation has a cost and is resource-consuming, and priorities have to be defined. As a consequence, not all desirable partnerships might actually materialise.

4.3. Opportunities and challenges for Europe in its cooperation with Russia

4.3.1. Opportunities for Europe

Despite internal criticism of agreements between Europe and Russia made in the nineties, Russia's industry and research institutes are interested in working more closely with their European counterparts under certain conditions. The Europeans are perceived as important and reliable partners, with a diversified and attractive offer for Russia and with cooperation being in the interest of both sides.
On the other hand, if Europe does not want to work with them, the Russians now have new alternatives, among the serious ones are China and India. For instance, Europe is involved in the first Russian scientific mission since the Mars 96 failure, but China as well for the first time.

Further cooperation at a time when Russia is launching ambitious plans and upgrading its space capabilities can mean more activities in which Europe could become involved, greater market opportunities for European industry, in particular, new development activities that are very important for some companies, and more learning opportunities in science and in manned spaceflight.

In addition, despite the overall political context that is not so positive, the coming years are certainly a good time to further cooperation. The conditions are favourable for the further development of cooperation; Europe benefits from its achievements with the ATV and Columbus and the relations between the heads of the space agencies are good. Moreover, Russia is now starting new

developments and upgrading its space capabilities. It is a good time to get onboard some of its projects that could help to advance our interests.

4.3.2. Challenges for Europe

There are opportunities, but there are also many challenges for Europe in its cooperation with Russia.

First, the analysis of Europe's cooperation endeavours highlights the broader challenges for Europe at a political level, i.e., the challenges of building a political Europe, of defining a common foreign policy as well as of fully using the potential of space as a political tool. These also impact relations with Russia.
Cooperation initially requires the definition of priorities. The first challenge for Europe is to clearly define and express its interests, priorities and objectives, which necessitates an efficient decision-making process. The current process is perceived as complicated and too slow, but its efficiency and responsiveness could improve with the adoption of the Lisbon Treaty and its new rules for decision-making.
Next, cooperation with Russia requires a political framework and a common understanding. As a prerequisite, European countries need to shape a common policy towards this key partner of the Union, which they have been unable to do satisfactorily up to now as illustrated by the recent difficulties to start the negotiations for the renewal of the PCA. This would strengthen Brussels' negotiating position vis-à-vis Moscow. The adoption of the Lisbon Treaty could improve the coherence and visibility of the EU foreign policy, with the stronger role of the new High Representative of the Union for Foreign Affairs and Security Policy, and could contribute to the definition of a common position towards Russia. However, the overall political context is not propitious to the development of cooperation with Russia. Some of Moscow's moves have neither facilitated the dialogue with Europe nor contributed to improve the public perception of Russia in Europe, and the situation is quite similar on the other side. Those issues contribute to an environment that is not very favourable for developing cooperation in whatever field. The assertiveness of former President Putin has created apprehension or at least concern with the Russian leadership's intentions. An evolution of the political discourse from both sides towards a more constructive approach given the many mutual interests is therefore necessary. Furthermore, there is an apprehension in Russia that because of the European decision-making rules - whether at EU level or at ESA level with an enlarging ESA - some countries might hinder or negatively impact decisions on cooperation with Russia. An important task for all the Union's members will be to facilitate the dialogue and improve the relations between Russia and some of the new EU member States.
Another key challenge of Europe in the space field is to fully exploit the potential of this asset in the political realm. European decision-makers should not focus only on the direct benefits of space programmes for European citizens and industry, but should use space and space policy to fulfil some of Europe's broader objectives. If it wants to develop, Europe should use space as a foreign policy tool to promote its values worldwide and to increase its influence on the global scene. To be able to efficiently use such a tool, Europe needs to be in an advantageous position and have leverage when discussing with its international partners. Remaining "an indispensable international partner providing first-class contributions to global initiatives and exerting leadership", as stated in the European Space Policy adopted in 2007 requires a strong European space, with the necessary political support and resources. In contrast, Russia is effectively using space as a foreign policy tool, for instance in its relations with India and China. Last, to maximise its benefits, Europe could derive full advantage from developing a long-term portfolio of partnerships with Russia rather than a series of one-time agreements.

Second, there are challenges associated with the current European organisation and mechanisms used to implement space cooperation with Russia.
An issue for Europe's international partners is the large number of persons and organisations to interact with and the lack of responsiveness of Europe due to its decision-making process. Responsiveness in international relations means attractiveness. Because of a lack of unity, Russia, like other partners, sometimes prefers to interact bilaterally with a single European country that has clearer priorities and a more efficient decision-making process.
The organisation of space cooperation in Europe has limitations that are clearly revealed in this analysis. First, there is a disconnection between the space agencies, which have implemented cooperation on space programmes, and the EU, which defines the Union's policy towards Russia. The actions of these organisations really need to be coordinated and consistent with a partner like Russia. It would require sharing information between these organisations,

which today seems difficult on some issues. Confidence-building measures could help address this difficulty. Then, even within the European space agencies, cooperation with Russia tends to be undertaken independently for each project or programme. This situation might improve the efficiency of cooperation, but weakens Europe's overall position towards Russia. This is particularly critical with Russia as its decision-process is unique and its space activities are undertaken in a more coordinated way because of the current structure of its space sector. Defining an overall space cooperation strategy would give Europe a better position to negotiate the terms of its cooperation and to propose alternatives to its partner if joint activities do not materialise.

Third, there are difficulties in implementing cooperation associated with language, different business and engineering practices, pricing, different technical standards, issues of export control, technology transfers and intellectual property rights, as well as to a relative lack of transparency. These challenges have not however prevented many past successes. Pre-conditions for cooperation therefore include technology safeguard agreements and harmonisation of business and engineering practices. If the Europeans are to cooperate further with the Russians, there will also be risks associated with technological dependence, which might have an impact on both costs and schedules.

Fourth, given Russia's recent evolution and new expectations, a prerequisite for any future cooperation is that it will have to be set on an equal footing.

Last, there are challenges for Europe more directly linked to Russia's cooperation with India or China. First, those two countries might be preferred to Europe for joint endeavours. Then, the market for European companies in Russia, India and China might decrease, despite an overall increase in activities. Finally, there are risks of undesirable technology transfers to India and China and further on to other countries.
Three areas of potential cooperation require specific and more in-depth analysis:

- Access to space;
- Navigation; and
- Manned spaceflight, science and exploration.

These are the most important fields of cooperation between Russia and Europe and are the ones in which major developments could occur and in which Europe will have to make some decisions in the short- to medium-term. These are successively addressed in the next sections.

4.3.3. Access to Space

For the purpose of this analysis, access to space is divided into launch systems and launch services.

Launch systems

Current launch systems and foreseeable developments

Table 2 summarises the main current launchers per category according to the country of their prime manufacturer. Russian and Ukrainian launch vehicles are presented jointly. The future developments expected worldwide in the short to medium term in this field include:

- In Russia and Ukraine
  - The discontinuation of the launches of systems no longer produced, i.e. Cyclone 3 and Dnepr
  - The replacement of Proton and Rockot by the new launcher Angara
- In the US
  - The qualification and use of new US launchers, in particular "private" ones

Country	USA	Europe	Russia / Ukraine	China	India	Japan
Light LVs	Pegasus Taurus Minotaur	Vega	Dnepr Start Rockot Cosmos 3M Cyclone			
Medium LVs	Delta-II Delta-IVM		Soyuz/Molnya Zenit	Long-March	PSLV GSLV	
Heavy LVs	Atlas-V Delta-IVH Shuttle	Ariane 5	Proton	Long-March		H2A

Table 2: Current Launch Systems

- In India and China
  - The gradual improvement in the performance and reliability of the Indians and Chinese launchers
- In Europe
  - The exploitation of Soyuz from Kourou, French Guyana
  - The advent of the Vega launcher

Artist's View of a Soyuz launch from Kourou Space Centre (Credit:CNES)

Cooperation on launch systems

Cooperation on launchers can take several forms:

- Purchase of systems and components
- Joint technology development
- Joint systems development
- Joint launcher development

The rationales for such cooperation include:

- Technological needs
  - Critical systems
  - Performance improvement
- Funding and cost sharing
- Schedule
- Improving the stability of the programme and of funding

The main ongoing cooperation activities on launchers are summarized in Figure 8. The main cooperation with Russia takes place in the propulsion field with the sale of RD-180 engines to the US, the earlier sales of the KVD-1 engines for the GSLV to the Indians and collaboration with Italy on the Vega upper stage engine.

In addition, Russia and Europe have initiated joint activities under their future launchers development programmes.

The future of European and Russian launchers

The main programmes underway for future launchers' development in Europe and Russia are:

- The Future Launchers Preparatory Programme (FLPP) of ESA
- The joint Oural programme of CNES and Roscosmos
- The Angara programme of Roscosmos

The main objectives of the two first programmes are to prepare the future of European access to space and increase European competitiveness.

The Future Launchers Preparatory Programme (FLPP)
The Future Launchers Preparatory Programme (FLPP), approved by ESA Ministerial Council in 2001, started in February 2004. This ESA programme aims at preparing the development of a new

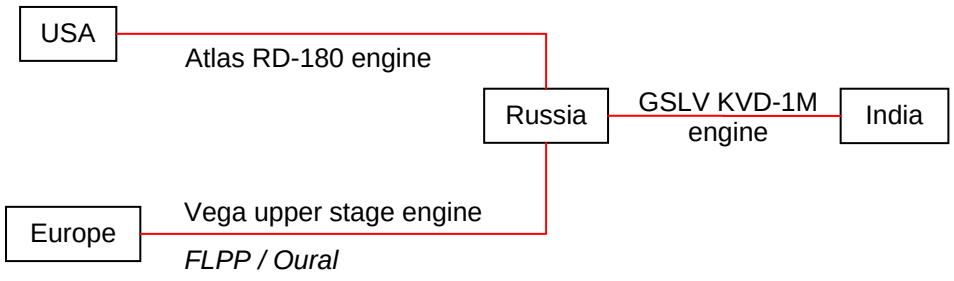


Figure 8: Current cooperation on launchers

generation launch vehicle to be operational in 2020. System studies and technology activities, including ground and in-flight tests, are being conducted to foster innovation in Europe in the launcher field in order to safeguard Europe's guaranteed access to space over the longer term.[83] Cooperation between Europe and Russia is being considered within this programme, especially in the field of propulsion.

The Oural programme

An agreement between CNES and Roscomos was signed in March 2005 to establish the Oural programme. France and Russia agreed to work together on research and technology for the development of future launch vehicles planned to succeed Ariane 5 by 2020.

The Angara programme

The Russian government adopted in August 1995 a resolution to develop a new launcher system, Angara, to replace the heavy launchers Proton. The Angara launchers family is currently under development. Its first version will be launched from Plesetsk and later from the new Vostochny cosmodrome. In the Security Council of April 2008, President Putin gave a new momentum to the programme and declared plans to have the first Angara launches from Plesetsk in 2011, taking into account that Proton has provided good and reliable services since 1965.

There are obvious synergies between the two European programmes and Europe should try to either coordinate both efforts or to integrate benefits of the French-Russian cooperation into a European programme. There are also potential synergies between European and Russian programmes. However, the timeframe of the Russian programme is quite different today, as Europeans are preparing the 2020-2025 period, whereas the new Angara launcher is planned to be launched for the first time in 2011. This difference implies that if Europe wants to work with Russia on new developments, it has to decide to do so in the near future, before the Russians have completed their new developments on the first versions of Angara.

The decision made by Europe to have an independent access to space does prevent the development of a joint launcher to replace Ariane 5, but it allows for joint technology or systems development, as long as European interests are preserved, i.e., no loss of activities or competitiveness for the European industry.

Joint developments still require both sides to address some challenges, including technology safeguard agreements, the coordination by space agencies of the industrial and scientific efforts and the identification of "win-win concepts" that allow industry to collaborate in their mutual interests.

Launch services

Current launch services and foreseeable developments

Table 3 summarises the current launch services providers.

The future developments expected worldwide in the short to medium term in this field are:

- The new Angara launcher
- The improvement of the Indian GSLV performance
- More commercial launches by India
- The new commercial launchers

Cooperation on launch services

The rationales for cooperating on launch services include:

USA	Europe	Russia/Ukraine	China	India	Japan
United Launch Alliance (ULA)	Arianespace	ISC Kosmotras	China Great Wall Industry Corporation	Antrix Corporation	Mitsubishi Heavy Industries
	Starsem Eurockot				
	International Launch Services (ILS)				

Table 3: Current Launch Services Providers

- Complementary systems performance
- Stabilization of the market
- Improve access to market
- Increase competitiveness
- Increase flexibility and responsiveness

Such cooperation can take several forms:

- Purchase of launches
- Back-up agreements between providers
- Joint exploitation
- Joint commercialization

However, cooperation is hindered by security and sovereignty issues on institutional markets and export control restrictions. In addition, in the years to come, competition will become fiercer as more launch service providers enter the market, including some with quite different cost and price structures, whereas the level of demand is bound to remain quite stable.

Current cooperation on launch services

As summarised in Table 3, today there are several joint ventures between Russian and European as well as American partners. These should be quite stable in the medium-term, despite changes in ILS, from which the American partner Lockheed withdrew.
In addition, Arianespace will start the exploitation of the Russian Soyuz in Kourou, French Guyana, with significant performance gains for the Soyuz launcher. This agreement is expected to have a stabilising effect on the market and this joint exploitation is supportive for facing competition and creating a win-win situation.

The future of European and Russian launch services

The future of European and Russian launch services should be considered in a market environment in which competition will become fiercer with emergent providers, including private providers, like the American ones and providers from rising space-faring nations like India and China. India will propose launch services with an increasing reliability and lower prices than its Western competitors. China is trying to sell its services despite the severe constraints imposed by the US. At the same time, it will be quite busy with its internal market. Russia, which cost structure is becoming more like Europe's, has to face this new competition just like Europe and the US. This is beneficial to European-Russian cooperation, even though at the same time costs increases in Russia leads to lower margins for the Europeans in their joint ventures.

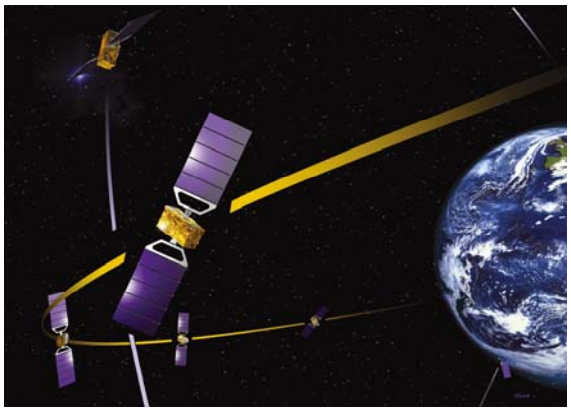
A major source of concern and uncertainty for the other providers is China. Its impact on the launch services market will clearly depend on US policies for China, as well as on the choices made by companies, including European ones, to use Chinese launchers. In addition, an important factor that affects demand today is the low dollar which is threatening the market of European providers, in particular, as there is no real and united political will in Europe to give preference to its own launchers. In the long-term, the only viable option for Europe is to create incentives to encourage European companies to "buy European". Today Europe has large space companies that make decisions by weighing the pro and cons at the corporate and not at the business unit level. This should be taken into account when designing incentives for these to be effective.

4.3.4 Navigation

A second important field in the Russian-European relations, which might be affected by the evolution of the cooperation between Russia, India and China, is satellite navigation.

The existing and planned systems

Table 4 summarises the current and future regional and global navigation systems. Today, there are four global systems in operation or planned and two planned regional systems. Each major space-faring nation has its own system, a situation triggered by Europe.



Artist's view of Galileo (Credit: ESA)

Cooperation in navigation systems

Navigation systems have three characteristics that drive cooperation. First, they have a

Country	USA	Europe	Russia	China	India	Japan
System	GPS	Galileo	GLONASS	Beidou/ Compass	IRNSS	QZSS/ JRANS
Coverage	Global	Global	Global	Regional/ Global	Regional	Regional
Operational	1995	2011-12	2009-10	2008	2011	2011?
Number of satellites – Nominal	24+2	27+3	24	5/ 27	7	3/7
Operations managed by	Department of Defence	Galileo Control Centres	Russian Space Forces	China Satellite Navigation Project Centre	IRNSS Navigation and Spacecraft Control Centres	JAXA.

Table 4: Regional and global navigation systems

sovereignty dimension that tends to limit cooperation as each player wants to have its own independent system, given the strategic importance of such dual-use systems. Second, there is a technical aspect which encourages interoperability and access to others' systems, as being able to use more satellites and systems means improved integrity monitoring, continuity, availability, accuracy, efficiency and reliability.[84] Third, there is a commercial dimension that encourages cooperation in order to reach new markets, whether for ground equipment and terminals or added-value downstream applications.
Cooperation between navigation service providers is therefore driven mainly by the development of a market for navigation applications (including accessing markets to enlarge the user base and create opportunities for the industry, raising awareness and promoting the use of navigation systems) and the minimization of risks (whether political, regulatory, economic or technological).

Cooperation between GNSS providers addresses:

- Technical harmonization of the systems for compatibility[85] and interoperability[86] which requires sharing technical information
- Defence of common interests like the protection of the GNSS spectrum and of the GNSS signals from interference
- Solutions to Intellectual property issues
- Joint certification
- Joint standards
- Development of joint ground equipments
- Development of joint applications
- Joint outreach to promote the use of radio-navigation
- Solutions to common issues like orbital debris
- Definition of liability
- Agreements on export control

Cooperation between GNSS providers and users include opening free access to signals or granting access to restricted signals, as well as training and information promoting the use of navigation systems.

Cooperation between all GNSS stakeholders includes:

- Development of augmentation systems[87], either space-based or land-based
- Research and industry cooperation including joint research and development on the navigation system, on the ground systems and on the applications
- GNSS ground stations hosting

Cooperation can take different forms.

- Bilateral negotiations, working groups and agreements between providers

The main bilateral agreement between providers is the one on the "Promotion, Provision and Use of Galileo and GPS Satellite-based Navigation Systems and Related Applications", signed between the US and Europe in June 2004.[88] This agreement established 4 working groups on: radiofrequency compatibility and interoperability; on trade and civil applications; on the design and development of the next-generation of systems; and on security issues related to GPS and Galileo.

- Bilateral agreements between providers and users

Such agreements include the ones signed between the EU and third countries on Galileo.

The first meeting of the International Committee on Global Navigation Satellite Systems (ICG) in November 2006 (Credit: UNOOSA)

- Discussions in multilateral forums for providers and users

The main forum is the International Committee on Global Navigation Satellite Systems (ICG) established in 2005. [89]
GNSS issues are also discussed within multilateral organisations, like the International Civil Aviation Organization (ICAO) or the International Maritime Organization (IMO).

- Discussions in multilateral forums of providers

During the 2nd meeting of the ICG in September 2007, a providers' forum was established. This forum is the main multilateral forum for GNSS providers.
Coordination between providers on the radiofrequency compatibility is achieved within the framework of the International Telecommunication Union (ITU), but this does not cover national security compatibility, which thus far can only be covered by bilateral agreements, as done between the US and Europe.

Existing cooperation between GNSS providers

Figure 9 shows the ongoing discussions on interoperability and compatibility between Europe and the other current or future navigation system providers, as well as existing cooperation on those topics between the US and Japan, and Russia and India. An agreement was signed in June 2004 only with the US.

However, cooperation takes place between the different players in other respects, as illustrated in Figure 10. Europe signed cooperation agreements with international partners including China in September 2003. An agreement with India was initialled in September 2005. As explained above, Russia and India are planning to cooperate on GLONASS with the launch by Indians of future satellites and joint developments on the next generation GLONASS satellites.
In addition to cooperation with other system providers, cooperation endeavours are being

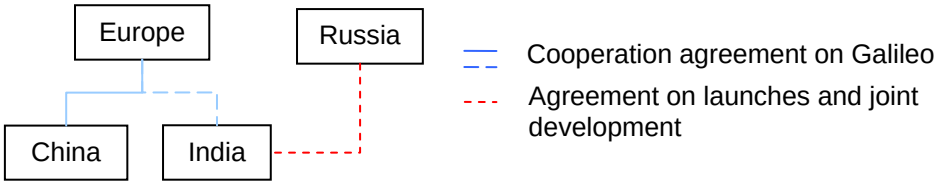


Figure 9: Interoperability and compatibility talks with other navigation system providers

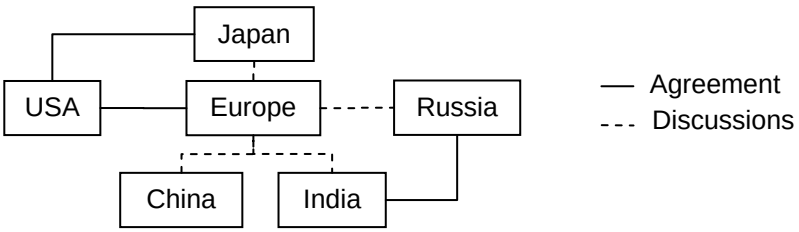


Figure 10: Other international cooperation between the navigation system providers

developed with potential users for commercial and strategic purposes, as done with several countries for Galileo.

The future of navigation systems and the role for Europe

The main challenges to Europe's cooperation on Galileo are first associated with the transfer of responsibilities from the Galileo Joint Undertaking (GJU) to the European GNSS Supervisory Authority (GSA) in 2007 and the redefinition of the role of the GSA, of the European Commission and of a possible GNSS Committee. Agreements were signed with third parties before 2007 and the way those third parties will be involved in the new organization still needs to be confirmed. A Galileo International Board (GIB) under the GSA was initially foreseen as a mechanism for international partners to participate in the programme.
A second set of challenges stems from the development of their own systems by "partner countries", like India and China. Those countries signed agreements with Europe but since then have decided to develop their own systems, global or regional. These decisions will certainly limit future cooperation with Europe.
At the same time, India has developed cooperation on GLONASS with Russia which will certainly constrain Europe's access to Indian market.

Europe has several options to address those various challenges:

- To define the future role of different types of partner countries in the programme
- To open access to restricted signals to some partners
- To further develop interoperability and compatibility with other providers, and first of all with Russia
- To take the initiative on the joint development of ground systems and to provide the private sector with a framework favourable to international cooperation for such development
- To organise outreach to users in potential partner countries
- To develop integrated applications, based on Galileo and possibly other systems, with international partners

Moreover, Europe has the opportunity to play a more important role within the ICG providers' forum and to take the lead in thematic forums between the service providers and users, which would focus on specific radio-navigation applications.

4.3.5. Manned spaceflight, space science and exploration

Space science and exploration

Rationale for cooperation in manned spaceflight, space science and exploration:

- Cost sharing
- Increasing the stability of the programme
- Improving the performance of the systems and ultimately the missions' results
- Improving the schedule

Moreover, exploration has an important dimension of international cooperation and contributes to the advancement of science and knowledge to the benefit of all humankind. However, those areas are fields of "frontier technologies", which tends to constrain cooperation, as the most technologically advanced partners want to protect their assets.

Current and planned systems

Table 5 summarises the main plans announced for space science and exploration, including planned manned missions.

Europe, through ESA, has two main programmes for future missions in those fields: Aurora for exploration and Cosmic Vision for science. In its Aurora exploration programme, Europe is following two main avenues: the exploration of Mars and of the Moon.
The priority in Europe remains the exploration of Mars with the European mission ExoMars and the planned Mars Sample Return that will require international cooperation. Between those two missions, scheduled to be launched in 2013 and 2020, respectively, a European precursor mission MarsNEXT could be launched.
A second direction is the Moon, with a possible mission MoonNEXT. In addition to European efforts, Germany will launch its own Moon mission Lunar Exploration Orbiter (LEO), scheduled today for 2013.

USA	Europe	Russia	China	India	Japan
US Space Exploration Policy	Exploration Programmes Aurora - ESA Lunar Exploration Orbiter (LEO) - Germany Science Programme Cosmic Vision - ESA	Federal Space Programme	Lunar Exploration Programme Chang'e 1.orbiting 2.soft landing 3.sample return Manned exploration programme 1.taikonauts 2.space lab 3.space station	Moon Programme Chandrayaan	Lunar Exploration Programme (Selene) Solar System exploration Programme: Primitive Body exploration (Hayabusa) Planetary Environment Measurement (Nozomi)

Table 5: Plans for space exploration

Artist's view of ExoMars (Credit: ESA)

Current cooperation

Figure 11 summarises the main cooperation ventures in science and exploration. As illustrated, Europe cooperates mainly with the US and Russia for its science and exploration missions. For more than a decade, Russia did not have a single mission in a field they used to be pioneers in during the Soviet era, but rather participated in European missions like Mars and Venus Express. The last Russian scientific and exploration mission was Mars 96, which was developed in cooperation with Europe but failed at launch.

Future cooperation and options for Europe

Figure 12 summarises cooperation on future science and exploration missions. Cooperation presented in italics is planned. The comparison between current and future cooperation reflects the evolution of cooperation between the different stakeholders.

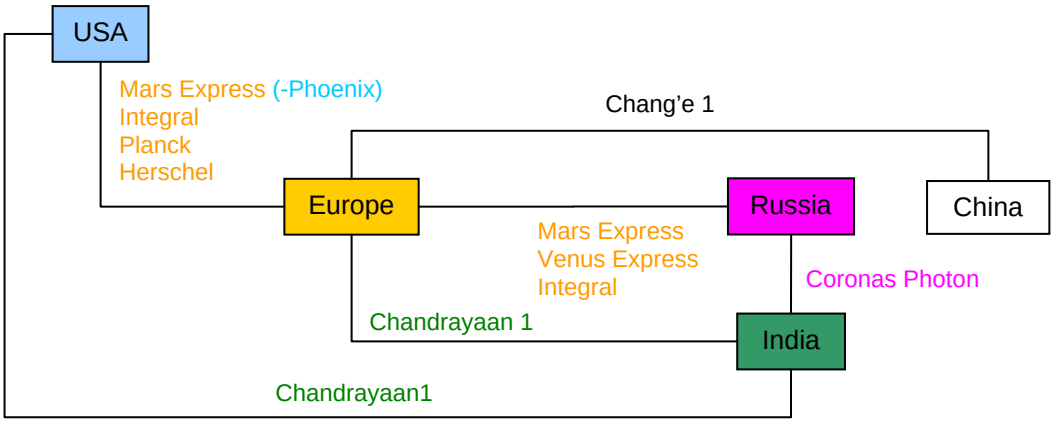


Figure 11: Cooperation in science and robotic exploration

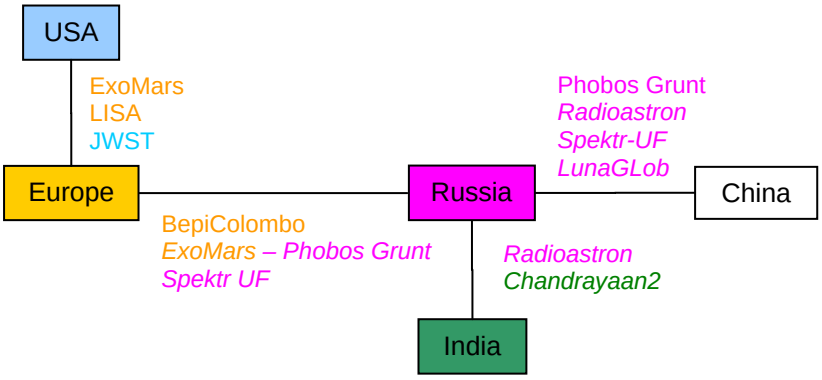
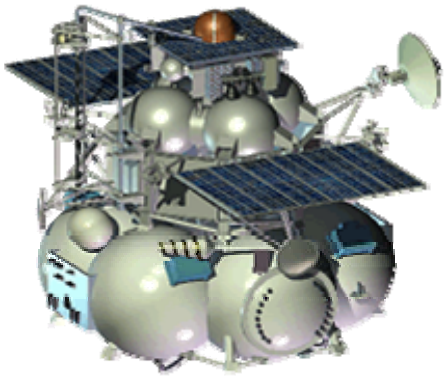


Figure 12: Cooperation on future science and robotic exploration missions

Coordination has already started for future Mars missions, in particular, between Europe and the US, but also with Japan.
Europe might go to the Moon on its own in a parallel effort with a precursor mission, but then it is likely to depend on the US efforts and plans and might join the American endeavour with experiments at a later stage, depending on the ESA member States' future interest in Moon exploration.

The prospects for future cooperation between Russia and Europe are feeble. Russia has plans in its Federal Space Programme for several scientific and exploration missions, the first of which will be Phobos Grunt. But space exploration and science - in particular - have not regained the same interest as other space fields and still suffers from a lack of funding and interest, especially given Russia's many other priorities in space. Russia demonstrated interest in using synergies between ExoMars and Phobos Grunt and in collaborating on Cosmic Vision.

However, the Russians have also found new alternatives for their own missions. For the first time, Russia is cooperating with India and China and will participate in some of its new partners' missions, including the Indian Chandrayaan-2.



The Phobos Grunt spacecraft (Credit: Lavochkin)

In robotic exploration, Europe is open to cooperation for its Mars missions, in particular for the future Mars Sample Return, given the resources necessary for this ambitious mission, but at the same time, Europe is currently developing its own technological capabilities in order to be able to cooperate as a significant partner. For the Moon, there has not been enough interest in Europe thus far to develop significant missions; therefore Europe is interested in cooperating with partners who have long-term plans for Moon exploration, i.e., the US. Cooperation for Moon exploration would therefore be of a very different nature and involves a different level of dependence on its partners than cooperation on the Mars missions. Moreover, because of the dependence on the US, any coordination and decisions affecting cooperation on Moon missions could be achieved later on, but the ones affecting Mars missions should be achieved soon. This would help Europe to be prepared and in an advantageous position for negotiating with its partners. Europe should master key technologies and coordinate its efforts to be an attractive partner.
There is today no Europe-Russia cooperation planned on exploration after the potential collaboration on ExoMars and Phobos-Grunt. Nonetheless, Europe could assume leadership in trying to become a bridge between the US and Russia for future exploration missions and programmes.

As regards science, Europe and Russia will cooperate mainly on BepiColombo. Apart from this mission, Europe is working with the US, while Russia, which is looking for partners for its next missions, has so far announced only cooperation with China and India. Russia has a long tradition of space science and an acknowledged expertise in that field. Some European and Russian scientists have worked together for decades. However there are uncertainties that tend to limit the interest of Europeans in further collaboration, including uncertainties associated with the funding, the schedule of

Russia's future missions and the actual status of the scientific community that severely suffered from the crisis in the nineties. This situation might evolve with the adoption by Russia of plans for their future scientific missions, which might include participation in European Cosmic Vision missions. But Europe could also miss some future opportunities with the Russians. Its position will continue impacting Russia's cooperation with other more determined partners. At the same time, Europe could certainly take the initiative in trying to coordinate missions with the US, Russia, India and even China to the benefit of the European and extra-European science community. Europe should use its unique advantage of having the possibility to cooperate with all other major players. It could also further engage in data sharing for future missions with those partners.

Manned space infrastructure

Current and planned infrastructure and current cooperation

The only existing manned space infrastructure today is the International Space Station (ISS). The various partners are presented in Figure 13.

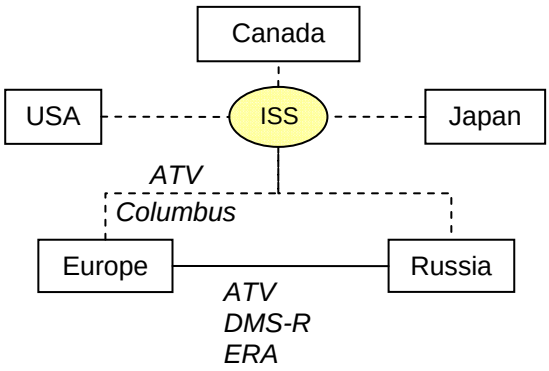


Figure 13: The main partners of the ISS, European contributions and elements of European-Russian cooperation

The main cooperation activities on the ISS between Europe and Russia, detailed in 4.2.1., are also listed. One must obviously add to these activities the transportation to and from the ISS of European astronauts and the use of the Russian segment.

As the only major space-faring nation not involved in the ISS, China has announced, since 2003, plans to build a laboratory and then a station on its own. India has not made similar commitments.

Artist's view of the ATV and the ISS (Credit: ESA)

Future cooperation and options for Europe

The ISS will operate at least until 2015. The US has announced that it will withdraw from the project in 2015, but the Russians and other partners hope to continue the exploitation of the station until 2020. With the American withdrawal, Russia has the unique opportunity to assume leadership in the future exploitation of the ISS. It would therefore be in its interest to federate the other partners and motivate them to continue the exploitation of the station. The future of the ISS will be driven by technical constraints, taking into account the Shuttle retirement in 2010, but also by its utilisation by the scientific community and industry. Space agencies promote science and technology research onboard the station. Only with a strong demand for utilization will the ISS get sufficient support to be used at the maximum of its potential. If Europe wants to take full advantage of its new assets, its agencies should foster the interest for Columbus with far-reaching utilization campaigns, use it for education purposes and support the Russian effort to continue the exploitation of the ISS.

In any case, after 2020, the US, Canada, Europe, and Japan will no longer have any infrastructure in Low Earth Orbit (LEO). Thus far, only the Russians have demonstrated an interest in LEO after the ISS and have proposed a post-ISS project in the perspective of exploration. This station would be dedicated to on-orbit assembly, as a first step for exploration.

Manned vehicles

Today only three countries are able to send humans into space: the US, Russia, and China. The current manned vehicles consist of the US Shuttle, the Russian Soyuz, and the Chinese Shenzhou. The US Shuttle fleet will be retired by 2010 and NASA is independently developing its own Ares/Orion next generation manned vehicle to replace it. These three countries represent the three alternatives for Europe to send astronauts, except if it decides to go its own. In fact, the only element missing in Europe's portfolio of activities is a manned vehicle, as Europe is still a passenger onboard a Russian or an American system.

If Europe really wants to pursue manned spaceflight activities, it will have to decide whether it wants to go on being dependent on others' transportation systems. If it does, then Europe will have the Russian and American options as long as, and if, they are available. If not, then Europe will have to invest in a manned vehicle and there are mainly two options: independent or autonomous access to space.
An independent access to space means a European-built manned transportation system, which is desirable for European industry that is longing for new development activities, but requires large investments and a strong political will. Such an ambitious project can be only achieved with the unequivocal political and financial commitment of ESA member States and if one or a few major European countries assume leadership. To acquire such a capability, Europe could cooperate with the US and/or Russia to obtain or jointly develop systems or technologies. Such cooperation raises challenges like technology safeguard and funding.
Another option, an autonomous access to space could be achieved by jointly developing a vehicle with one of the three countries which master manned space transportation. Joint vehicle development might be the best option for European industry if a "win-win concept" is found with the partner country and as long as it does not prevent a future independent access to space. A joint development does not exclude and can indeed be a first step towards a future independent access to space. The only option for a joint vehicle development appears to be Russia, which is currently considering its options to replace Soyuz. Russia is starting new developments for its manned spaceflight and is looking for partners. It has shown the willingness to adapt its plans to cooperate with Europe. As a result, ESA and Roscosmos started a joint study with their industry in 2006 to investigate a potential joint Crew Space Transportation System (CSTS). At the same time, Russia also announced talks with India on the development of their future manned vehicle, again demonstrating potential alternatives.
There are significant challenges to a European-Russian joint vehicle development, including compatible visions of their future manned space endeavour, but also differences in production costs, technology safeguard issues and the need for sufficient political support and funding on both sides. However, Europe today has a unique opportunity for its future manned activities with important scientific and industrial consequences. The ESA member States should decide very soon if they want to cooperate with Russia on such a programme. The Russians might not wait for Europe and decide to work on their own or cooperate with others, in particular, with India. Even though Europe should not wait if it is interested, one should bear in mind that Russia does not have secured funding for either CSTS joint activities or an independent development yet and that India does not have yet a comprehensive manned programme and funding for it, which might hinder joint work with the Russians.

Manned exploration

Announcements have been made of intentions to conduct manned space exploration by the US, Russians, Chinese, Japanese, Indians and Europeans. All of them promoted a global endeavour and supported cooperation and collaboration.

In manned exploration, Europe could promote an international endeavour and become a bridge between today isolated partners. There are various possible cooperation/competition scenarios for manned exploration from several competitive programmes to a harmonized single international programme including all the main partners. A cooperative scenario would be in everyone's interests and if Europe is willing it could play the role to promote harmonization between the largest partners.

4.4. Conclusions

Space is now back on Russia's strategic agenda, as the country tries to valorise its industrial heritage and adopts a more confident posture on the international scene, and thanks to its economic recovery, Moscow is today reinvesting in its space sector and rebuilding its space capabilities.

Europe and Russia have a long history of successful and mutually beneficial space cooperation, and in the past decade, they have strengthened their ties and engaged in new joint activities. There have been ups and downs, but these have not prevented the development of a long-lasting and further developing cooperation. At the same time, Russia has developed new partnerships in the field of space with other countries, especially with the two great rising space-faring nations, China and India. Recent developments in those relations do have the potential to impact Europe, its space activities and its space cooperation with Russia. The Russians still demonstrate a strong interest in working with Europe, but now have other attractive options as well.

Europe and Russia have become very interdependent, and despite a political context that is not really encouraging, today Europe has great opportunities to further its cooperation with Russia. Nonetheless, if Europe wants to move forward with Russia, it should act in a timely manner. Russia is in fact starting new programmes, especially in the field of launchers, and is rebuilding all of its space capabilities, covering the entire spectrum of satellite systems. Europe could play a role by getting actively involved in joint work, and derive great benefits from it. Today, there are new opportunities for cooperation and Russia is clearly interested in working with Europe. However, if Europe does not seize those opportunities, others might, on a bilateral basis. In particular, if Europe is serious and ambitious about the future of its space activities, its industry needs new development activities and those could be undertaken in some of the new projects that could be jointly carried out with Russia.

For instance, in the navigation field, Europe is trying to redefine its international partnerships and in order to maximise opportunities and minimise risks, it should offer interesting prospects to its partners, including India and China. Europe could also take the lead in political initiatives to further cooperation among navigation systems providers and collaboration with users in specific areas.

In the area of launchers, Europe needs to prepare the future and could do so with Russia who has decided to give a new impetus to the development of its new launchers, but it has to be decided now, as the Russian timeframe is much shorter than the European one.

Then, if Europe wants to pursue human spaceflight activities and be more than passenger, it has two options. First, it could decide to go on its own which would require very strong political and financial support and would also probably require cooperation with the Russians on key systems. Or Europe could develop the CSTS with the Russians which seems a viable option in the long-term if a "win-win" concept can be defined.

In space exploration and science, Europe should further develop its relations with Russia so as not to miss future opportunities and become a less interesting alternative than other more determined partners, like India or China. Europe could furthermore take the lead in bridging the gap between the main players.

Cooperating with Russia, like with others, is not easy and the overall context is not very favourable today. Difficulties also arise because of the differences in economic models. On the other hand, if Europe wants to play a role in the global space landscape over the long term, it has to develop strong partnerships with major players. Europe and Russia have already built a strong framework for cooperation, even though some elements are still missing, and are already very interdependent. Adding the missing building blocks could enable them to build a sound foundation for European-Russian cooperation and open many opportunities that could further Europe's interests. However, for such a cooperation to be really effective Europe needs a common, coherent and coordinated policy, a more efficient decision-making process and to build on its recently adopted European Space Policy for the long-term. Europe needs to integrate its space cooperation within its overall policy towards Russia, which would contribute to the stability of the relations and the reliability of its partner. Moreover, if Europe decides to move forward, the space agencies should fully use their capital, i.e., their history of cooperation and knowledge of the Russian partners, within the political framework for cooperation set out with the European Commission.

Annex A

Fact Sheets on Russia, India and China

RUSSIA

Russia[90]

KEY DATES

June 1991	Election of President Boris Nikolayevich Yeltsin
December 1991	Dissolution of the USSR into 15 independent republics and creation of the Commonwealth of Independent States (CIS)
1997	Russia formally joins the G8
December 1999	Vladimir Vladimirovich Putin becomes acting president, succeeding President Yeltsin
May 2000	Election of President Vladimir Vladimirovich Putin

TOTAL AREA[91]

17 075 400 km^2 (1st rank)

POPULATION[92]

Total population
142.4 millions

Annual population growth
-0.5%

POLITICS[93]

Government type
Federation

Executive branch
- Chief of State: President Dmitry Anatolevich Medvedev (since May 2008)
- Head of government: Premier Vladimir Vladimirovich Putin (since May 2008)

Elections
- President
  - Elected by popular vote
  - Four-year term
  - Eligible for a second term
  - Last election held in March 2008 (next election to be held in March 2012)
- Premier appointed by the President with the approval of the Duma

Legislative branch

Bicameral Federal Assembly

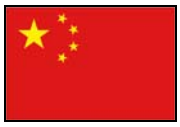
Federation Council
- 168 seats
- Appointed by the top officials in the 84 federal administrative units and federal cities
- Four-year terms

State Duma
- 450 seats
- Elected by popular vote by proportional representation from party lists winning at least 7% of the vote
- Four-year term
- Last elections held in December 2007

ECONOMY

GDP (Purchasing Power Parity) [94]	$2068 billion PPP
GDP at current prices[95]	$1480 billion
Real GDP growth rate[96]	7,0%
GDP per capita (PPP)[97]	$14625 PPP
Budget[98]	Expenditure: $299 billion Revenue: $262 billion
Public debt[99]	7% of GDP
Inflation rate[100]	11.4%
GERD[101]	1.16% of GDP
Unemployment rate[102]	2.4% registered – 7.2% survey-based
Military expenditures[103]	3.7% of GDP

CHINA



China[104]

KEY DATES

1937-1945	Sino-Japanese War
October 1949	People's Republic of China, as the successor state of the Republic of China, proclaimed by Mao Zedong and retreat of Chiang Kai-shek and the Nationalists to Taiwan
1958-1960	The Great Leap Forward
1966-1969/1976	The Cultural Revolution
1976	Death of Mao
1978	Launch of the Four Modernizations by Deng Xiaoping
1989	Tiananmen Square protests
1997 and 1999	Return of Hong-Kong and Macau to China

TOTAL AREA[91]

9 571 300 km^2 (3rd rank)

POPULATION[92]

Total population
1.3 billion

Annual population growth
+0.6%

POLITICS[93]

Government type
Communist state

Executive branch
- Chief of State: President HU Jintao – Vice President ZENG Peiyan (since March 2003)
- Head of government: Premier WEN Jiabao (since March 2003)

Elections
- President and Premier
  - Elected by the National People's Congress (NPC)
  - Five-year term
  - Eligible for a second term
  - Last election held in March 2003
  - Premier nominated by the President and confirmed by the NPC

Legislative branch
Unicameral National People's Congress (NPC)
- 2985 seats
- Elected by municipal, regional and provincial people's congresses
- Five-year terms
- Last elections held in December 2007/February 2008

ECONOMY

GDP (Purchasing Power Parity)[94]	$12989 billion PPP
GDP at current prices[95]	$3713 billion
Real GDP growth rate	11.5%
GDP per capita (PPP)[97]	$9785 PPP
Budget[98]	Expenditure: $640.6 billion Revenue: $634.6 billion
Public debt[99]	18.9% of GDP
Inflation rate[100]	5.9%
GERD[105]	1.4% of GDP
Unemployment rate[102]	4.2% registered
Military expenditures[103]	2% of GDP

INDIA

India[106]

KEY DATES

August 1947	Independence of India and partition of the country with the creation of Pakistan
1947-1948 and	First Kashmir War between India and Pakistan (to be followed by conflicts in 1965,1971 and 1999)
January 1950	India becomes a republic and its new constitution comes into effect
50ies	Development of the Non-Aligned Movement with India as a founding member
1962	Sino-Indian War
1974	India becomes a nuclear state with its first underground nuclear test

TOTAL AREA[91]

3 287 263 km^2 (7th rank)

POPULATION[92]

Total population
1.1 billion

Annual population growth
+1.4%

POLITICS[93]

Government type
Federal republic

Executive branch

- Chief of State: President Pratibha PATIL (since July 2007)– Vice President Hamid ANSARI (since August 2007)
- Head of government: Prime Minister Manmohan SINGH (since 22 May 2004)

Elections
- President
  - Elected by an electoral college
  - Five-year term
  - No term limits
  - Last election held in July 2007 (next election to be held in August 2012)
- Prime minister chosen by parliamentary members of the majority party following legislative elections

Legislative branch
Bicameral Parliament

Council of States (or Rajya Sabha)
- Up to 250 members
- Up to 12 members are appointed by the President, the remainder are chosen by the elected members of the state and territorial assemblies
- Six-year terms

People's Assembly (or Lok Sabha)
- 545 seats
- 543 members elected by popular vote and 2 appointed by the President
- Five-year terms
- Last election held in May 2004 (next election to be held before May 2009)

ECONOMY

GDP (Purchasing Power Parity)[94]	$5210 billion PPP
GDP at current prices[95]	$1249 billion
Real GDP growth rate[96]	8.9%
GDP per capita (PPP)[97]	$4543 PPP
Budget[107]	Expenditure: $145.2 billion Revenue: $182.4 billion
Public debt[99]	58.8% of GDP *(federal and state)*
Inflation rate[100]	5.2%
GERD[101]	0.69% of GDP
Unemployment rate[108]	8.1%
Military expenditures[103]	2.9% of GDP

Annex B

Space in the Russian Federation

THE RUSSIAN FEDERATION

1. Russia's space activities

1.1 Institutional framework

1.1.1. The Federal Space Agency

The Federal Space Agency (FSA) of the Russian Federation is an independent authority of executive power in charge of civil space activities.
The Russian space agency (RKA), established in 1992, was responsible for the management and implementation of mainly civil space activities, while the military space activities were under the responsibility of the Military Space Forces. In 1999, the RKA is restructured and becomes Rosaviacosmos to also encompass the aeronautical activities. In 2004, the aeronautical and space activities are split again and the space agency becomes the Federal Space Agency (FSA) or Roscosmos. The agency, headed by Yuri N. Koptev from 1992 until 2004, has been headed by Anatoly N. Perminov since 2004. Following the Decree "On the systems and structure of federal bodies representing executive power" of 9 March 2004, Roscosmos gained ministerial status as it became one of the 28 Federal Agencies, reporting directly to the Government.

Roscosmos' main responsibilities include:
- Implementing the space policy developed by the Government
- Implementing the Federal Space Programme and coordinating the work conducted at the Baikonur spaceport
- Managing the State property in space infrastructure
- Coordinating international cooperation (including for commercial ventures)

Roscosmos employs about 300 people. According to the regulation from June 2004, Roscosmos is to have a maximum number of employees of 213 (excluding the security and service personnel). Its structure is detailed in Figure 14.

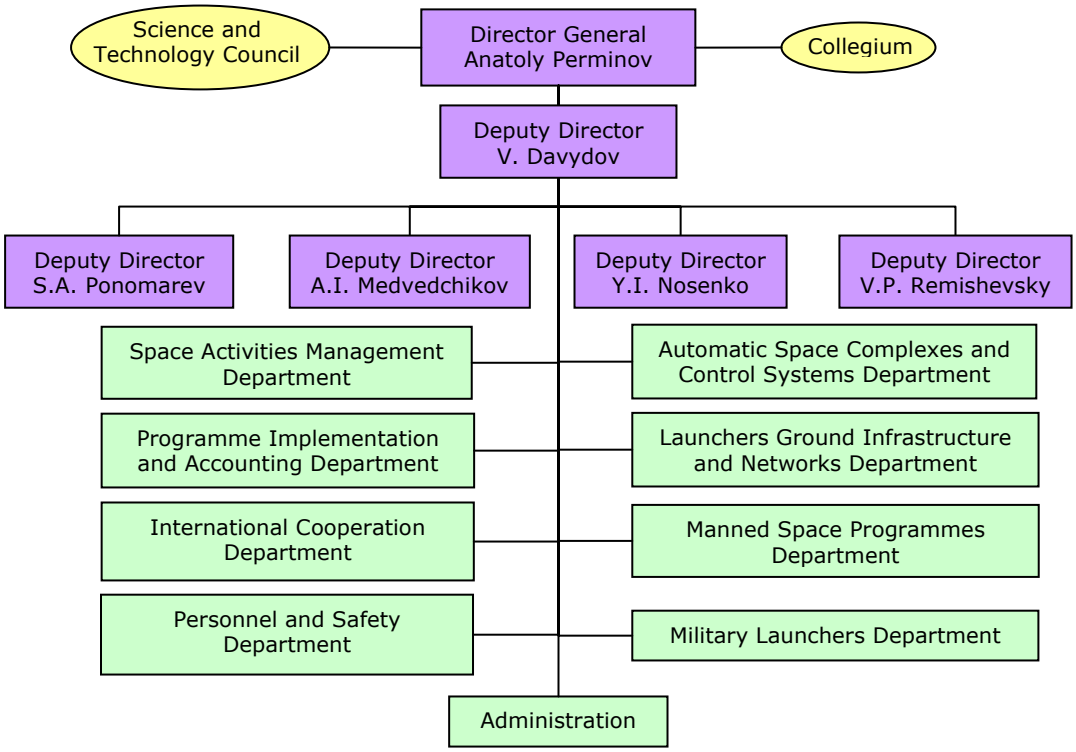


Figure 14: Structure of the Federal Space Agency

1.1.2. The Russian Academy of Sciences

Space science has traditionally been under the responsibility of the Russian Academy of Sciences (RAS). The RAS was established in 1724, was a key institution during the Soviet Union and which importance was further reaffirmed when it was reinstated as the supreme scientific institution of Russia by a Decree of the President in 1991, as shown in Figure 15.
The Academy includes 9 departments (structured by scientific field), 3 regional branches, and 14 regional scientific centres. In 2007, the RAS employed more than 100 000 people, including more than 50 000 scientific staff. The tendency is to reduce this large number of staff. By 2009, the number of staff should be reduced down to less than 90 000 staff, including less than 45 000 scientific staff.

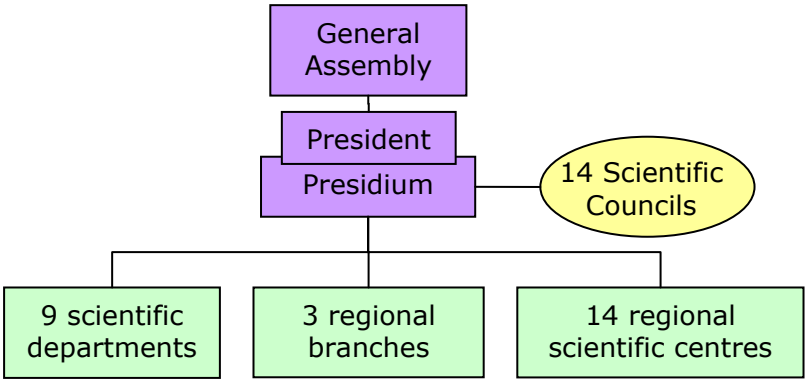


Figure 15: Structure of the Russian Academy of Sciences

1.1.3. The Ministry of Defence

The Ministry of Defence has the responsibility of the Federal Target Programme on cosmodromes and has a large responsibility in the modernisation and management of the GLONASS dual-use system. It is responsible for two of the five sub-programmes of the GLONASS programme. The Ministry is responsible for important military space programmes, covering a wide spectrum and including signals or electronic intelligence and reconnaissance missions and military launches.

1.2. Financial Framework

1.2.1. Science and Technology policy-making and funding

S&T Policy-making in Russia

As detailed in Figure 16, the main players in science and technology policy in Russia are:
- The Ministry of Education and Science
- The federal agencies (including the Federal Space Agency)
- The Russian Academy of Sciences

The President is advised by a Council on Science, Technology and Education. Both legislative bodies, the State Duma and the Federation Council, have their own committees on science and technology. The Interagency Commission for Science and Innovation Policy, established in 2004, is coordinating the relevant organs of the executive on science and innovation policy.

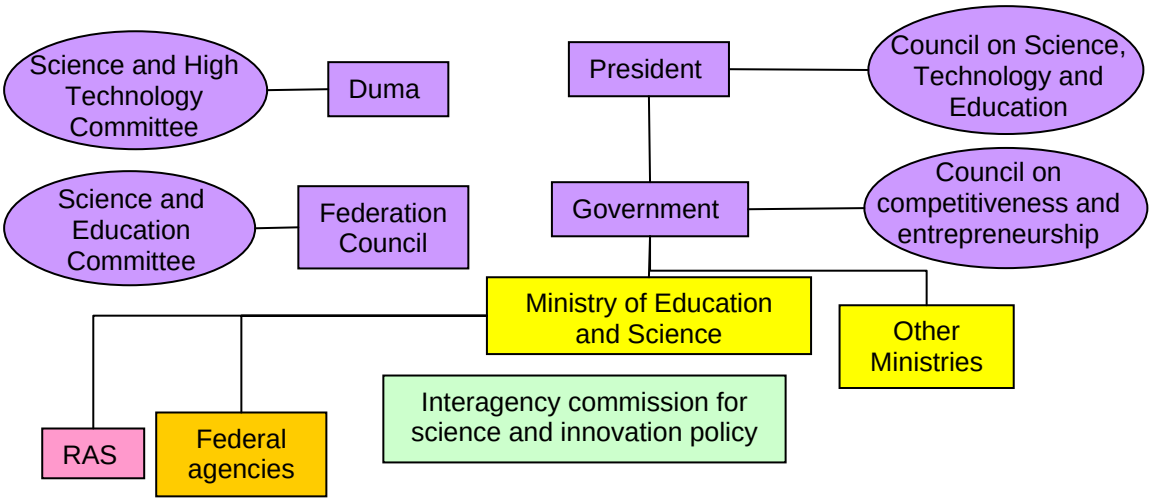


Figure 16: Science and Technology Policy-Making Structure in the Russian Federation

Russia's S&T policy is defined in:

- Long-term strategic documents, including the *Strategy for the Development of Science and Innovation up to 2015*
- Relevant laws and presidential decrees, including *Research and Development in Priority Areas in Science and Technology in 2007-2012*
- Federal targeted programmes

National Priorities in S&T

Eight priority fields have been defined in the science and technology policy of the Russian Federation for the period 2006-2010: security and terrorism counteraction; life sciences; nanosystems and materials; information technologies and communications systems; armament and military technologies; rational use of natural resources; transport, aviation and space systems; and energy and energy efficiency.

Financing of R&D in Russia

The Russian State supports R&D by supporting financial institutions and funding special projects and programmes as shown in Figure 17.

The Federal Agency on Science and Innovation is the agency, under the responsibility of the Ministry of Education and Science, in charge of implementing the science and innovation policies.
The Russian Fund for Basic Research[109] (RFBR) supports fundamental research. The Foundation for Assistance to Small Innovation Enterprises (FASIE)[110] implements the government's policy for the development and support of small innovative enterprises. The Russian Foundation for Research in Humanities[111] (RFRH) supports of scientific work in humanities.

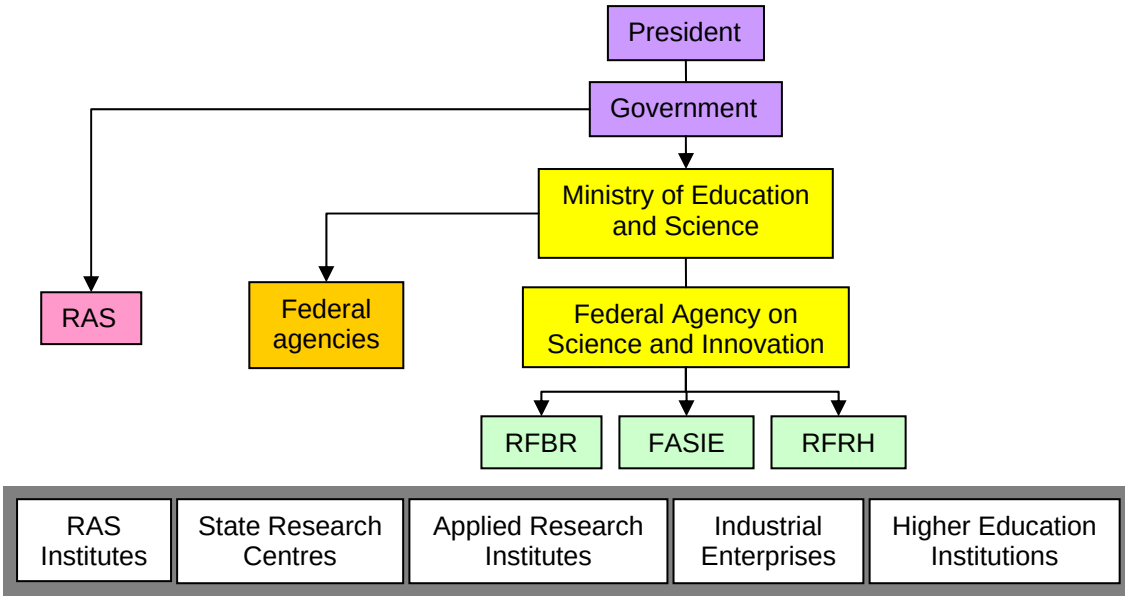


Figure 17: Research and Innovation Funding in Russia

R&D Expenditure

The level of Gross Domestic Expenditure for R&D (GERD) in the Russian Federation has increased in the past decade, as detailed on Figure 18, and reached in 2007 a level comparable to the EU27 average level, which is much lower than the levels of the US (2.6% of the GDP) and Japan (3.3%).

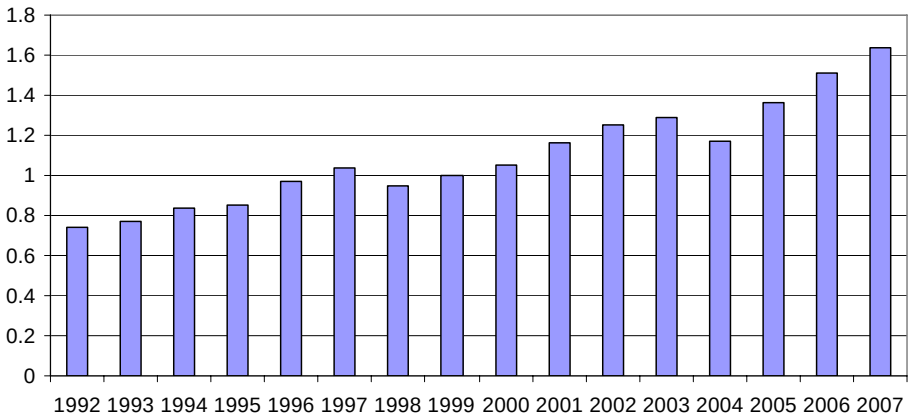


Figure 18: Russian GERD (as a percentage of the GDP)

The Russian government has set the following R&D national targets for 2015:

- a gross domestic expenditure on R&D at 2.5% of the GDP
- a ratio of business expenditure on R&D to gross domestic expenditure on R&D (BERD/GERD) at 70%

The Russian S&T sector

The main advantages of the Russian S&T sector include its strong fundamental research, unique applied research capacities in selected fields, including space and aeronautics and weaponry, and unique scientific facilities. Its main weaknesses include the low level of civil R&D outputs and return on investment, the disconnect between R&D efforts and the market demand, the low level of private investment in R&D and the relative unattractiveness of scientific careers for young people.

1.2.2. Space policy-making and funding

Space policy-making

As detailed in Figure 19, the main stakeholders in the Russian space policy-making are the President, the Government, and in particular the Ministry of Defence, and the Federal Space Agency.

The President of the Russian Federation exercises the overall leadership on space activities. The President asserts the main principles of the Russian space policy through presidential decrees.[112]

The Government examines and approves the Russian space-related programmes. The Security Council as a department of the Presidential Executive Office, advises the President on space issues related to national security.

Space activities in the Russian Federation are conducted according to Federal Space Programmes. The two first Space Programmes took place over the 1992-2000 and 2001-2005 periods, and the third and current Federal Space Programme last from 2006 until 2015.

The Federal Space Programmes are funded to a large extent by the federal budget but also by non-budgetary governmental funds. The federal budget, including the budgets of the FSA and the RAS, is adopted by the State Duma and approved by the Federation Council. The Federal Space Agency drafts the proposal of the Federal Space Programme in concordance with the Russian Academy of Sciences and other ministries and submits it to the Government.

In addition to the ongoing space programmes, the Government has been tasked to prepare a long-term space strategy up to 2020 and to be endorsed by the Security Council.

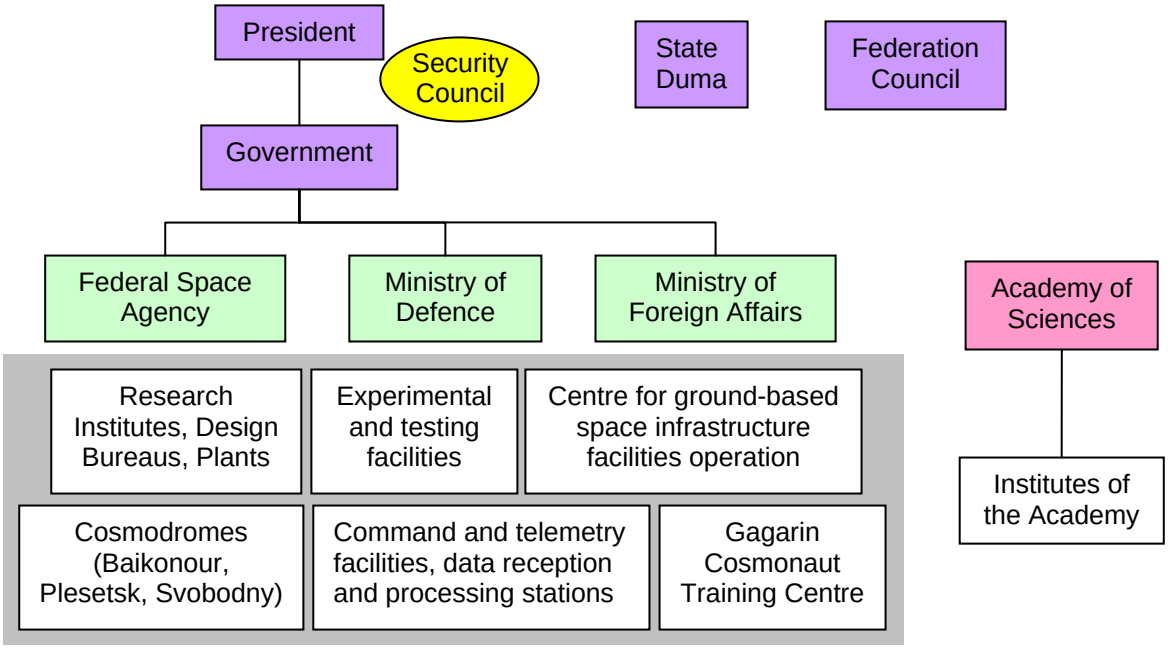


Figure 19: Stakeholders of the Russian Space Activities

Space funding

Russia is conducting currently 3 large civil space programmes:

- The Federal Space Programme 2006-2015
- The Federal Target Programme on GLONASS 2002-2011
- The Federal Target Programme on the Development of Russia's cosmodromes 2006-2015

Each of those is further detailed in 2.2.

Funding of the Federal Space Programme 2006-2015

The Federal Space Programme (FSP) 2006-2015 represents a total budget of 487 billion rubles (about 13 billion euros). It includes a budget of 305 billion rubles and extra-budgetary funds, i.e. co-financing by companies, of 182 billion rubles.
Figure 20 presents the total funding for the FSP over the 2006-2010 period. In 2007, the FSP received 24.4 billion rubles (about 660 million euros) from the federal budget and 25,6 billion rubles (about 700 million euros) from non-budgetary sources.

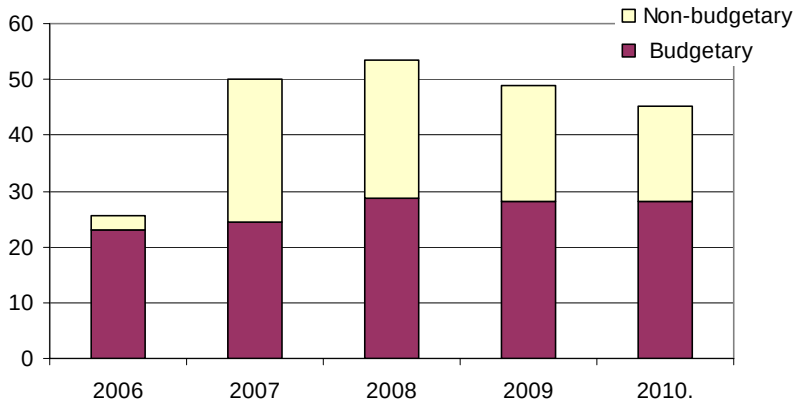


Figure 20: Funding of the Federal Space Programme (in billion rubles)

The allocation of the budget in 2007, presented in Figure 21, demonstrates the importance of fundamental and applied research.

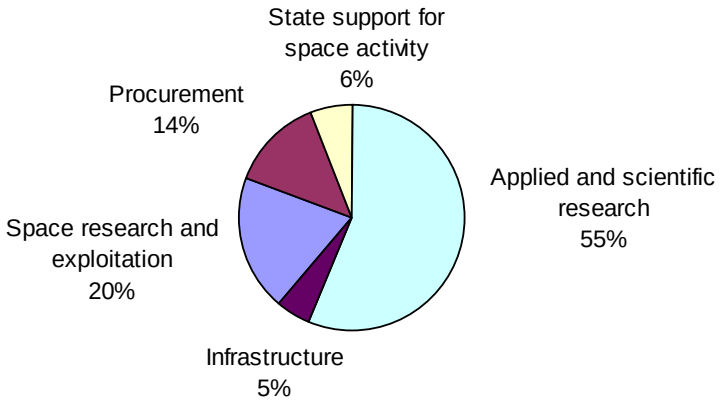


Figure 21: Budget allocations for the Federal Space Programme in 2007[113]

Funding of the Federal Target Programme GLONASS

The Federal Target Programme GLONASS 2002-2011 has a total budget of 70 billion rubles (about 1.9 billion euros), of which 54 billion rubles come from the federal budget and 16 from non-budgetary sources, i.e. co-financing by companies.
Figure 22 presents the funding of the programme over 2002-2010. In 2007, it received 9.8 billion rubles (about 270 million euros) from the federal budget and 1.9 billion rubles (about 50 million euros) from non-budgetary sources.

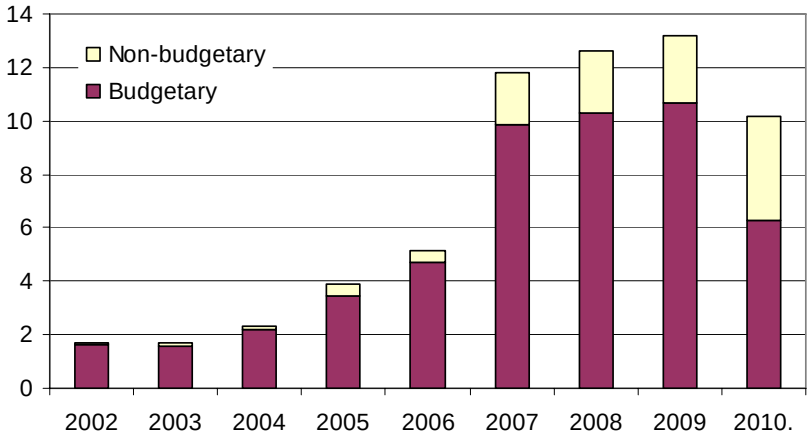


Figure 22: Funding of the Federal Target Programme on GLONASS (in billion rubles)

Funding of the Federal Target Programme on cosmodromes

Figure 23 presents the funding of the Federal Target Programme on cosmodromes over the 2006-2010 period. In 2007, the programme received 1.8 billion rubles (about 50 million euros).

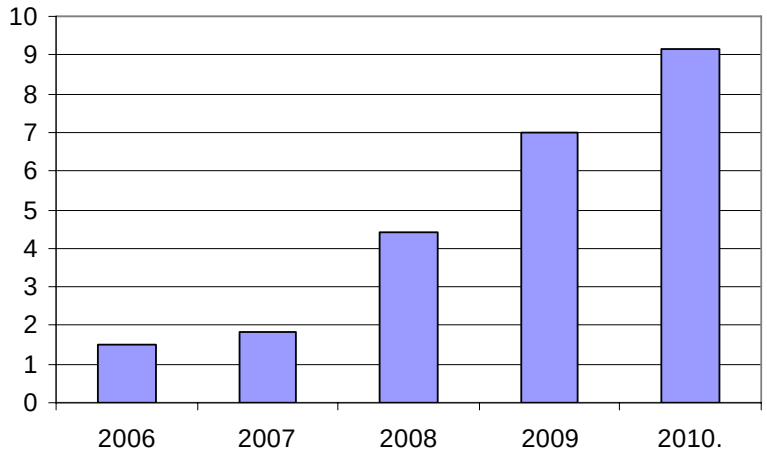


Figure 23: Funding of the Federal Target Programme on cosmodromes (in billion rubles)

Budget of the Federal Space Agency

In 2007 the official budget of the FSA was 32.9 billion rubles (about 0.9 billion euros) including dual-use programmes. The level of this budget remains quite low given the spectrum of Russian activities and in comparison with others. The FSA budget represents 13 times less than NASA's budget or 3 times less than ESA's budget. This budget has however significantly increased over the past years, as shown in Figure 24.

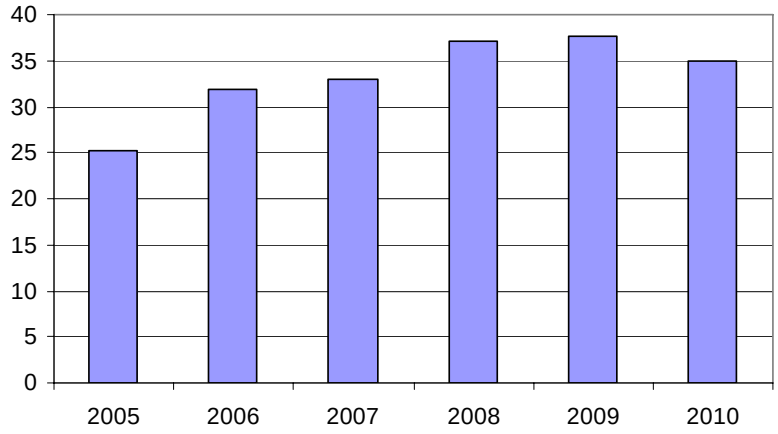


Figure 24: Roscosmos' budget (in billion rubles)

As presented in Figure 25, a large share of the 2007 FSA budget covered the Federal Space Programme (74%) and the GLONASS Programme (12%). Within the other 14% of the FSA's budget, about 10% goes to the realisation of international obligations, such as the use of the Baikonour infrastructure.

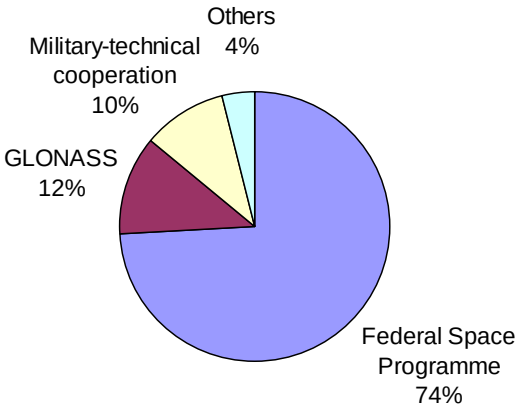


Figure 25: Roscosmos' budget distribution[114]

In addition to the federal budget, the FSA gets additional funding from commercial launches of space tourists and foreign cosmonauts, from its joint ventures with foreign partners and the Russian participation in international projects.[115]

Market might represent about 30% of the Russian space industry revenues, i.e. 300 million dollars a year.[116]

1.3. Scientific and technical capabilities

1.3.1. Main achievements

Only the main "firsts" are listed below to illustrate the long list of achievements of the Soviet Space Programme.

1957
- First intercontinental ballistic missile, the R-7 Semyorka
- First satellite, Sputnik 1
- First living creature in space, the dog Laika on Sputnik 2

1959:
- First firing of a rocket in Earth orbit, first artificial satellite of the Sun, first telemetry to and from outer space, Luna 1
- First probe to impact the moon, Luna 2
- First pictures of the moon's far side, Luna 3

1960
- First animals to safely return from Earth orbit, the dogs Belka and Strelka
- First probe launched to Mars, Marsnik 1

1961
- First probe launched to Venus, Venera 1
- First man in space Yuri Gagarin on Vostok 1

1963
- First woman in space, Valentina Tereshkova

1965
- First EVA, by Aleksei Leonov
- First probe to hit another planet (Venus), Venera 3

1966
- First probe to make a soft landing on and transmit from the surface of the Moon, Luna 9
- First probe in lunar orbit, Luna 10

1967
- First unmanned rendezvous and docking

1969
- First docking between two manned craft in Earth orbit and exchange of crews, Soyuz 4 and Soyuz 5

1970
- First samples automatically returned to Earth from another body, Luna 16
- First robotic space rover, Lunokhod 1
- First data received from the surface of another planet (Venus), Venera 7

1971
- First space station, Salyut 1
- First probe to orbit another planet (Mars), first probe to reach surface of Mars, Mars 2

1975
- First probe to orbit Venus, first photos from surface of Venus, Venera 9

1986
- First permanently manned space station, Mir, which orbited the Earth from 1986 until 2001

1987
- First crew to spend over one year in space, Vladimir Titov and Musa Manarov on board of TM-4 - Mir

1.3.2. Main activities and capabilities

Current capabilities

The spectrum of Russia's current activities and capabilities of the Russian Federation is summarised below in the main fields. It is noticeable that as of April 2008, Russia does not have any "scientific" and meteorological satellites.

Manned space flight	As part of the International Space Station (ISS): ▪ Docking module Zvezda ▪ Docking module Pirs ▪ Functional Cargo Block (FGB) Zarya
Search and Rescue COSPAS-SARSAT	None
Science and exploration	None
Meteorological	None
Telecommunications	11 satellites for RSSC 3 Yamal satellites for Gascom
Earth Observation	Resurs DK-1 (Multi-spectral remote sensing)
Navigation	GLONASS (16 satellites as of January 2008)

Launchers

The launchers mentioned in italics have a Ukrainian prime manufacturer, i.e. Yuzhnoye/Yuzhmash.

Small Launch vehicles

Launch vehicles	Start-1	Strela	Rockot	*Dnepr*
Upper stage	-	-	Breeze-KM	Upper stage
Launch site / launcher type	Svobodny/ground Mobile	Baikonur/silo	Baikonur/silo Plesetsk/ground	Yasny Launch Base Baikonur/silo
Launch mass, t	47	105	107	212
Payload mass, t				
Maximum	0.63	1.55	1.95	3.7 (H=300 km)
H=650 km, i=97˚	0.22	0.82	1.1	0.9
H=1000 km, i=63˚	0.2	0.92	1.5	-
Fairing diameter / length, m	1.36/3.34	1.9/6.7	2.6/6.7	3/3.2
Maiden launch	1993-Plesetsk 1997-Svobodny (launch site decommissioned)	2003	1990-Baikonur 2000-Plesetsk	1999 Production discontinued

Launch vehicles	Cosmos-3M	*Cyclone -2*	*Cyclone-3*
Upper stage	-	-	S5.M
Launch site	Plesetsk	Baikonur	Plesetsk
Launch mass, t	109	183	188
Payload mass, t			
H=200 km	1.5	3.2	3.6
H=650 km, i=98˚	-	-	2.35
H=1500 km, i=63˚…65˚	-	-	2.15
GTO	-	-	-
GEO	-	-	-
Fairing diameter / length, m	2.4 / 5.7	2.2 / 10.7	2.7 / 9.5
Maiden launch	1967 Production discontinued	1969	1977

Medium Launch vehicles

Launch vehicles	Soyuz-U	Soyuz-FG	Soyuz-FG	Molniya-M	Soyuz-2 1A	Soyuz-2 1A	Soyuz-2 1B	Soyuz-2 1B
Upper stage	-	-	Fregat	-	-	Fregat	Fregat	Fregat
Launch site	Baikonur	Baikonur	Baikonur	Plesetsk	Plesetsk	Baikonur	Baikonur	Plesetsk
Launch mass, t	309	309	309	305	309	309	309	305
Payload mass, t								
H=200 km	7.15	7.44	-	-	6.65	6.85	8.05	7.65
H=650 km, i=98˚	-	-	3.4	2.0	4.3	4.3	4.85	5.2
H=24000 km, i=56˚	-	-	1.4	-	-	1.417	1.45	-
GTO	-	-	1.5	-	1.2	1.6	1.839	1.45
GEO	-	-	0.4	-	-	0.65	0.87	0.45
Fairing diameter / length, m	3.3 / 10.1	3.3 / 10.1	3.7/7.7	2.7/8.4	4.11/11.43	4.11/11.43	4.11/11.43	4.11/11.43
Maiden launch	1973	2001	2001	1966	2004	2006	2006	2007?

Launch vehicles	*Zenit-2*	*Zenit-3SL*	*Zenit-2SLB*	*Zenit-3SLB*
Upper stage	-	DM-SL	-	DM-SLB
Launch site	Baikonur	Sea Launch	Baikonur	Baikonur
Launch mass, t	456	470	459	467
Payload mass, t				
H=200 km	13.7	16.0 (i=0˚)	13.9	13.9
H=650 km, i=98˚	-	-	-	-
H=1500 km, i=63˚…65˚	3.0	-	2.9	2.9
GTO	-	6.0 (i=0˚)	-	3.6
GEO	-	-	-	1.6
Fairing diameter / length, m	3.9/13.65	4.15/11.4	3.9/13.65	4.1/10.1
Maiden launch	1985	1999	2007	2008

Heavy Launch vehicles

Launch vehicles	Proton-K	*Proton-K*	Proton-M
Upper stage	DM-01	*Breeze-M*	Breeze-M
Launch site	Baikonur	*Baikonur*	Baikonur
Launch mass, t	690	*690*	703
Payload mass, t			
H=200 km, i=51.6°	20.9	*20.9*	22.0
H=19100 km, i=64.8°	4.6	*4.3*	4.5
GTO	5.6	*5.0*	6.0
GEO	2.43	*2.87*	3.2
Fairing diameter / length, m	4.35/10	*4.35/11.6*	4.35/13.2
Maiden launch	1994	*1999*	2001

Future Launch Vehicles

In August 1995, the Russian Government adopted a resolution to develop a new launcher system, Angara, to replace the heavy launchers Proton. The Angara launchers family is under development at Khrunichev. It will be first launched from Plesetsk and later from the new Vostochny cosmodrome. In the April 2008 session of the Security Council, President Putin gave a new momentum to the programme and declared plans to have the first Angara launches from Plesetsk in 2011.

Launch vehicles	Angara-1.1	Angara-1.2	Angara-A3	Angara-A5
Upper stage	-	Breeze-M	Breeze-M	LOX/LH_2 upper stage
Launch site	Plesetsk	Plesetsk	Plesetsk	Plesetsk
Launch mass, t	149	171	480	773
Payload mass, t				
H=200 km, i=63°	2.0	3.7	14.6	24.5
H=1500 km, i=63°	1.34	2.3	9.0	-
GTO (V=1500 m/s)	-	-	2.4	6.6
GEO	-	-	1.0	4.0
Fairing diameter / length, m	2.5/6.7	3.7/9.8	4.35/13.2	4.5/20.0
Maiden launch	?	2011	?	2011

Launch facilities

The main launch facilities of Russian launchers are presented below with the main associated launchers.

Launch site	Launchers
Plesetsk	▪ Cosmos 3M ▪ Cyclone 3 ▪ Soyuz ▪ Molnya ▪ *Angara*
Baikonour, Kazakhstan	▪ Cyclone-2 ▪ Soyuz ▪ Zenit ▪ Proton

The Svobodny launch facilities are deactivated and the new facilities in Vostochny will be built. More details on the Federal Target Programme for the Development of Russian Cosmodromes can be found in 2.2.

1.3.3. The Russian space sector and its reorganisation

Constituent organizations of the Federal Space Agency

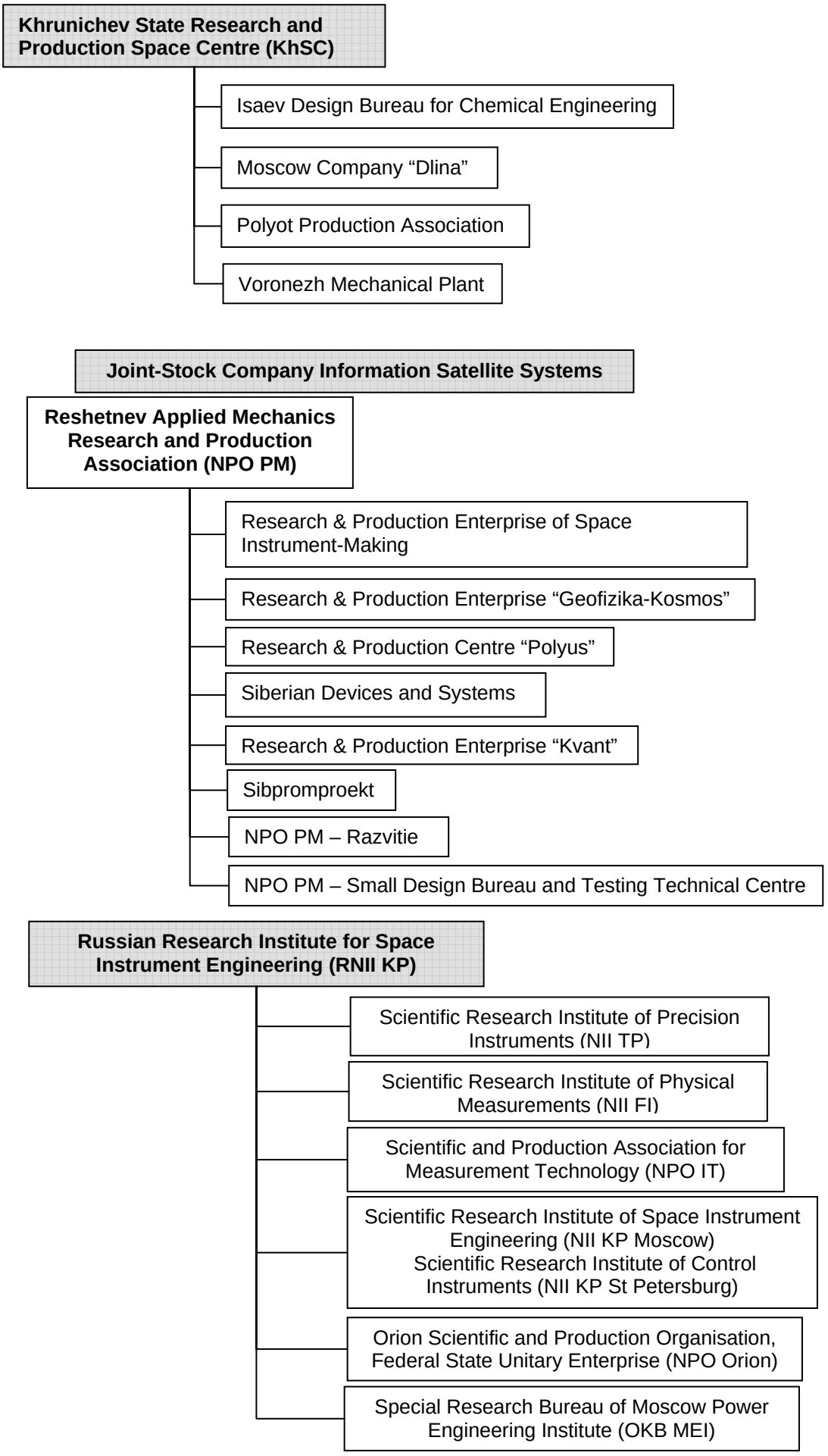
The FSA is responsible for 112 organizations, which represent most of the Russian space sector. These enterprises employ 250,000 people and are divided into:

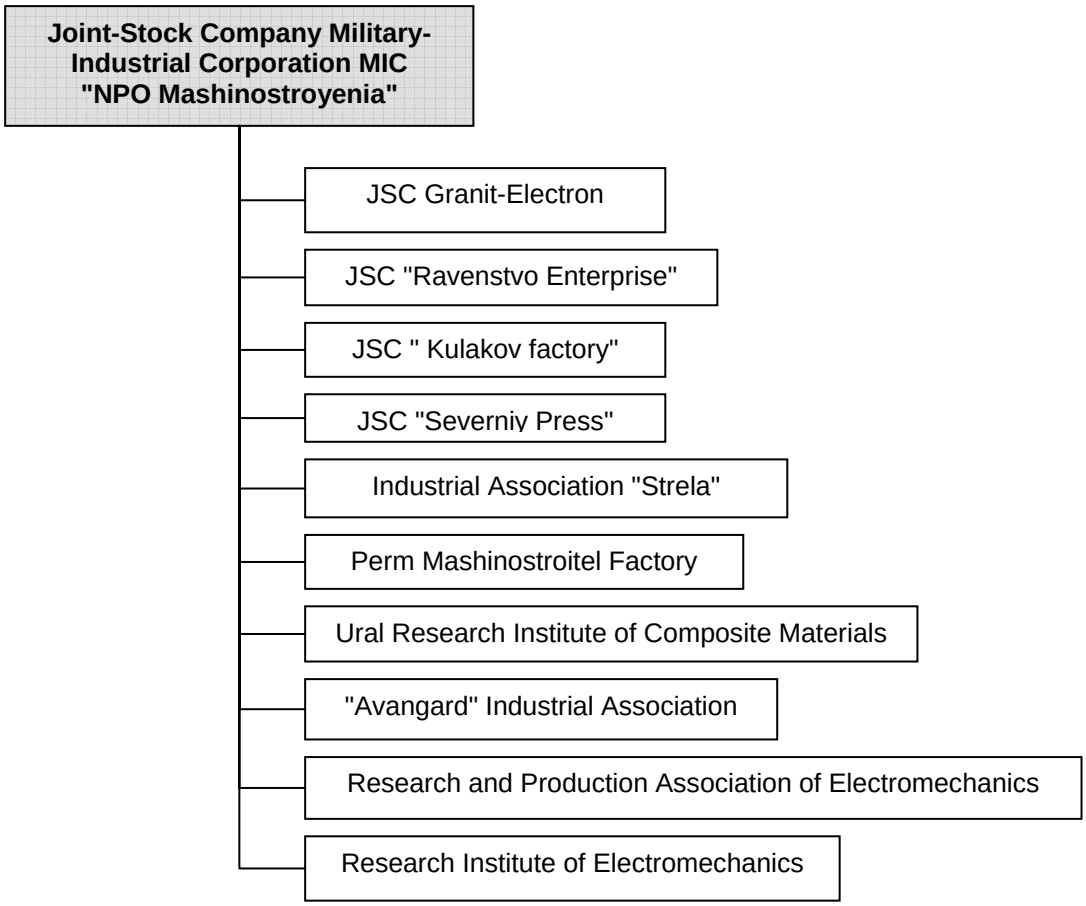
- Design offices, scientific research and design institutes
- Industrial companies
- Specialized centres and enterprises

Restructuring of the Russian space industry

According to the "Strategy for Development of the Space Industry up to 2015" ratified by the Government in January 2006, the space industry will be restructured in order to improve its competitiveness. The strategy includes the formation of a new organisational structure of the branch by creating 10-11 horizontally and vertically integrated structures by 2010 and setting up 3 to 4 space corporations that would encompass most of the main enterprises of the field before 2015.

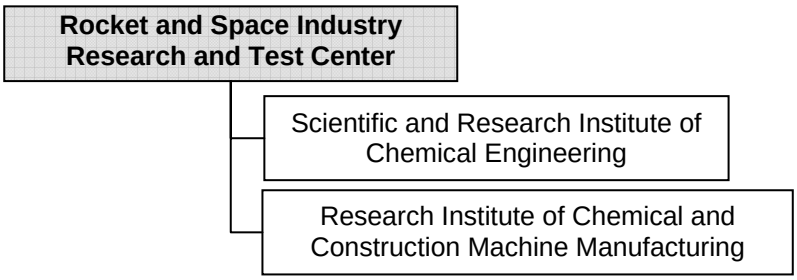
So far restructuring has taken place around the Khrunichev State Research and Production Space Centre and Reshetnev Applied Mechanics Research and Production Association.
The Khrunichev State Research and Production Space Centre (KhSC) was reorganised around the launchers activities according to a Presidential Decree of January 2007. The four subsidiaries of KhSC are: Polyot Production Association; Voronezh Mechanical Plant; the Moscow Company "Dlina"; and the Isaev Design Bureau for Chemical Engineering.
NPO PM is reorganised around the communications and navigation satellite activities. On June 9, 2006, the President of the Russian Federation signed the Decree "Related the Joint-Stock Company Information Satellite Systems" to be established under the responsibility of Reshetnev Applied Mechanics Research and Production Association NPO PM. The subsidiaries of the new enterprise are: Research & Production Center "Polyus" (Tomsk); the Research & Production Enterprise "Kvant" (Moscow); Siberian Devices and Systems (Omsk); Research & Production Enterprise "Geofizika-Cosmos" (Moscow); Research & Production Enterprise of Space Instrument-making (Rostov-on-Don); Sibpromproekt (Zheleznogorsk) ; *NPO PM – Razvitie (Zheleznogorsk); NPO* PM - Small Design Bureau and Testing Technical Center (Zheleznogorsk).
The Russian Research Institute for Space Instrument Engineering (RNII KP) will be restructured together with NII TP, NII FI, NPO IT, NII KP NPO OrionOKB MEI.[117]


Khrunichev State Research and Production Space Centre (KhSC)
Isaev Design Bureau for Chemical Engineering
Moscow Company "Dlina"
Polyot Production Association
Voronezh Mechanical Plant
Joint-Stock Company Information Satellite Systems
Reshetnev Applied Mechanics Research and Production Association (NPO PM)
Research & Production Enterprise of Space Instrument-Making
Research & Production Enterprise "Geofizika-Kosmos"
Research & Production Centre "Polyus"
Siberian Devices and Systems
Research & Production Enterprise "Kvant"
Sibpromproekt
NPO PM – Razvitie
NPO PM – Small Design Bureau and Testing Technical Centre
Russian Research Institute for Space Instrument Engineering (RNII KP)
Scientific Research Institute of Precision Instruments (NII TP)
Scientific Research Institute of Physical Measurements (NII FI)
Scientific and Production Association for Measurement Technology (NPO IT)
Scientific Research Institute of Space Instrument Engineering (NII KP Moscow)
Scientific Research Institute of Control Instruments (NII KP St Petersburg)
Orion Scientific and Production Organisation, Federal State Unitary Enterprise (NPO Orion)
Special Research Bureau of Moscow Power Engineering Institute (OKB MEI)



Further restructuring will take place around Glushko Energomash Research and Production Association (Energomash NPO) in the field of propulsion, around Reutov Engineering Research and Production Association in the field of electronics, the Progress State Research and Production Rocket Space Centre (TsSKB-Progress), and the Korolev Rocket and Space Corporation Energia (RSC Energia).[118]

In addition, the Rocket and Space Industry Research and Test Center was created by merging the Scientific and Research Institute of Chemical Engineering with the Scientific and Research Institute of Chemical and Construction Machine Manufacturing.



Cooperation with other Russian organisations

Roscosmos is cooperating with the following Russian organizations:

- Astrasystems[119], Moscow, was created in 2005 by Energya, Kaskol and the Russian Insurance Centre to promote the Russian space industry in global markets.
- The Institute for Biomedical Problems (IBMP)[120], Moscow
- RAS Vernadsky Institute of Geochemistry and Analytical Chemistry[121], Moscow
- RAS Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation (IZMIRAN)[122], Troitsk, Moscow Region
- Gromov Flight Research Institute[123], Zhukovskiy, Moscow Region
- Zhukovsky Central Aerohydrodynamic Institute[124], Zhukovskiy, Moscow Region
- The Russian Satellite Communications Company (RSCC), a national satellite communications operator[125]

The Russian Academy of Sciences

Space-related activities are conducted mainly in the Department of Physical Sciences within its General Physics and Astronomy Section, in particular in the Space Research Institute (IKI), as well as in the Institute of Astronomy[126], the Pulkovo Observatory[127], the Institute of Applied Astronomy[128], the Institute of Radio Engineering and Electronics[129], the Special Astrophysical Observatory[130], and in the Department of Physical Chemistry and Biology, in the Institute for Biomedical Problems (IBMP) of the State Research Centre of the Russian Federation.
Among the 14 Scientific Councils of the RAS Presidium, there is a Space Council. In addition, an "Interdepartmental Council on Space Power Problems" was established between the RAS and Rosaviaksomos (now FSA).

1.3.4. International joint ventures

Launchers

- Sea Launch Company[131]

The Sea Launch Company was created in 1995 as a joint venture between five partners from USA, Russia, Ukraine and Norway to commercialize Zenit-3SL launch services from a platform in the Pacific Ocean. The responsibilities and shares of the partners are detailed in Table 6 and Figure 26.

Company	Country	Responsibility
Boeing	USA	Payload fairing, spacecraft integration and mission operations
Aker Kvaerner	Norway	Launch platform and command ship
Energia	Russia	Block DM-SL upper stage (Zenit-3SL upper stage), launch vehicle integration and mission operations
Yuzhnoye / Yuzhmash	Ukraine	First two Zenit-3SL stages, launch vehicle integration support and mission operations

Table 6: Sea Launch partners and their responsibilities

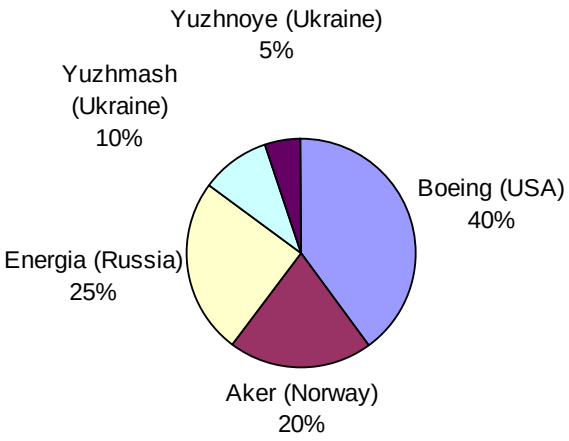


Figure 26: Sea Launch shareholders

In 2003, the Sea Launch partners decided to commercialize a new version of the Zenit-3SL launcher, the Zenit-3SLB, from Baikonour and created the Land Launch system. Land Launch is marketed by the Sea Launch Company with a subcontracting arrangement with Space International Services (SIS) as shown on Figure 27. The Sea Launch Company provides contracting and management functions for the Land Launch system, while SIS provides all launch system components, mission integration and launch operations from Russia, Ukraine and Kazakhstan.

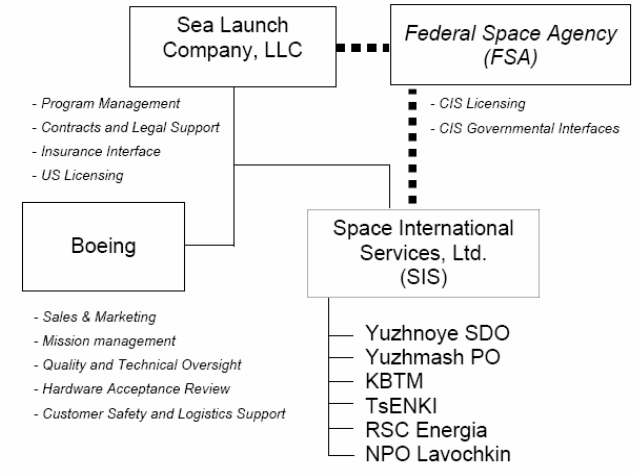


Figure 27: Structure of Sea Launch

- International Launch Services (ILS)[132]

ILS was created in 1995 to commercialize the Proton launch services. It is an American–based joint venture of Space Transport Inc., Khrunichev State Research and Production Space Center of Moscow and RSC Energia of Moscow. Lockheed Martin withdrew from the joint venture in 2006.

- Eurockot Launch Services[133]

Eurockot was created in 1995 to commercialize the Rockot launch system to operators of Low Earth Orbit (LEO) satellites. It is a joint venture of EADS Astrium and Khrunichev State Space Research and Production Space Center (KhSC), holding 51% and 49% respectively. It has dedicated launch facilities in Plesetsk Cosmodrome in Norther Russia.

- Starsem[134]

Starsem was created in 1996 to commercialize the Soyuz launch services. It is a joint-venture between EADS Space, Arianespace, the Russian Federal Space Agency and the Samara Space Center (TsSKB-Progress), as detailed in Figure 28.

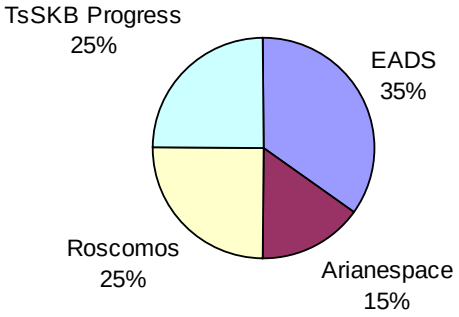


Figure 28: Starsem's shareholders

Propulsion technologies

- Snecma – OBK Fakel

In 1993, Snecma (belonging today to the Safran Group) teamed up with the Russian manufacturer of plasma thrusters, EDB Fakel. Safran markets the Fakel SPT100 stationary plasma thruster in Europe, via the joint venture ISTI, created with the American satellite manufacturer Space Systems/Loral. About 50 of these thrusters have been sold to Thales Alenia Space and Astrium, and some of them are already in service today on three satellites: Intelsat 10, Inmarsat 4-F1 and Inmarsat 4-F2. Safran is also developing its own plasma thruster in collaboration with Fakel, the PPS 1350, based on European technologies. The first application of this thruster was on the ESA mission Smart-1, which it propelled into orbit around the Moon.

1.4. Legal Framework

1.4.1. National space legislation

The Russian space activities are regulated by the law *On space activities* adopted in August 1993. In this law, the responsibilities of the President, the Government and the Federal Space Agency in the country's space activities are established.

In October 1996, the 1993 law was modified and the new law contributed to the deregulation of the sector. For instance, it removed a number of norms and standards present in the first edition of the law, such as the prohibition of conducting explosions in space and limiting the participation of organizations with foreign capital in the Federal Space Programme. The need to inform the public about space activities in Russia was also removed. This law was further amended several times in 2003, 2004, and 2006.

The Presidential Decree *On the Systems and Structure of Federal Bodies Representing the Executive Power* of March 2004 established the Federal Space Agency as one of the 28 Federal Agencies, reporting directly to the Prime Minister.

1.4.2. International treaties and arrangements

The Russian Federation, as a successor state to the Soviet Union, ratified most of the main international treaties governing space activities as detailed in Table 7.

Outer Space Treaty	R
Rescue Agreement	R
Liability Convention	R
Registration Convention	R
Moon Agreement	-
Nuclear Test Ban	R
ITU	R

Table 7: Russia's ratification of the main international treaties

The Russian Federation is partner of the Missile Technology Control Regime (MTCR) and is participating State of the Wassenaar Arrangement as well as a subscribing State to the Hague code of conduct against Ballistic Missile Proliferation.

1.4.3. Export Control

The main export control organization is Rosoboronexport State Corporation.[135] It is the sole Russian state intermediary agency for export and import of military and dual-purpose products, technologies and services. The Enterprise was established in 2000.

2. National policies

2.1. Rationale for space activities

Russia's main rationales for investing in space are:
- Maintaining and further developing the expertise and capabilities
- Prestige
- National security
- Economic benefits and diversification of the economy in a high-tech field

2.2. National priorities in the space field

Russia is currently conducting 3 large civil space programmes:
- The Federal Space Programme 2006-2015
- The Federal Target Programme on GLONASS 2002-2011
- The Federal Target Programme on the Development of Russia's Cosmodromes 2006-2015

2.2.1. The Federal Space Programme 2006-2015

The implementation of this programme is under the responsibility of Roscosmos. The programme was adopted by Decree of the Government of the Russian Federation on 22 October 2005. As mentioned in 1.2.2., the total budget of the programme over the 2006-2016 has been estimated at about 500 billion rubles, i.e. more than 13 billion euros.

The main missions included in the Federal Space Programme 2006-2015 are listed in Table 8. The missions in italics refer to commercially funded missions.

Scientific missions	
Exo-atmospheric astrophysics	Astrophysical observatories ▪ Spektr-Radioastron 2008 ▪ Spektr-UF - WSO ▪ Spektr-RG to become Spektr-RG/eROSITA/Lobster 2011 ▪ Gamma-400 2013
Planetology	▪ Phobos-Grunt 2009 ▪ Luna-Glob 2012 ▪ Venera-D 2016
Study of the Sun	▪ Coronas-Photon ▪ Resonans 2012 ▪ Interheliozond 2014
Research in space biology, physiology and materials science	▪ Bion-M ▪ Photon-M ▪ Vozvrat-MKA
Earth Observation missions	
Hydrometeorology	▪ Meteor-M (x3) ▪ Meteor-MP (x3) ▪ Electro-L ▪ Electro-M
Earthquake detection and emergencies monitoring	▪ Kanopus-V (x4)
Natural resources monitoring	▪ *Resurs-P (x2)*
Gas prospecting and pipeline monitoring	▪ *Smotr (x6)*
Radar	▪ *Arkon-Viktoria (x2)* ▪ *Arkon-2 (x2)* ▪ *Kondor-3 (x4)*
Remote sensing smallsat	▪ *Ekola (x2)*
International Space Station	
	▪ Docking Cargo Module 2010 ▪ Laboratory Module FGB-2 2008? ▪ OKA-T maintenance spacecraft
COSPAS SARSAT	
	▪ Sterkh (x4)

Table 8: Missions of the Federal Space Programme 2006-2015

24 commercially-funded telecom satellites will also be deployed under the Federal Space Programme 2006-2015, i.e. 21 Express, 1 Yamal, Polyarna Zvezda, and Sadko. In addition, 2 Luch-M relay systems and 12 Gonets-M personal communication and data transfer system in LEO will be launched and funded by the Programme budget.

The 2008 year budget of Roscosmos will be used to accomplish the following tasks:[136]

- Preparation of the national space policy principles for the period up to 2020 and after
- Preparation of the projects' changes in the GLONASS and the Federal Space Programme, taking into account the discontinuation of American shuttles flights beginning from 2010 and two-fold increase in the station's crew number
- Development of the federal special-purpose programme "Use of space activities for the social and economic development of the Russian Federation and its regions 2009-2015"
- Organization of works guaranteeing the beginning of the building of the new spaceport "Vostochny" in the Far-Eastern federal region

- Launches of :
  - Three satcoms Express-AM33, -AM44, and - MD
  - Two meteorological satellites Electro-L and Meteor- M
  - Two scientific spacecraft Spectrum- R and Koronas- Photon
  - Seven transport ships, including two manned ships Soyuz-TMA, and five cargo ships Progress-M
  - Six navigation satellites GLONASS- M
  - Two spacecraft Sterkh for the international system of search and rescue KOSPAS - SARSAT

2.2.2. The Federal Target Programme on GLONASS 2002-2011

The GLONASS programme was established by the resolution of the Security Council of the Russian Federation of 6 February 2001. All the programme's stakeholders are summarised in Figure 29. The Federal Space Agency, Roscosmos, is coordinating the programme.

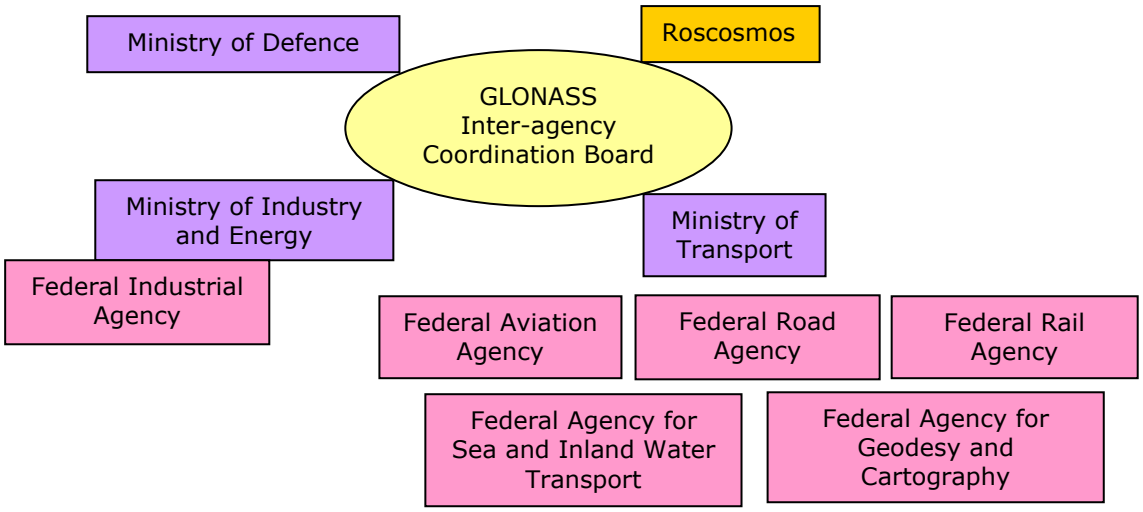


Figure 29: Stakeholders of the GLONASS programme

The development of the GLONASS system started in the seventies with the first launches of actual satellites in 1985-1986. The system is nominally composed of 24 satellites, 21 in use and 3 spares. It was declared operational in September 1993 by President Yeltsin but the constellation was not complete until December 1995, as detailed in Figure 30. After the completion of the system, Russia was not able to maintain it and the number of satellites gradually decreased down to 7 satellites in 2001. The current Federal Target Programme started in 2002 and the constellation is expected to be completed by 2011-2012.

Figure 30: GLONASS System Deployment (number of satellites deployed)[137]

2.2.3. The Federal Target Programme on the Development of Russia's Cosmodromes 2006-2015

The Federal Target Programme on Cosmodromes is under the responsibility of the Ministry of Defence but also involves the Federal Agency for Special Construction.
The goals of the programme is to ensure Russia's guaranteed and independent access to space, i.e. launches of the entire spectrum of launch vehicles and spacecraft to all required orbits from the Russian territory. For that purpose, the Plesetsk launch infrastructure will be upgraded to launch defence satellites onboard Soyuz-2 rockets from 2010 and a launch pad will be built for the new Angara launcher.[138]

The programme is divided into two stages. During the first stage (2006-2010) the Plesetsk launch infrastructure is being upgraded for Soyuz-2 launches and the construction of the infrastructure for the new Angara launcher is starting. During the second stage (2011-2015), all military launches from Baikonour, Kazakhstan, will then be transferred to Plesetsk and the launch infrastructure for Angara will be completed.

The Federal Target Programme is to be amended in 2008 to include the construction of the Vostochny cosmodrome. In November 2007, President Putin signed a decree converting the Svobodny launch infrastructure in the Amur region of the Russian Far East into the new launch infrastructure Vostochny. At the Security Council's session of April 2008 he has given a new impetus to the construction of Vostochny and to the development of the new Angara launcher. The new objectives are to launch from Vostochnny the first unmanned missions in 2015 and all Russian manned missions, which so far have been launched from Baikonour, after 2020.[139,140]

All the present goals of the Federal Target Programme on the Development of Russia's cosmodromes are summarized in Figure 31.

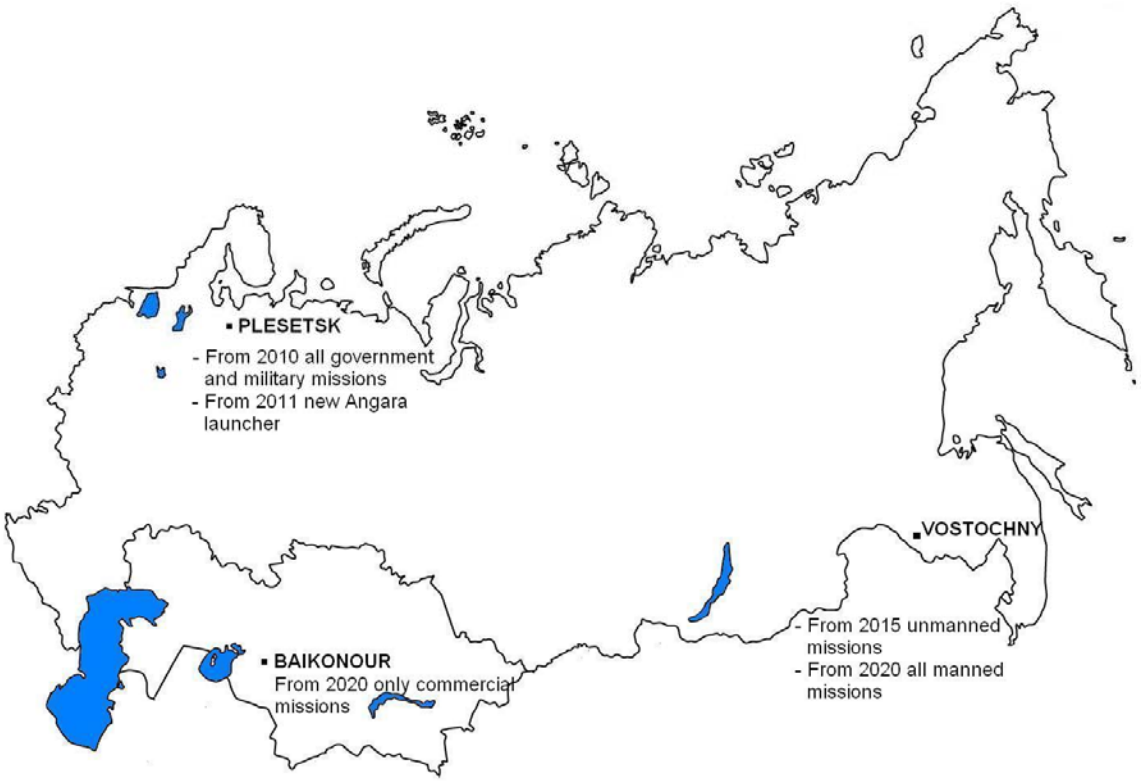


Figure 31: The objectives of the Federal Target Programme on Cosmodromes

2.3. International cooperation

2.3.1. International organisations

The Russian Federation as a successor state of the Soviet Union belongs to the main space-related organisations, as detailed in Table 9.

ITSO / Intelsat	M
Intersputnik	M
Intercosmos	M
IMSO / Inmarsat	M
Eutelsat	M
Eumetsat	-
GEOSS	M
KOSPAS-SARSAT	M

Table 9: Russia's membership in the main space-related international organizations

2.3.2. Cooperation agreements

In addition to its agreements with the CIS countries, Russia has intergovernmental agreements with:

- Belgium
- Bulgaria
- France
- Germany
- Hungary
- Italy
- Spain
- ESA
- Australia
- Brazil
- Chile
- China
- India
- Indonesia
- Japan
- Mexico
- Republic of Korea
- USA
- South Africa

Russia has also multilateral intergovernmental agreements on the ISS, on launches from Baikonour, on Cospas-Sarsat and on a regional radionavigaiton service in the Far-East.

Annex C

Chronologies of Russia's Space Cooperation with India and China

Russian - Chinese Space Cooperation

50ies
USSR gave China two German A-4s and invited students to study Soviet rockets

September 1956
Agreement to sell China 2 R-1 missiles [141]

October 1956
Delivery of the 2 R-1 missiles to China [42]

20 August 1957
Signing of the agreement "New Defence Technical accord 1957-87" to supply missile models, technical documents, designs and specialists[141,142]

January 1958
Delivery of several R-2 missiles along with blueprints and technical documents and arrival in China of a hundred Soviet specialists [42,142]
Beginning of "Project 1059", aimed at producing Chinese a copy of the R-2 missile [141]
Fifty Chinese graduates went to study in Moscow [142]

August 1960
Split between the USSR and China - Relations suspended – 1400 Soviet specialists returned to Moscow and over 200 joint projects were cancelled [141,142]

5 November 1960
Maiden flight of the DF-1, the Chinese version of the R-2 [42]

May 1989
President Gorbachev's visit to China – Relations restored

May 1990
Signing of an agreement to cooperate on ten projects in fields including satellite navigation, space surveillance, propulsion, satellite communications, materials, intelligence sharing and space systems testing [142]

December 1991
Dissolution of the USSR

18 December 1992
Signing of a ten-year intergovernmental agreement on space cooperation[143]
Chinese students invited to study the Soyuz spacecraft, Russian ground and tracking facilities and environmental control systems for manned spacecraft [144]

25 March 1994
Signing of a protocol on space cooperation between CNSA and the Russian Space Agency, updating the 1992 agreement [145], with a main focus on manned spaceflight [42,142 ,146, 141]

25 March 1995 [42,141 144, 147]
Signing of an intergovernmental agreement on space cooperation, specifying Russian assistance to China in the area of manned spaceflight and sale of engines.

The Chinese bought Russian RD-120 rocket engines, a LOX/Kerosene engine used for the 2nd stage of the Zenit launcher. The Russians refused to sell RD-170 engines, a powerful LOX/Kerosene engine originally used for the 1st stage of Energya.

The Chinese later bought an entire spacecraft life support system, a Kurs rendez-vous system, a docking module, a full Soyuz capsule - emptied of all equipment and electronics - and a Sokol spacesuit that is used during ascent and landing but not for EVAs.
The agreement also included the training of two Chinese cosmonauts at Star City.

25 April 1996
Signing of a ten-year intergovernmental agreement on space cooperation in the field of manned spaceflight, including the training of Chinese specialists at Star City [145,146]

1996-98
Training of two cosmonauts instructors, Wu Tse and Li Tsinlung, at Star City[144] with 20 to 50 Chinese specialists[141]

1997
Agreements on the 1997-98 programme of Russian-Chinese cooperation in manned spaceflight and on the 2000-2002 programme of cooperation on exploration[148]

Early 2000
Agreement to set up a joint sub-committee on space cooperation of the committee for the regular meeting between the Chinese and Russian Prime Ministers

25-26 May 2000
1st meeting of the joint sub-committee on space cooperation in Beijing
Signing of a protocol including an elaboration of bilateral space initiatives, including joint programmes in navigation, manned space missions, space communications and space research.[145]

2000
Discussions on a possible utilisation of the Mir station by the Chinese [141]

2000
Discussions on cooperation in manned spaceflight - Agreement for:[141,144]
Technical assistance in the design of the Chinese space station
Russians would build a limited number of components of the station
Training for taikonauts and ground controllers
Transfer of 36 specific areas of station technology - only eleven had resulted in contracts[145]

January 2000
Technical consultancy of two Russian cosmonauts, A. Berezovoi and A. Filipchenko [144]

July 2001
Signing of a five-year space cooperation agreement (2001-2006), including joint endeavours in research, construction of space systems and instruments

August 2001
2nd session of the joint sub-committee on space cooperation

27 June 2002
Submission to the Conference on Disarmament of a joint proposal for a new international treaty to ban weapons in outer space

13 August 2002
3rd session of the joint sub-committee on space cooperation
36 priorities in space exploration up to 2005 discussed

22 August 2002
Meeting of Russian and Chinese Prime Ministers who confirmed 21 areas of cooperation in the space field
Russians agreed to fly Chinese experiments to the Russian module of the ISS[144] - a kilo of rice seeds from Harbin Institute of Technology on a 6-month culture experiment[141]
Russia and China agreed to 13 areas of bilateral space cooperation, including remote sensing, telecommunications, and navigation.

29 August 2003
4th session of the joint sub-committee on space cooperation[149]

24 August 2004
5th session of the joint sub-committee on space cooperation[150]

27 June 2005
6th session of the joint sub-committee on space cooperation[151]
Plans for joint Moon research formalised[152]
Setting up of the joint task group on Moon and Deep Space exploration (part of the joint sub-committee on space cooperation)
Joint projects might include an Ultraviolet space observatory, a joint system of radio interferometers and Radioastron[153]

September 2005
29 projects added to the cooperation programme 2004-2006[154]

November 2005
Signing of a ten-year cooperation agreement (2007-2016) in ten project areas including:
Mars missions (including the future Russian Phobos-Grunt with the Chinese Yinghuo 1)
Spacewalk training for taikonauts
Advice to China on lunar landing probes
Possible cooperation on the future Spektr-UF (WSO/UV), Radioastron and a Russian-Chinese system of very long baseline radio-interferometers using existing radio telescopes[153]

12 May 2006[155]
9th session of the joint sub-committee on space cooperation

9 November 2006 [144,156]
Statement of cooperation on the Russian missions Phobos-Grunt, Spektr–UF (WSO/UV) (China would contribute a telescope instrument and ground monitoring stations[157]) and Radioastron, as well as on the next Chang'e missions
Joint programme for 2007-2011 adopted [158]
In 2006, 38 joint projects are undertaken[156]

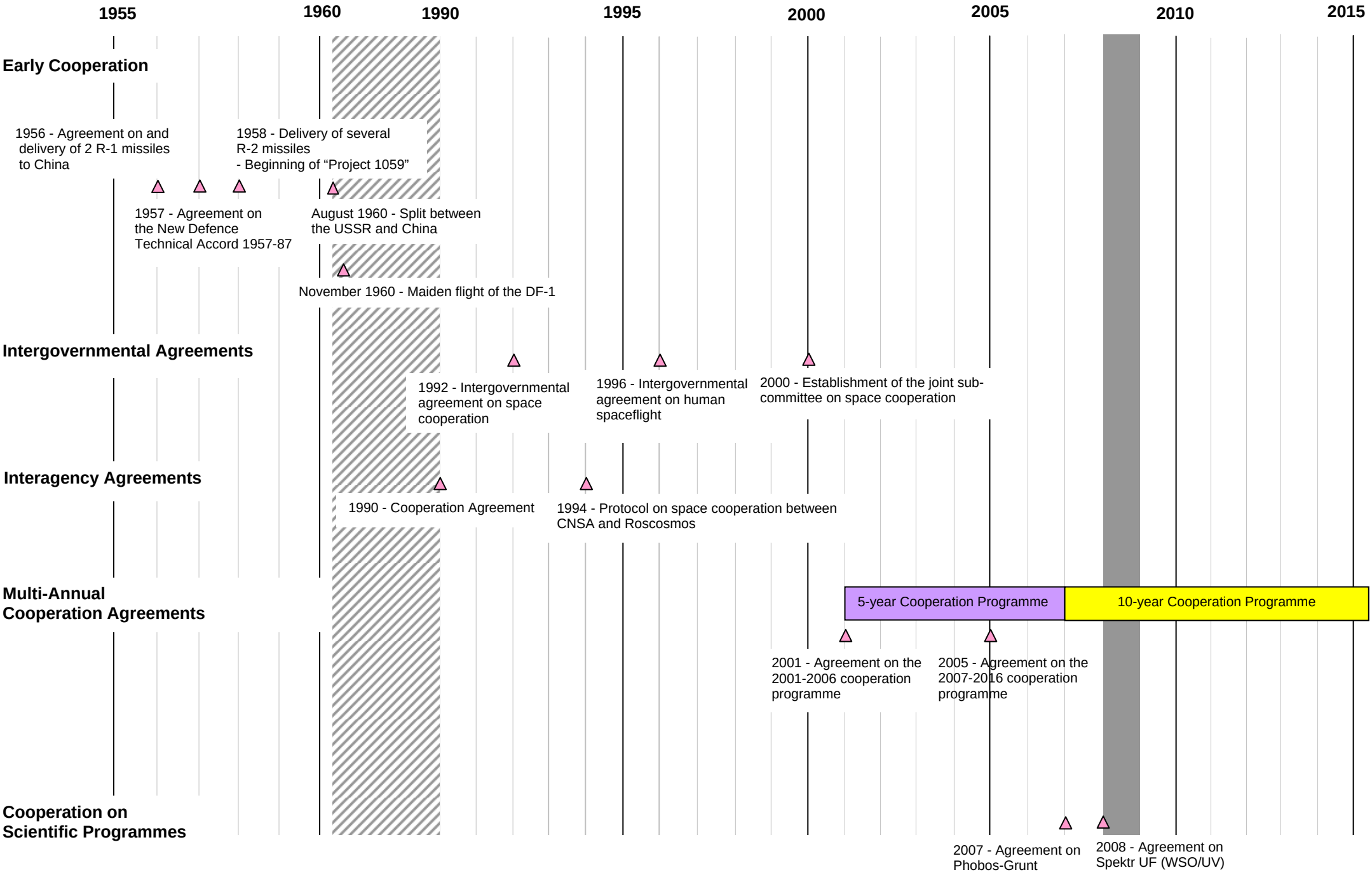
26 March 2007
Agreement on joint exploration of Mars with the Chinese Yinghuo 1 onboard Russian Phobos Grunt[159,160] *(to be launched in October 2009)*

28 June 2007 [161,162]
3rd meeting of the joint task group on Moon and Deep Space exploration (part of the joint sub-committee on space cooperation)
Discussion on Phobos-Grunt, Spektr UF (WSO/UV), Radioastron and a Russian-Chinese system of very long baseline radio-interferometers using existing radio telescopes and joint Moon studies

February 2008
Sino-Russian conference on Spektr UF (WSO/UV) in Beijing

12 February 2008
Joint submission to the Conference on Disarmament of the draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects

April 2008
Signing of an agreement on cooperation for Spektr UF (WSO/UV) - China could contribute with an instrument (spectrograph) and could participate in the ground segment construction and use[163]


Russian – Chinese Space Cooperation
1955
1960
1990
1995
2000
2005
2010
2015
Early Cooperation
1956 - Agreement on and delivery of 2 R-1 missiles to China
1957 - Agreement on the New Defence Technical Accord 1957-87
1958 - Delivery of several R-2 missiles
- Beginning of “Project 1059”
August 1960 - Split between the USSR and China
November 1960 - Maiden flight of the DF-1
Intergovernmental Agreements
1992 - Intergovernmental agreement on space cooperation
1996 - Intergovernmental agreement on human spaceflight
2000 - Establishment of the joint sub-committee on space cooperation
Interagency Agreements
1990 - Cooperation Agreement
1994 - Protocol on space cooperation between CNSA and Roscosmos
Multi-Annual Cooperation Agreements
5-year Cooperation Programme
10-year Cooperation Programme
2001 - Agreement on the 2001-2006 cooperation programme
2005 - Agreement on the 2007-2016 cooperation programme
Cooperation on Scientific Programmes
2007 - Agreement on Phobos-Grunt
2008 - Agreement on Spektr UF (WSO/UV)

Russian - Indian Space Cooperation

60ies
The USSR assisted India in setting up the Thumba Equatorial Rocket Launching Station (TERLS)

1970
MoU between the USSR and India on their collaboration in the organisation of atmospheric research with soviet sounding rockets at TERLS[164]

19 April 1975
Launch of the first Indian satellite Aryabhata by a Cosmos Soviet rocket
Aryabhata was developed, manufactured and tested with Soviet assistance

7 June 1979
Launch of the second Indian satellite Bhaskara-I by a Cosmos Soviet rocket
Bhaskara-I was developed, manufactured and tested with Soviet assistance

---

20 November 1981
Launch of the third Indian satellite Bhaskara-II by a Cosmos Soviet rocket

April 1984
Flight of Squadron Leader Rakesh Sharma aboard the Salyut 7 space station, as part of the Intercosmos Programme

17 March 1988
Launch of IRS-1A by a Soviet rocket Vostok - First Soviet commercial launch

---

December 1991
Dissolution of the USSR

1993
Agreement on the joint development of a cryo-engine to be flown as the GSLV upper stage, later denounced by President G.H. Bush as a violation of the MTCR
The US applied commercial sanctions to India, and Russia pulled out of the agreement (negotiations ISS were ongoing)[144]

1994
New agreement on the cryo-engine KVD-1.
Russia agreed to transfer three, later renegotiated to seven, KVD-1 without the associated technology. India was required to use the KVD-1M (Indian version) only for peaceful purposes, not to re-export it nor to modernise it without Russian consent

1994
Signature of intergovernmental and interagency agreements on cooperation in space exploration

---

18 April 2001
Maiden launch of the GSLV with the cryo-engine KVD-1M (Satellite: Gsat-1)

8 May 2003
2nd launch of the GSLV with KVD-1M (Satellite:Gsat-2)

20 September 2004
3rd launch of the GSLV with KVD-1M (Satellite: Edusat)

December 2004[165]
First agreement signed on GLONASS
Cooperation in ground infrastructure development and participation of India in the GLONASS constellation sustainment

December 2005[166]
Agreement to protect intellectual property rights and safeguard technology used in GLONASS
The agreement envisages the launch of GLONASS satellites on the Indian GSLV launcher and the access to GLONASS signals by India. It also envisages joint development of user equipment for the exploitation of GLONASS signals for commercial purposes.[167]
Agreement on Coronas-Photon (including the integration of the Indian RT-2 payload and joint experiment using this payload)

8 July 2006
Failure of the 4th launch of the GSLV with KVD-1M (Satellite: Insat-4C)

4 October 2006
Discussion on space cooperation
One of the projects considered was the Russian participation in the second Indian lunar mission, Chandrayaan-2, then planned for 2010-2011. It was expected that NPO Lavochkin would develop technology for taking lunar soil samples for the probe.

March 2006[166]
Two agreements on GLONASS
- India to launch a Glonass-M on GSLV
- Joint development of the Glonass-K (India to supply the platform of the satelites)

August 2007
Aryabhatta Research Institute of Observational Sciences' telescope made by Russian and Belgian firms to be installed in India's Himalayas in 2012
The Russian government might contribute one million euros

September 2007[168]
Discussion on space exploration including:
- Chandrayaan 2 as a joint mission
- Students satellite – YouthSat with Russian and Indian scientific instruments onboard a satellite built and launched by India to study the Earth's upper atmosphere
- Coronas-Photon / The Tata Institute of Fundamental Research will supply a low-energy gamma ray telescope for a Russian spacecraft that was planned to be launched in 2008 to study solar physics

13 November 2007
Roscosmos and ISRO signed an agreement for joint lunar exploration through 2017, including the construction of a module that will orbit the Moon
In 2011, India plans to launch its second lunar probe, Chandrayaan-2, which would carry a 400-kilogram lunar rover built in Russia

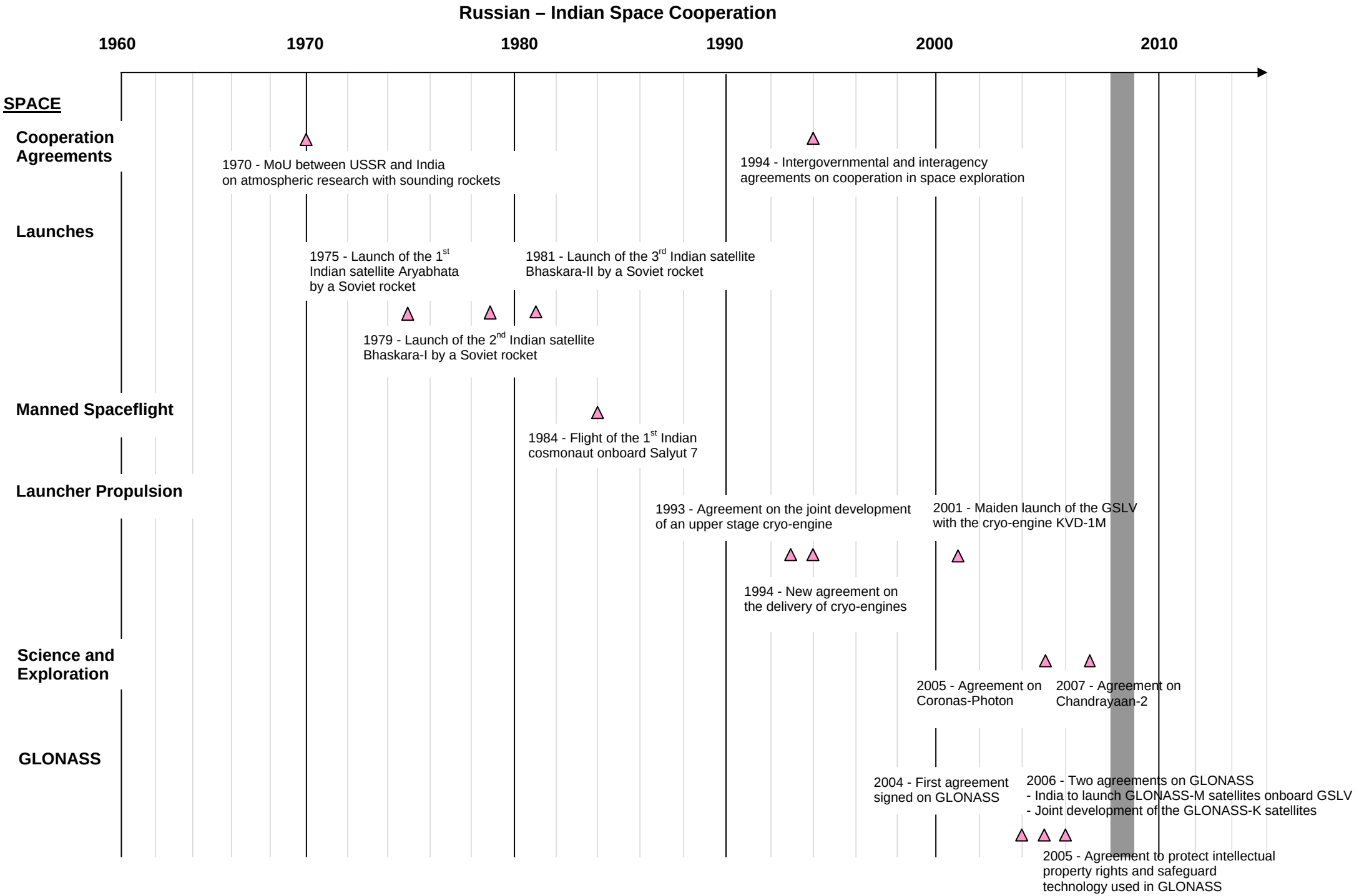
28 December 2007
Announcement to develop a new generation of manned vehicle – Negotiations expected to begin in January 2008 with Energya

Indian space experts were granted access to Russian ground control facilities (mission control and ground tracking equipment)

2007
Refurbishment of the 64-meter Russian antenna in Bearslake to support the Chandrayaan-1 mission

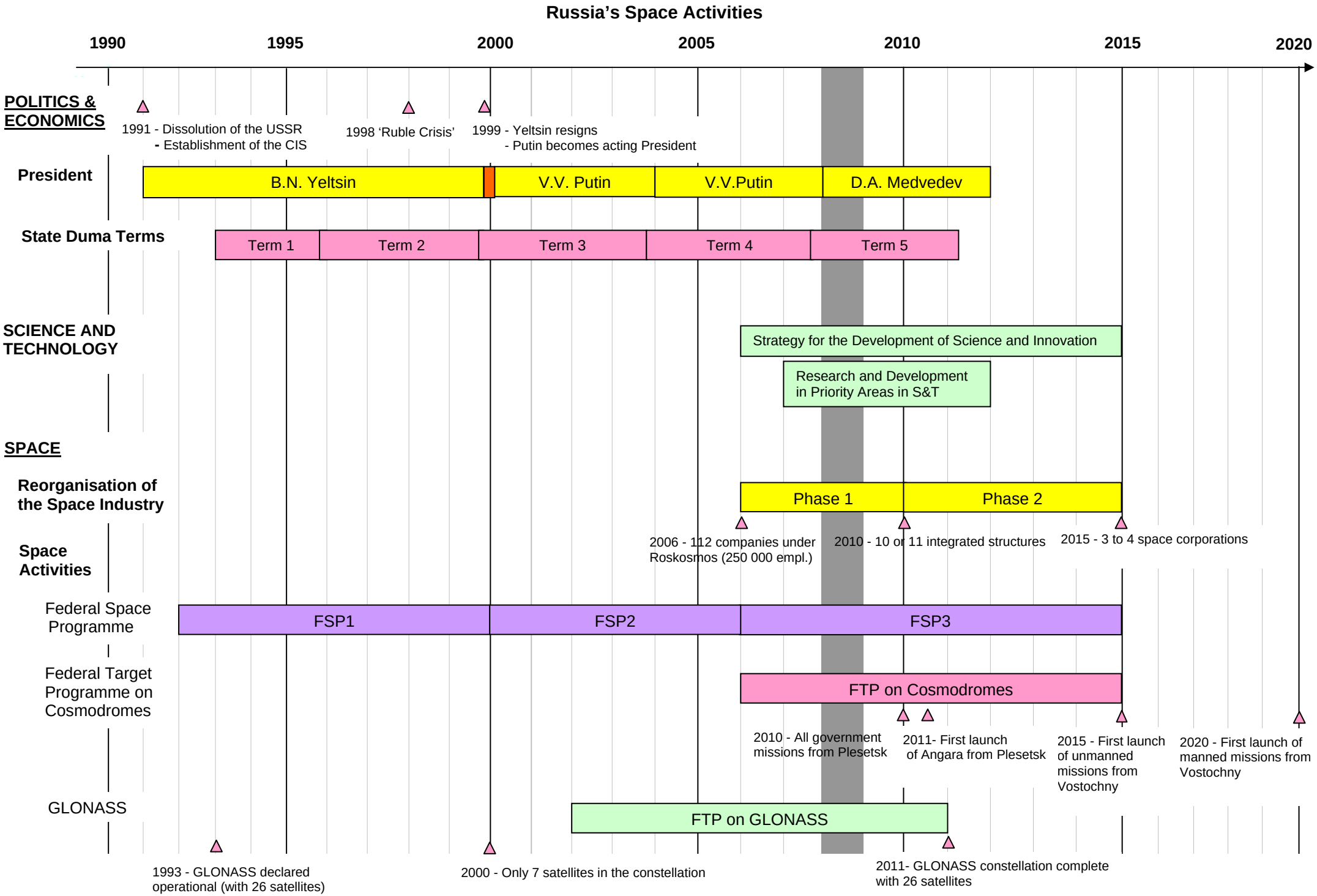
5 March 2008
Meeting between A. Perminov and M. Nair:[169]
- ISRO asked Roscosmos to send an Indian astronaut to the ISS
- ISRO proposed cooperation for upgrading the Soyuz spacecraft
- A joint working group of 8 agencies representatives will be formed to coordinate joint projects

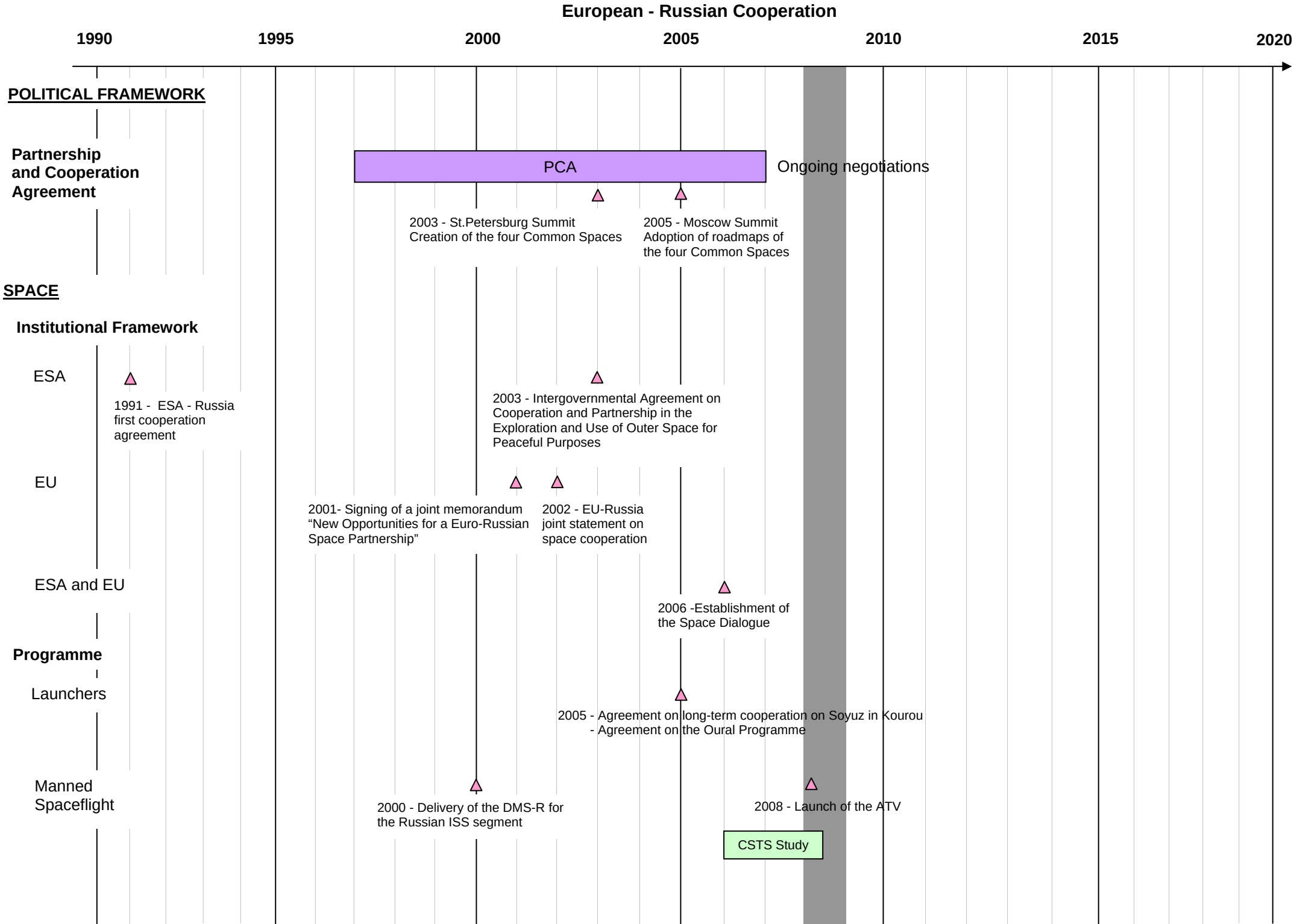
2008-9
The Indian National Centre for Radio Astrophysics (NCRA) should participate in the Russian mission Radioastron


Russian – Indian Space Cooperation
1960
1970
1980
1990
2000
2010
SPACE
Cooperation Agreements
1970 - MoU between USSR and India on atmospheric research with sounding rockets
1994 - Intergovernmental and interagency agreements on cooperation in space exploration
Launches
1975 - Launch of the 1st Indian satellite Aryabhata by a Soviet rocket
1981 - Launch of the 3rd Indian satellite Bhaskara-II by a Soviet rocket
1979 - Launch of the 2nd Indian satellite Bhaskara-I by a Soviet rocket
Manned Spaceflight
1984 - Flight of the 1st Indian cosmonaut onboard Salyut 7
Launcher Propulsion
1993 - Agreement on the joint development of an upper stage cryo-engine
2001 - Maiden launch of the GSLV with the cryo-engine KVD-1M
1994 - New agreement on the delivery of cryo-engines
Science and Exploration
2005 - Agreement on Coronas-Photon
2007 - Agreement on Chandrayaan-2
GLONASS
2004 - First agreement signed on GLONASS
2006 - Two agreements on GLONASS
- India to launch GLONASS-M satellites onboard GSLV
- Joint development of the GLONASS-K satellites
2005 - Agreement to protect intellectual property rights and safeguard technology used in GLONASS

Annex D

Chronologies of Russia's Space Activities and of European-Russian Cooperation


Russia's Space Activities
1990
1995
2000
2005
2010
2015
2020
POLITICS & ECONOMICS
1991 - Dissolution of the USSR
- Establishment of the CIS
1998 'Ruble Crisis'
1999 - Yeltsin resigns
- Putin becomes acting President
President
B.N. Yeltsin
V.V. Putin
V.V.Putin
D.A. Medvedev
State Duma Terms
Term 1
Term 2
Term 3
Term 4
Term 5
SCIENCE AND TECHNOLOGY
Strategy for the Development of Science and Innovation
Research and Development in Priority Areas in S&T
SPACE
Reorganisation of the Space Industry
Phase 1
Phase 2
2006 - 112 companies under Roskosmos (250 000 empl.)
2010 - 10 or 11 integrated structures
2015 - 3 to 4 space corporations
Space Activities
Federal Space Programme
FSP1
FSP2
FSP3
Federal Target Programme on Cosmodromes
FTP on Cosmodromes
2010 - All government missions from Plesetsk
2011- First launch of Angara from Plesetsk
2015 - First launch of unmanned missions from Vostochny
2020 - First launch of manned missions from Vostochny
GLONASS
FTP on GLONASS
1993 - GLONASS declared operational (with 26 satellites)
2000 - Only 7 satellites in the constellation
2011- GLONASS constellation complete with 26 satellites


European - Russian Cooperation
1990
1995
2000
2005
2010
2015
2020
POLITICAL FRAMEWORK
Partnership and Cooperation Agreement
PCA
Ongoing negotiations
2003 - St.Petersburg Summit
Creation of the four Common Spaces
2005 - Moscow Summit
Adoption of roadmaps of the four Common Spaces
SPACE
Institutional Framework
ESA
1991 - ESA - Russia first cooperation agreement
2003 - Intergovernmental Agreement on Cooperation and Partnership in the Exploration and Use of Outer Space for Peaceful Purposes
EU
2001- Signing of a joint memorandum "New Opportunities for a Euro-Russian Space Partnership"
2002 - EU-Russia joint statement on space cooperation
ESA and EU
2006 -Establishment of the Space Dialogue
Programme
Launchers
2005 - Agreement on long-term cooperation on Soyuz in Kourou
- Agreement on the Oural Programme
Manned Spaceflight
2000 - Delivery of the DMS-R for the Russian ISS segment
2008 - Launch of the ATV
CSTS Study

Annex E

Space in the EU-Russia Common Spaces' Road Maps

The Road Map to the Common Economic Space

Excerpts from the Road Map tor the Common Economic Space adopted by EU and Russian leaders at the St Petersburg Summit in May 2005

"1. General issues of trade and economic cooperation

1.6. Enterprise policy and economic dialogue

Objective: the development of in-depth dialogue on economic reform and enterprise policy, including an exchange of information on economic issues and policies, aiming at the improvement of the framework conditions for economic operators and their competitiveness, including dialogue in industrial policy

Actions:
Develop a dialogue on industrial policy. The specific sectors for this dialogue should include: Aerospace industries

Improvement of the framework conditions for industrial and R&D cooperation with the objective to foster industrial cooperation regarding design, production and exploitation of aerospace products"

"3. Networks: telecommunications and transport

3.1 Telecommunications, information society and e-business

Objectives: Co-operate towards the creation of a common EU-Russia Information Society area

Actions:
Provide appropriate environment for a fruitful cooperation on joint projects in space applications on broadcasting, telecommunication and broadband multimedia systems development"

"5. Space

Objective: to build an effective system of cooperation and partnership between the EU and the Russian Federation in the following fields of space activities:

- Access to Space: Launchers and Future Space Transportation systems:
- Space Applications: Global Navigation Satellite Systems (GNSS); global monitoring by satellites and satellite communications (see also section 3.1.)
- Space exploration and the use of the International Space Station (ISS)
- Space Technologies Development

Actions:
- Political cooperation to create favourable framework conditions in the field of space transportation, accompanying the cooperation between the European Space Agency and Russia; cooperation for the development of infrastructure for the launch of Russian SOYUZ-ST Launcher from the European Spaceport in the Guiana Space Centre

- Enhance and strengthen cooperation on Galileo and GLONASS GNSS including on compatibility and interoperability between the two systems and the creation of the conditions for industrial and technical cooperation, in the context of an intergovernmental agreement (see also section 3.2.)

- Provide appropriate environment for fruitful cooperation on Global Monitoring for Environment and Security (GMES) programme and for joint projects in satellite communication systems

- Coordinate the EU and the Russian positions towards the Global Earth Observation initiative (GEO)
- Continue cooperation and partnership in joint initiatives in space explorations, including Space Science on which relevant activities shall be carried out in the framework of the Common Space on Research and Education, including Culture
- Continue cooperation in the use of the ISS
- Support joint programmes and projects in Space Technology Development
- Setting up an expert group to establish an EU-Russia Dialogue on Space
- In the framework of the PCA institutions, establish a mechanism for cooperation to comply with the objectives agreed by the Parties
- Exchange information and ensure consultation on respective space programmes"

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Acronyms

APSCO	Asia-Pacific Space Cooperation Organisation
ASAT	Anti-Satellite Test
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ASLV	Advanced Satellite Launch Vehicle
ATV	Automated Transfer Vehicle
BERD	Expenditure on R&D in the Business Enterprise Sector
CBERS	China-Brazil Earth Resources Satellite
CIS	Commonwealth of Independent States
CNES	Centre National d'Etudes Spatiales
CNSA	Chinese National Space Administration
CSTS	Crew Space Transportation System
DF	Dong-Feng
DFH	DongFangHong
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Centre)
EC	European Commission
ENP	European Neighbourhood Policy
ENPI	European Neighbourhood and Partnership Instrument
EO	Earth Observation
ERA	European Robotic Arm
EU	European Union
ESA	European Space Agency
EVA	Extra-Vehicular Activity
FASIE	Foundation for Assistance to Small Innovation Enterprises
FCB	Functional Cargo Block
FDI	Foreign Direct Investment
FLPP	Future Launchers Preparatory Programme
FSA	Federal Space Agency
FSH	Fanhui Shi Wexing
FSP	Federal Space Programme
FY	FengYun
G8	The Group of Eight leading industrialized democratic nations
GAGAN	GPS Aided Geo Augmented Navigation
GDP	Gross Domestic Product
GEO	Global Earth Observation initiative
GEO	Geostationary Orbit
GEOSS	Global Earth Observation System of Systems
GERD	Gross Domestic Expenditure on Research and Development
GIB	Galileo International Board
GJU	Galileo Joint Undertaking
GLONASS	Global Navigation Satellite System
GMES	Global Monitoring for Environment and Security

GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GSA	European GNSS Supervisory Authority
GSLV	Geosynchronous Satellite Launch Vehicle
GTO	Geostationary Transfer Orbit
IAEA	International Atomic Energy Agency
IBMP	Institute for Biomedical Problems
ICAO	International Civil Aviation Organization
ICBM	Intercontinental Ballistic Missile
ICG	International Committee on Global Navigation Satellite Systems
ICT	Information and Communication Technology
IKI	Space Research Institute
ILS	International Launch Services
IMO	International Maritime Organization
IMSO	International Mobile Satellite Organization
INCOSPAR	Indian Committee for Space Research
IRNSS	Indian Regional Navigational Satellite System
ISRO	Indian Space Research Organisation
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
ITSO	International Telecommunications Satellite Organization
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
KSLV	Korea Space Launch Vehicle
KT	KaiTuozhe
LEO	Low Earth Orbit
LEO	Lunar Exploration Orbiter
MTCR	Missile Technology Control Regime
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NPC	National People's Congress
NPT	Non-Proliferation Treaty
OECD	Organization for Economic Co-operation and Development
OSCE	Organization for Security and Cooperation in Europe
PCA	Partnership and Cooperation Agreement
PPP	Purchasing Power Parity
PPWT	Prevention of the Placement of Weapons in Outer Space
PSLV	Polar Satellite Launch Vehicle
QZSS	Quasi-Zenith Satellite System
R&D	Research and Development
RAS	Russian Academy of Science
RFBR	Russian Fund for Basic Research
RFRH	Russian Foundation for Research in Humanities
RKA	Russian space agency

RSCC	Russian Satellite Communications Company
S&T	Science and Technology
SCO	Shanghai Cooperation Organisation
SIS	Space International Services
SJ	Shijian
SLC	Sea Launch Company
SLV	Satellite Launch Vehicle
SRE	Space Recovery Experiment
TACIS	Technical Aid to the Commonwealth of Independent States
TERLS	Thumba Equatorial Sounding Rocket Launching Station
UN	United Nations
UNOOSA	United Nations Office for Outer Space Affairs
US	United States
USSR	Union of Soviet Socialist Republics
VLBI	Very Long Baseline Interferometry
WSO/UV	World Space Observatory for Ultraviolet
WTO	World Trade Organization
ZY	Ziyuan

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Mission Statement of ESPI

The mission of the European Space Policy Institute (ESPI) is to provide decision-makers with an independent view and analysis on mid- to long-term issues relevant to the use of space.

Through its activities, ESPI contributes to facilitate the decision-making process, increases awareness of space technologies and applications with the user communities, opinion leaders and the public at large, and supports students and researchers in their space-related work.

To fulfil these objectives, the Institute supports a network of experts and centres of excellence working with ESPI in-house analysts.