
**Space Collaboration
between India and France
-Towards a New Era-**

Ajey LELE

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IFRI
27, RUE DE LA PROCESSION
75740 PARIS CEDEX 15 – FRANCE
Tel: +33 (0)1 40 61 60 00
Fax: +33 (0)1 40 61 60 60
Email: ifri@ifri.org

IFRI-BRUXELLES
RUE MARIE-THÉRÈSE, 21
1000 – BRUXELLES – BELGIQUE
Tel: +32 (0)2 238 51 10
Fax: +32 (0)2 238 51 15
Email: info.bruxelles@ifri.org

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Executive Summary

India and France have been collaborating on various aspects of science and technology for more than five decades. In the sphere of space research, this collaboration began in the early 1960s, with France providing assistance to India's Rohini sounding rockets programme. Over the years, France has played a constructive role in helping India to develop its ground and space infrastructure, as well as its launching platforms and human resources. In point of fact, France has emerged as one of India's most dependable partner in the realm of space. And while this space relationship witnessed a period of dormancy in the 1990s, it gained momentum with the strategic partnership agreement of January 1998. Since then, India and France have further engaged in joint satellite development programmes as well as in joint commercial launch services. India in 2013 has even relied on French launch services in order to put strategic communication satellites into space for the Indian Navy.

The long-standing and wide-ranging nature of this space cooperation reflects a significant amount of political, scientific and economic investment from both sides. Pragmatism has also been a key factor, as this relationship has not been overtly advertised, as opposed to other sectors related to armament transfers or civilian nuclear cooperation. However, this paper suggests that the time has come for India and France to take this collaboration to the next level and to develop a common approach on sensitive issues such as space security and space awareness. The author provides the following recommendations to advance Indo-French collaboration in space:

In the 21st century, the lines between the militarisation and weaponisation of space are fading very rapidly. It is important for states like France and India to debate these issues and present a joint point of view.

States like France and India, which are against space weaponisation, should join hands together along with other important and likeminded states (if any) towards canvassing a space treaty mechanism.

Both India and France should come together and use their good offices to engage other states and make a beginning towards developing a global Space Situational Awareness (SSA) network in order to effectively tackle the problem of space debris.

Given their stated interests in cooperating in the fight against terrorism, India and France should jointly develop and deploy spy

satellites for the purpose of gathering intelligence for counter-terrorism operations.

France and India could develop a joint plan for all future Moon and Mars missions and also undertake joint research towards understanding the nature of minerals available there.

Given India's development of its Geostationary Satellite Launch Vehicle (GSLV) programme, India's dependence on French launch services will soon be reduced. Both France and India should adjust their cooperation program accordingly. They could join hands to seize a major portion of the growing global satellite launch market with India's Antrix and France's Arianespace working together. Both agencies should also engage in expanding various other emerging areas of space commerce, including space tourism.

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Introduction

International cooperation in the peaceful use of space has been an important feature in international relations for many years. States are interested in using satellites for establishing safe and low-cost communication networks, making more reliable weather forecasts, managing natural resources, improving navigation and managing disasters. Various global international programmes have been created in these areas. Technology transfers and economic factors also play an important role in stimulating cooperation in the fields of space research. Such cooperation is of special importance for developing countries, because it may serve as an incentive to overcome scientific and technical backwardness. Hence, for developing states, it is important to invest in space research and to benefit from various applications of space sciences and engineering achievements¹. Definitely, the Indian political and scientific leadership had this premise in mind when engaging developed states in the space realm and France could be considered as a natural choice in this process.

Indian Prime Minister Narendra Modi's visit to France in April 2015 could be clearly viewed as a step towards larger Indo-French engagement in general and commitments in outer space in particular. One of the main stops of Mr Modi's visit was an appointment with the city of Toulouse, which is a hub for French / European aerospace research and industry. The visit to Toulouse gave Mr Modi an insight of the European aerospace company, Airbus. Mr Modi, while in Toulouse, also visited the French National Centre for Space Studies (CNES) and held discussions regarding prospects for further cooperation in the area of space. Overall, this recent political engagement clearly indicates that space is an important area in the growing bilateral cooperation.

This paper discusses the Indo-French relationship in the outer space arena. It firsts provides a context of bilateral relations by presenting the history of the overall relationship and expands on some important advances during the last few decades. It then presents a narrative for space cooperation, highlighting important

Ajey Lele is Assistant Director of the Institute for Defence Studies and Analysis (IDSA) in New Delhi. He was a Research Fellow with the IDSA from 2001 to February 2015 and has an expertise in weapons of mass destruction (notably biological weapons), space and national security, and non-military threats.

1. Alla G. Masevitch, "Influence Of Space Exploration on the Development of Mankind", *Acta Astronautica*, vol. 19, No. 9, 1989, pp. 755-757.

cooperation activities between India and France in this sector since the early 1960s. Finally, it offers an assessment of the space segment of the Indo-French relationship and suggests new perspectives for its future development.

Background on Indo-French relations

Important strategic proprieties of present Indo-French bilateral relations essentially involve cooperation in the sectors of defence and security, science and technology, civilian nuclear technology and space. The roots for this on-going bilateral relationship could be traced backed to history. As independent, modern states, India and France have traditionally had close and friendly exchanges for several decades. However, their historical interactions actually started in the seventeenth century. Some engagement was also evident in the period when India was fighting for its independence.

A friendly but distant relationship from the late 1940s to the late 1980s

Historically, since the seventeenth century onwards there have been contacts amongst Indian and French people, not essentially as friends but more as subjects and rulers. As it was called then, French India (the French possessions acquired by the French East India Company in India from the second half of the seventeenth century onward) ruled over a few pockets of India approximately from 1816 to 1954, under the shadow of the British colonial power². While India became independent in 1947, when the British left the country, the French maintained their presence until around 1954, when they accepted to transfer their territorial possessions to the Indian Union. The Indo-French Treaty of Cession of May 1956 has remained as a foundation for good and cordial relations between the two countries³. Finally, on 16 August 1962 both states exchanged the instruments of ratification under which France ceded to India full sovereignty over the territories it held⁴.

2. These pockets included Pondicherry, Karikal and Yanam on the Coromandel Coast (India's south-eastern coastal region), Mahé on the Malabar Coast (a long and narrow coastline on the south-western shore of India), and Chandernagor in Bengal.

3. B Krishnamurthy, Indo-French Relations, Shipra, New Delhi, 2005, pp.7-8. The document is available at <<http://mea.gov.in/bilateraldocuments.htm?dtl/5302/Treaty+establishing+De+Jure+Cession+of+French+Establishments+in+India>> accessed on 20 November 2014.

4. A treaty of cession was signed by the two countries in May 1956. It was ratified by the French parliament in May 1962. The city of Pondicherry and the other enclaves of

As an independent state, India quickly overcame its colonial past and engaged the states that had once ruled it by force. France appeared as India's natural acquaintance. As transparent democracies and secular republics, India and France have always shared similar ideals and values of cultural diversity, sovereignty and pluralism. However, post-independent India evolved a policy of non-alignment and during the Cold War era, it forged a special relationship with the USSR. During this period, in spite of friendly relations, generally limited enthusiasm was witnessed in the Indo-French relationship. However, the cordiality in the bilateral relationship continued to exist – particularly in the area of science and technology – and some engagement was visible as early as the 1960s.

The Indo-French relationship in the area of science and technology gained momentum in the late 1980s. IFCPAR/CEFIPRA (Indo-French Centre for Promotion of Advanced Research/Centre Franco-Indien pour la Promotion de la Recherche Avancée) was established by India and France in 1987 to support their science and technology partnership. Detailed research on the effectiveness of CEFIPRA indicates that the creation of this organization has helped strengthen this partnership⁵. Both India and France have effectively engaged in mutually beneficial scientific research cooperation, connecting self-organizing research collaboration as well as formal, dedicated programmes. In areas like mathematics, the development of sophisticated monsoon climate models, environmental chemistry, neurosciences, etc., a significant amount of progress has been made possible by joint collaboration. However, CEFIPRA has had a very limited role in promoting bilateral cooperation in space and civil nuclear technology. While India and France have also nurtured a long successful partnership in the specific areas of space research and civil nuclear cooperation, these collaborations have primarily been the result of politically supported strategic endeavours.

Karikal/Karaikal, Mahé and Yanaon/Yanam came to be administered as the Union Territory of Puducherry from the 1st of July 1963.

5. Sujit Bhattacharya, Arshia Kaul, Shilpa, Praveen Sharma, "Role of bilateral institution in influencing collaboration: case study of CEFIPRA—a bilateral S&T institution established by India and France", *Scientometrics*, n° 102, 2015, 169–194. It also may be noted that during the late 1970s India had provided engineering expertise to France to realise the Viking engine. This eventually enabled France/EU to compete in launch capability (Ariane) with the US and Russia (as noted in conversation with Dr V Siddhartha, an Emeritus Indian Scientist who has also worked with ISRO).

The Indo-French strategic partnership since 1998

In the post-Cold War period, France was the first country with which India established a 'strategic partnership'. The bilateral strategic partnership was signed in January 1998, on the occasion of the high-profile visit by French President Jacques Chirac to India. France found a natural ideological convergence with India's ambitions of seeking strategic autonomy. After India's nuclear tests in May 1998 (*Pokhran-II* tests), many states in the world opposed India's nuclear policies and submitted the country to a new series of 'sanctions' (India had been put under a regime of sanctions since its first nuclear test of 1974). In this difficult context, France was the first major power to open talks with India and to show some understanding of India's political and security compulsions for going nuclear.

Since the establishment of the strategic partnership in 1998, bilateral relations have witnessed growing engagement in various areas, from cultural ties to commerce, education, science & technology and defence. Particularly, there has been growing cooperation and exchanges in strategic areas such as defence, counter-terrorism, space and nuclear energy. In the nuclear field, the global approach towards India changed dramatically after the announcement of the 2005 Indo-US civilian nuclear agreement. After the International Atomic Energy Agency (IAEA) and Nuclear Suppliers' Group (NSG) allowed India to resume full civil nuclear cooperation with the international community, France was the first country to grab this opportunity and to enter into an agreement on nuclear energy with India. France has also been a strong supporter of India's increasing role in international organisations, including as a permanent member of the United Nations Security Council. Moreover, France endorses India joining the four important multilateral export controls regimes: the Nuclear Suppliers Group, Missile Technology Control Regime, Australia Group, and Wassenaar Arrangement.

It appears that both states have learned to live with their differences too. For instance, France's defence sales to Pakistan have not gone over well with India. More recently, they had divergent views on the 2011 NATO intervention in Libya and France could be unhappy about India's position on issues such as Ukraine. At the same time, India supported the French military intervention (2012-13) in Mali and voted in favour of three resolutions of the Security Council on Mali in 2012. India even announced a very substantial financial contribution for Mali. Both states are fully aware about China's growing presence in the Indian Ocean and have conducted joint maritime exercises in this region⁶.

6. Bharti Chhibber, "India-France Relations: Tremendous Scope Ahead", *Mainstream*, Vol LI, No 10, 23 February 2013.

In spite of a robust inter-governmental relationship and strong people-to-people ties, the business relationship has remained weak. Bilateral trade was about 7 billion euros in 2013, less than half of India's trade with Germany. French investments in India are showing an increasing trend in recent years, but this hardly does justice to the fact that there are more than 800 French enterprises in India. These include industry leaders such as Alstom, Airbus, Alcatel, BNP Paribas, L'Oreal and Louis Vuitton. Information Technology (IT) services provider Capgemini employs over 50,000 people in India and has plans to double this in the next five years⁷. Beyond routine trade, there are various other areas where both states are cooperating too. For instance, there is an increased educational cooperation. With the growth in the Indian aviation market, various private airlines operating in India are finding Airbus platforms to be the most reliable and viable option. On the strategic front, cyber security could be viewed as a newer area for collaboration.

During the last couple of years, the rapid progress in the Indo-French bilateral relationship has become possible owing to the involvement of the top political leadership from both countries. India singled to the rest of the world about how important they viewed their ties with France by inviting French President Nicolas Sarkozy as the chief guest at India's Republic Day parade in January 2008. In the same year, Indian Prime Minister Manmohan Singh visited France and was the Guest of Honour at the 14 July 2009 Bastille Day Celebrations. President Sarkozy undertook his second visit to India in December 2010. Interestingly, he started this visit not by engaging the power centres in New Delhi, but by directly landing at Bangalore to visit India's space establishment, thus giving a signal on how important space was in the bilateral relationship. As President, François Hollande continued Mr Sarkozy's India policies and visited India in February 2013. The Indian political establishment gave similar political signals and India's new Prime Minister Narendra Modi visited France in April 2015.

7. Rakesh Sood, "Namaste France, Bonjour India", *The Hindu*, 10 April 2015.

A Space Collaboration Narrative between India and France

From the 1960s onwards, the Indo-French partnership has mostly been a story of constructive engagement despite a few periods of dormancy. Interestingly, in all these years, one area of promise has always been the engagement in the space area. Actually, space collaboration has been the 'unsung hero' of this successful bilateral relationship.

France as one of India's oldest partners in the space arena

The Indian space programme had a humble beginning. It started by experimenting with sounding rockets in the early 1960s. India's space vision was articulated by its founding father Dr. Vikram Sarabhai and it was decided that its space programme would be civilian in nature. The milestones in the history of this programme can be briefly summarized as follows:

- A dedicated space agency, the Indian Space Research Organisation (ISRO), was established in 1969.
- The first satellite mission by ISRO, the Aryabhata Satellite was launched on 19 April 1975.
- By 1980, India became a space-faring nation, a nation capable of launching satellites by using indigenously developed rocket technology.
- On 9 September 2012, ISRO successfully launched its 100th space mission. This mission was a commercial venture with France and Japan being the customers.

Today, ISRO is capable of undertaking various intricate missions like multiple satellite launches in a single mission. ISRO has also successfully conducted missions to Moon (2008-09) and Mars (2013-14). The satellites launched as part of these two missions entered their respective orbits and from very close vicinity undertook various observations for months (the Mars mission is still in progress). One of the sensors on India's craft to the Moon (Chandrayan-1) was instrumental in finding the presence of water on the Moon. India's mission to Mars (MOM- Mars Orbiter Mission), with a cost of approximately 70 million US dollars, has earned a reputation of a successful case in frugal engineering.

In the sphere of space research, the collaboration between India and France began in the early 1960s as Dr. Vikram Sarabhai and Prof. J. Blamont of France were closely associated with the Indian efforts for the setting up of the UN-sponsored Equatorial Rocket Launching Station at Thumba, in the southern state of Kerala⁸. Prof Blamont was one of the main architects of the French space programme. One of his notable posts was that of being the first Director of Science and Technology of the newly formed French space agency known as *Centre National d'Etudes Spatiales* (CNES, 1962). He devoted his energies to nurturing space research in France and in fostering international cooperation in this field, particularly with India. He was instrumental in initiating the Indo-French space cooperation between the Department of Atomic Energy (DAE)⁹ and the CNES in 1964. The DAE was established in 1954 and various scientific activities at that point in time were happening under its umbrella, space being one of them. It is thus important to note that India is one of the oldest partners of France in the space arena. India was actually the CNES's second international partner in space after the United States back in 1963.

French scientists and industry helped India to conceptualise its space programme in the initial years of its development. Scientists from both states also conducted a few joint scientific experiments during that period. The first French-Indian space cooperation agreement was signed on 15 May 1964 between CNES and DAE. This agreement covered licences to build Sud-Aviation's Belier and Centaure sounding rockets in India, with the accompanying transfer of solid-propulsion technologies¹⁰. Under the patronage of the United Nations and overseen by CNES, 50 French rockets were built locally

8. This small village in the southern parts of India was chosen because the geomagnetic equator passes through this location. The Indian spaceport, the Thumba Equatorial Rocket Launching Station (TERLS) was dedicated to the United Nations on 2 February 1968 by then Prime Minister of India, Mrs. Indira Gandhi. Owing to this, scientists from several countries including France started utilizing the facility for conducting rocket-based experiments. This allowed Indian scientists to interact with various other scientists and also learn from various activities taking place at TERLS. When Dr. Vikram Sarabhai died on 30 December 1971, the TERLS and associated space establishments at Thiruvananthapuram were renamed as the Vikram Sarabhai Space Centre (VSSC) in his honour.

9. In August 1948, the Indian Atomic Energy Commission was established as a part of the Department of Science. Scientists like Dr. Vikram Sarabhai from India's Physical Research Laboratory (PRL) and Dr. Homi Bhabha from the Atomic Energy establishment were also working together on Cosmic Ray research. Subsequently, they began work on issues related to space science and hence India began its space activity under the umbrella of the Department of Atomic Energy. Dr. Sarabhai constituted the Indian National Committee for Space Research (INCOSPAR, 1962). This organisation eventually grew to become Indian Space Research Organisation (ISRO) by 1969.

10. Sud Aviation was approached for building simpler sounding rockets. This company was created in 1957 by the merger of Sud-Est Aviation (SNCASE) and Ouest Aviation (SNCASO) companies. They were chosen because of their capability to provide solid-propellant sounding rockets whose storage and use were simplified. Please refer <www.sat-net.com/serra/sudav_e.htm>, accessed on 18 May 2015.

and launched from 1965 onwards from the Thumba equatorial launch site¹¹.

It is important to appreciate that initially Indian scientists conducted some experiments using foreign sounding rockets. Originally, India's sounding rocket programme was established with assistance from the US and the USSR. India launched the first sounding rocket (Nike-Apache) on 21 November 1963. Subsequently, a plan to indigenously build Indian sounding rockets was put into action and was called as Rohini Sounding Rockets (RSR) Programme. India received French assistance for both phases: before the launch of Rohini programme and also for the Rohini programme's development¹². In 1967, the first rocket under the Rohini programme (RH-75) was launched – a single stage solid propellant vehicle. India's solid propellant sounding rocket family uses indigenous rocket motors derived from French Belier / Jericho rocket engine technology¹³. The Rohini programme is still operational today and ISRO currently uses RH-200, RH-300, and RH-300 Mk-II and RH-560 Mk-II rockets.

In 1965 an agreement was reached with France for the transfer of the technology of the Centaure rocket, a two-stage sounding rocket. CNES supplied DAE with four Centaure rockets with payloads for vapour cloud experiments. It was decided that the experimentation would be carried out through collaboration with Physical Research Laboratory (PRL) in India. Various other programmes like exchanges of scientists and engineers were put in place, while efforts were also made to engage the budding scientific community by facilitating admissions for Indian students in France¹⁴.

11. <www.ambafrance-in.org/IMG/pdf/cnes_mag_october_2014.pdf?11445/> accessed on 10 January 2015.

12. <www.ambafrance-in.org/IMG/pdf/cnes_mag_october_2014.pdf?11445/> accessed on 11 January 2015.

13. The Belier family of sounding rockets was developed by Sud Aviation, with the only, or upper stage being variants of the Belier stage powered by a Jericho rocket motor. These were the most significant series of French civilian suborbital rockets. Manufacturing licenses were sold to India and Pakistan, becoming the basis of their rocket industries, refer to <www.astronautix.com/lvs/belier.htm> and <www.astronautix.com/lvs/rh.htm> accessed on 20 May 2015.

14. B Krishnamurthy, Indo-French Relations, Shipra, New Delhi, 2005, p.133.

Wide-ranging cooperation programmes in the space sector

Subsequently, ISRO was established as an independent space agency (in 1969) and India-France cooperation grew further. France gave assistance to India in multiple areas of space science and technologies and as part of various collaborative projects. For better appreciation, it is useful to consider this relationship under specific segments.

Political and Institutional Mechanisms

In 1972, CNES and ISRO signed a Co-operation Protocol, which resulted in the establishment of the ISRO-CNES Joint Commission. Essentially, this joint commission was used to discuss the possibilities of collaboration in regards to satellite launch vehicles (SLVs) and communication satellites¹⁵. The CNES-ISRO Cooperation protocol was further compounded by two Inter-governmental agreements, respectively signed in 1977 and in 1993. The 1993 agreement, which included study of co-operative programmes in satellites and balloons for space research and applications, has been instrumental in expanding the cooperation in the arenas of remote sensing, meteorology, communications and development of various other joint projects¹⁶.

This relationship received a major boost in 1998 when space was defined as a priority area of the newly launched strategic partnership between the two countries. From then on, India and France envisaged cooperation on joint satellite development. This bilateral relationship gained further momentum ten years later, when the Indo-French framework agreement was signed in September 2008, detailing a need to set up joint research programmes, instruments and launch satellites. This agreement mainly covered the areas of mutual cooperation as follows¹⁷:

- Study of climate change with earth observation satellites;
- Development of micro-satellites and mini-satellites for scientific purposes;
- Joint research and development activities;

15. Nuclear Threat Initiative (NTI), Indian Missile Chronology, June 2012, <www.nti.org/media/pdfs/india_missile_3.pdf?_=1339452308>, accessed on 20 May 2015.

16. "50 Years of Indo-French Space Co-Operation", <<http://indembkwt.org/English%2050%20YEARS%20OF%20INDOFRENCH%20SPACE%20COOPERATION.pdf>>, accessed on 18 March 2015.

17. "50 Years of Indo-French Space Co-Operation", <<http://indembkwt.org/English%2050%20YEARS%20OF%20INDOFRENCH%20SPACE%20COOPERATION.pdf>>, accessed on 18 March, 2015.

- Development of ground infrastructure for joint satellite missions;
- Organization of combined training programmes;
- Exchange of technical and scientific personnel.

This agreement was taken forward during President Sarkozy's 2010 visit to India. During this visit the progress made in developing the Megha-Tropiques and SARAL satellites for possible 2011 launch was discussed and it was also decided that both states needed to broaden the scope of their exchanges and further develop their joint efforts in this field¹⁸. Then, on 5-6 February 2013, both India and France participated in the Science Seminar and Research and Technology Workshop held at Bangalore in India, and developed ambitious follow-on space cooperation proposals. Those plans were included in the Joint Statement issued by India and France during the state visit of President Hollande to India on 14 February 2013.

Finally, on the occasion of his first official visit to France in April 2015, Indian Prime Minister Narendra Modi signed three MoUs concerning space issues. One such MoU is about conceptualising a detailed programme between ISRO and CNES on the future course of action. This agreement proposes cooperation in the areas of Satellite Remote Sensing, satellite communications and satellite meteorology; space sciences and planetary exploration; data collection and location; operations of satellite ground stations and spacecraft mission management; space research and applications. The MoU covers potential cooperation activities such as joint earth observation missions, hosted payload opportunities and Mars exploration¹⁹. The two other MoUs involve a two-year extension of the Megha-Tropiques satellite project and a K_a -band propagation experiment over Indian tropical region.

Ground Infrastructure

India received assistance from France for developing the ground infrastructure of its space programme, including support in the area of tracking. Around 1965, CNES sold a launching stand to India and also donated some ground equipment, including COTAL Radar with a range of about 300-km, for tracking the actual trajectory²⁰.

18. <www.ambafrance-in.org/India-France-joint-Statement>, accessed on 18 May 2015.

19. "Modi in France: List of agreements signed", India Today, 10 April 2015

20. A. Baskaran, "Technology Accumulation in India's Space Programme Ground Systems: The Contribution of Foreign and Indigenous Inputs", Discussion Paper, Middlesex University Business School, London, <https://eprints.mdx.ac.uk/4254/1/Baskaran_-_Technology_Accumulation_in_Ground_Systems.pdf> accessed on 18 February 2015.

Launch Vehicles

ISRO's Polar Satellite Launch Vehicle (PSLV) is regarded as ISRO's most reliable workhorse. It is a four-stage rocket developed and operated by ISRO and as of March 2015, it has made 29 launches, with 27 consecutive successful missions. India has used this rocket even for launching its Moon and Mars missions. There is a French angle to this success story, as the second stage (which is a liquid stage) of PSLV uses an engine, which has been produced with French assistance. More precisely, ISRO obtained liquid engine technology with the help of the French. The Société Européenne de Propulsion, Europe's largest producer of liquid propulsion engines, gave ISRO the technology in return for India's help in developing the French liquid engine -- the Viking -- and for the parts it made for the Ariane rocket²¹. ISRO has farmed out the manufacture of the engine to three Indian companies: Machine Tools Aids & Reconditioning of Hyderabad, Godrej and Kerala Hitech Industries Limited (Keltec) based in Thiruvananthapuram. The final assembly of the engines and the stages is, however, carried out by ISRO²².

Launch Services

Presently, the Ariane system is considered as one of the most reliable satellite launch platforms in the world and, interestingly enough, India has been associated with it almost since the birth of this rocket. Indeed, India's first experimental communication satellite APPLE (Ariane Passenger Payload Experiment) was launched by the French Ariane-1 (V-3) launch vehicle in 1981²³. Ariane's track record was very limited at that time: while its first flight -- in December 1979 - - had proved a success, its second flight ended up being a failure. For its third flight, in June 1981, India was asked to provide a payload. Even though the offer was made without any financial implications, India still took the risk with its satellite. India's show of faith in the vehicle was vindicated as the APPLE was eventually launched successfully²⁴.

Arianespace, France has been the major provider of launch services to Indian Geo-Stationary satellites. On the commercial front, ISRO has been a valued customer for Arianespace for many years, with 18 Indian Geo-Stationary satellites of India having been launched²⁵. India has a significant amount of dependence on

21. "Countdown to self-reliance", *Down to Earth*, 15 Sept. 1993, <www.downtoearth.org.in/node/31405>.

22. "GSLV: lessons for ISRO", *The Hindu*, 15 April 2001.

23. "50 Years of Indo-French Space Co-Operation", <<http://indembkwt.org/English%2050%20YEARS%20OF%20INDOFRENCH%20SPACE%20COOPERATION.pdf>>, accessed on 28 March 2015.

24. U R Rao, *India's Rise as a Space Power*, Cambridge University Press, New Delhi, 2014 p.60.

25. <www.ambinde.fr/space-sector-cooperation/bilateral-relations-with-france>.

Arianespace for the launch of heavy (4- to 6-tons) satellites into geostationary orbit because of the non-availability of indigenous vehicles for launching heavy satellites.

It is important to note that on 30 August 2013, an Ariane 5 rocket launched India's first dedicated strategic satellite GSAT-7, a communications satellite for the Indian Navy. This arrangement should not be viewed only as a commercial activity but also as one that demonstrates India's faith in the French administration, where they are depending on a foreign agency for the launch of a strategic system into space²⁶. But the fact is that India had put its faith in Ariane system since the beginning.

In recent years, India has emerged as a provider of launch services for the Franco-European satellite industry. Under a commercial Launch Service Agreement between Antrix Corporation Limited (ANTRIX), the commercial arm of ISRO, and ASTRIUM SAS, a Company under EADS (European Aeronautic Defense and Space Company), France, two advanced Remote Sensing SPOT satellites were successfully launched in 2012 and in 2014 on-board ISRO's Polar Satellite Launch Vehicle²⁷. These two SPOT satellites have been developed by Airbus Defence and Space with private funding. Their imagery is now being sold by Airbus to a range of commercial and government clients, including the French military authorities²⁸.

Satellite Systems

The initial focus of the Indo-French relationship in the space sector was essentially in the areas of telemetry and data sharing, in addition to providing launching facilities. During the initial years of its space programme development, what India was lacking was not the knowledge about satellite designing and manufacturing capabilities, but having requisite testing facilities. In the case of the APPLE system, CNES provided the thermal testing facilities for this satellite at the Space Centre at Toulouse.

Projects for joint satellite development started taking shape mainly after the realisation of the strategic partnership in 1998. Indeed, in November 1999, France and India signed a Statement of Intent for the joint development of a satellite called Megha-Tropiques (Megha means clouds in Sanskrit and Tropiques means tropics in French) for atmospheric studies in the tropics. This Megha-Tropiques

26. Ajey Lele, "India's French Connection in space", *The Space Review*, 18 March 2013, <www.thespaceview.com/article/2261/1>, accessed on March 23, 2015.

27. <www.ambinde.fr/space-sector-cooperation/bilateral-relations-with-france>, accessed on 8 March 2015. SPOT-6 was launched by ISRO during its PSLV-C21 mission in September 2012. The 714 kg French Earth Observation Satellite SPOT-7 was successfully injected by ISRO's PSLV-C23 on June 30, 2014.

28. Stephen Clark, "French imaging satellite in orbit after launch from India", 30 June 2014, <<http://spaceflightnow.com/pslv/c23/140630launch/#.VS9aLHKfrmI>>, accessed on March 26, 2015.

earth observation satellite was eventually launched on 12 October 2011 by India's PSLV-C18 mission. This 1000-kg satellite has been jointly developed by ISRO and CNES to understand the monsoon dynamics and its forecasting. Today, there is a global demand for the data generated by Megha-Tropiques, especially as this data has been made available globally, free of cost.

The Megha-Tropiques system is composed of a mini-satellite developed jointly by France and India. It includes a platform derived from the Indian IRS (Indian *Remote Sensing System*) platform and a set of three payloads (MADRAS, a microwave imager to study precipitation and cloud properties; SAPHIR, a microwave sounding instrument for atmospheric water vapour, and SCARAB, a radiometer to measure outgoing radiation fluxes (IR,UV,Visible) at the top of the atmosphere)²⁹.

For a tropical country like India, continuous and reliable weather observations are a must for the prognosis of various weather patterns. The data available on the equatorial region all across the globe has always been sparse. This is because at the equator, the division of land and sea is highly diverse. Since this region is mostly covered by oceans, very few weather observatories are available both in real-time or otherwise. Because of the lack of weather observations, understanding about the atmospheric physics of this region has remained limited. This, in turn, has impacted both short-term and long-term weather forecasting. Megha-Tropiques is expected to fill this void, at least partially. It provides useful capacities for cyclone and monsoon prediction and studying the nature of climate change taking place over the region. Megha-Tropiques is networked with the Global Precipitation Constellation Mission (GPCM) being put up by the US and Japan jointly. Information on the weather and climate close to the equator has importance for states in Africa, Oceania and South America too³⁰. Scientists have found this mission to be a major success and now, around four years of data with high quality are available and offer considerable scientific input. To meet user demand, the mission was extended by two years in May 2014.

The second important joint project of satellite development is the satellite called SARAL. In February 2013, India successfully launched its PSLV-C20/SARAL mission with the main payload a 409-kilogram satellite named SARAL (Satellite for ARGOS-3 and ALTika). SARAL has oceanographic applications to study the circulation of

29. CNES, *Megha Tropiques*, <<http://smc.cnes.fr/MEGHAT/>>, accessed on 28 March 2015. The SCARAB instrument, designed to study the Earth Radiation Budget, is a cross track passive multi-spectral scanning radiometer sensing the earth/atmosphere when the spacecraft is moving ahead.

30. Ajey Lele, "The PSLV-C18 Mission and Indo-French Collaboration in Space", 14 October 2011, <www.idsa.in/idsacomments/ThePSLVC18MissionandIndoFrenchCollaborationinSpace_alele_141011.html>, accessed on 14 Feb 2015.

ocean currents and measure ocean surface topography. This information is vital in predicting the development of weather in the short-term and climate change in the long-term. This satellite has two independent payloads developed by the French space agency CNES: Argos-3 for data collection, a platform for collecting data from ocean buoys and weather data centres and AltiKa altimeter (radar altimeter) for ocean surface topography (study sea surface altitude), operating at high frequency K_a band. These payloads were integrated into a satellite bus from India, where the satellite was also assembled.

The data received from the SARAL is incorporated into the French programme of operational oceanography development. The collected data has also contributed to the Global Ocean Data Assimilation Experiment (GODAE), the first international operational oceanography experiment. SARAL is somewhat similar to ISRO's Oceansat-2, a satellite launched in September 2009 to study surface winds and ocean surface strata³¹. The inputs provided by this satellite assisted NASA for monitoring the Hurricane Sandy³².

Appreciating the importance of knowing more about the tropical region, ISRO, CNES and ONERA (the French Aerospace Research Agency) signed a MoU in April 2015 for K_a -band propagation experiment over the Indian tropical region. The main objective is to collect K_a -Band attenuation data, using available K_a -Band transmission and perform analysis along with corresponding radiometer and meteorological data³³.

Apart from these joint projects with France, ISRO is also involved in manufacturing custom-made satellites for various clients. An advanced communication satellite HYLAS (Highly Adaptable Satellite) was built by ISRO on a commercial basis in partnership with EADS-Astrium of Europe. This satellite was successfully launched on 27 November 2010 by the European Ariane-5 V198 launch vehicle. This HYLAS satellite, which has been developed for Avanti Communications, UK, consists of ten high-power transponders that use eight in K_a and two in Ku band frequencies. The satellite delivers high-speed broadband services through its spot beams over Europe. The contract for building the satellite was won in the year 2006, after competing along other leading manufacturers from the United States and Europe, through the strategic alliance worked out between Antrix/ISRO and EADS Astrium of France. The alliance was formed in

31. Ajey Lele, "India's French Connection in space", *The Space Review*, March 18, 2013, <www.thespacereview.com/article/2261/1, accessed on April 10, 2015>

32. This super-storm Sandy (Oct 22-Nov 2, 2012) was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season. It is also known as the second-costliest hurricane in United States history.

33. "Modi in France: List of agreements signed", *India Today*, 10 April 2015.

early 2006 to jointly develop communication satellites with ISRO platforms and Astrium payloads and market them internationally³⁴.

This alliance between Antrix/ISRO and EADS Astrium has also led to the development of a satellite called W2M. This satellite -- the heaviest spacecraft built by ISRO so far (weighing 3,462 kg at lift-off) -- was launched on 20 December 2008 for the operator Eutelsat. Under the W2M contract, EADS Astrium was the prime contractor in charge of the overall programme management. While EADS Astrium built the communication payload, Antrix/ISRO built the satellite bus, and integrated and tested the spacecraft³⁵. This satellite faced problems initially owing to the partial failure with its power system. However, after its redeployment at a different location, it is functioning normally and is expected to operate till 2020.

34. ISRO, "Antrix/ISRO and EADS Astrium built commercial communication satellite launched successfully", 27 November 2010, <www.isro.gov.in/update/27-nov-2010/antrix-isro-and-eads-astrium-built-commercial-communication-satellite-launched#sthash.3P685xwO.dpuf>, accessed on 16 Apr. 2015 and "ISRO's communication satellite HYLAS launched successfully", *The Hindu*, 27 November 2010.

35. "ISRO makes \$40 mn profit out of W2M satellite", *The Economic Times of India*, 19 Dec. 2008.

An assessment of the Indo-French cooperation in space

For nation-states, international collaboration is an important constituent in the process of nation building. State-to-state relations get built in order to gain from each other's capabilities and experiences. Scientific capacity building is an important process in nation building. Particularly, for developing states it is critical to have support from technologically superior states in order to 'leapfrog' in the realm of science and technology. During the initial developmental phase of its space programme, India received support from a few states and France was one of them.

A cooperation based on dependability and trust

During the developmental phase of India's space programme, there was significant amount of dependence on foreign sources for various components, and France was one such state to provide a variety of technical assistance to India. In particular, France played a constructive role towards assisting India to develop its ground and space infrastructure, launching platforms and human resources. One unique aspect of the Indo-French relationship in those years was the absence of any form of exploitation by France. India was dependent on France mainly for technological assistance; it was also not financially sound at that point in time. In view of this situation, the overall French approach was not to make India's space ambitions 'dependent' on them, but to allow India to experiment, discover and develop on its own. For instance, the Franco-German satellite SYMPHONIE was placed above the Indian Ocean arch from 1977 to 1979, thus allowing ISRO to gain experience in space telecommunication systems by conducting a series of innovative communications experiments.

After its first nuclear weapon explosion on 18 May 1974 (Pokhran-1), India was placed under sanctions regime and regime members were barred from selling and/or giving any technological assistance that would further Indian Space Programme. The early 1980s was particularly a difficult period because India had by then acquired the distinction of becoming a space-faring state and sought to make further progress both in launching platforms and satellite manufacturing. In the early 1990s, the Russians were prevented by the US government from undertaking any technology transfer agreement with India and, hence, India was denied cryogenic

technology required to launch heavy satellites. The US fear was that India could use such technology to develop missiles and hence Washington told Russia that giving technology to India amounted to violating MTCR (Missile Technology Control Regime) guidelines. Subsequently, India conducted its second nuclear tests (Pokhran-II) in 1998 and fresh sanctions were put on the country.

Overall, India remained under the sanctions regime for more than three decades. During all these turbulent years, in respect of the space cooperation programme, France never abandoned India. While abiding by the sanctions regime, France assisted and cooperated with the Indian space agency in every possible manner. French firms like Thompson-CSF appear to have supplied ISRO electronic components during this difficult period³⁶. Also, some efforts were possibly made to ensure that restrictions within provisions like MTCR would not interfere with the supply of required components to ISRO.

Thus, France has emerged as one of India's most dependable partners in the realm of space. And while this space relationship witnessed a period of dormancy around the late 1970s and in the 1990s, it gained momentum with the strategic partnership agreement of January 1998. From then on, various joint projects have been advanced, making this relationship more vibrant. Now, after five decades of cooperation, it is clear that the space segment has been instrumental in taking the Indo-French strategic partnership to new heights. Pragmatism has been the key for this relationship. This is a relationship that has not been overtly advertised, as opposed to other sectors related to armament transfers or civilian nuclear cooperation. Nevertheless, in the space sector, India and France have made steady progress by appreciating each other's requirements while highlighting their mutual 'strengths'.

One of the basic reasons for the success of this relationship has been the nature of the political engagement from both sides. It needs to be appreciated that the overall bilateral relationship has always been forward-looking and accommodative. This definitely has played a role in taking the space agenda forward. At the operational level, the scientific leadership has played a role in ensuring that various projects are executed efficiently. There has been appreciation of the efforts put in by the scientific community in both states. Dr. K Kasturirangan, Chairman ISRO (1994 to 2003) is recipient of the French Officer de Legion d'Honneur for his outstanding contribution to India's space missions and promoting scientific cooperation (2002). On the occasion of the 66th Republic Day Celebrations on 26 January 2015, Prof. Jacques Blamont was conferred the Padma Shri, one of

36. A Baskaran, "Technology Accumulation in India's Space Programme Ground Systems: The Contribution of Foreign and Indigenous Inputs", Discussion Paper, Middlesex University Business School, London, <https://eprints.mdx.ac.uk/4254/1/Baskaran_-_Technology_Accumulation_in_Ground_Systems.pdf> accessed on 18 February 2015.

the highest civilian honours of India, for his distinguished service in the field of science. He had taken part in November 1963 in the launch of the first rocket from India and was invited, 40 years later, to the celebrations held in Thiruvananthapuram to mark the 40 years of the Indian Space Programme³⁷.

The recent evolution of the Indo-French partnership

Over the last decade or so, satellite development has emerged as a new area for collaboration between India and France. In this field, ISRO has made significant contributions both in developing satellites and providing launching services. In some cases, ISRO has manufactured satellites for European clients too. In regards to joint satellite development projects, the focus has been more on designing a system, which could provide data required for meteorological purposes. These inputs have played a major role in understanding the tropical climate, especially as these satellites could play a role in providing real-time assistance (if required) for disaster management. Presently, Megha-Tropiques is making its data available free of cost and this could be viewed as the contribution made by both India and France towards tackling the challenges of climate change. Unfortunately, some of the joint projects have also faced significant delays. One case in point was the launch of Megha-Tropiques. This satellite was to go in space in 2005. However, there was an inordinate delay of six years. The exact reasons for such delays are not known, but it would be in the interests of both the states to ensure that their projects follow a reasonable timeline.

Given France's assistance in developing India's most reliable launch vehicle, the PSLV, which has allowed for significant progress in the Indian space programme as a whole, it can be argued that France has been associated with the overall success of India's space programme. Moreover, a commercial Launch Service Agreement has been successfully put in place amongst the agencies of both states. Apart from jointly developing satellites, ISRO has also launched the satellites for France. All this implies that ISRO has developed a very reliable launch system and even technologically advanced powers like France are confident about their capabilities and hence are offering satellite-launching contracts to them.

37. T.S. Subramanian, "The Indian Space Research Organisation celebrates 40 years of excellence in space", *Frontline*, Volume 21, n° 1, 03 – 16 January 2004.

Indo-French cooperation in comparison with other major partners

It is also useful to assess the Indo-French space collaboration in the larger context of India's space collaborations with other major players. Particularly, amongst the space-faring nations, India has worked in close partnership with the US and Russia. In fact, India has been associated with the US since the very beginning of its space programme, in the 1960s. The first sounding rocket India launched in November 1963 was a US rocket called Nike-Apache. Later on, NASA was involved in the Satellite Instructional Television Experiment (SITE) in the mid-1970s. Under the coveted Indian National Satellite (INSAT) System, all the four satellites of the INSAT-1 series were built to India's specifications by a US-based firm, with US launch vehicles placing three of the satellites into orbit. In the remote sensing domain, India was one of the first countries to establish a reception station for receiving data from NASA's Earth Resources Technology Satellite (ERTS, later renamed LANDSAT). However, owing to India's nuclear policies, the bilateral engagement remained almost dormant during the period 1975 to 2005.

NASA and ISRO have engaged in an active collaboration over the last decade. In many ways, India's first mission to the Moon (2008) stands as the pivot of recent Indo-US space cooperation. ISRO's Moon mission carried two payloads from NASA, a Miniature Synthetic Aperture Radar to map ice deposits on the lunar surface and a Moon Mineralogy Mapper to assess the mineral resources of the Moon. This has been executed under the framework of an agreement with NASA to carry out lunar exploration, signed in July 2008. Subsequently, scientists from both nations succeeded in making a path-breaking discovery about the presence of water on the Moon, based on the data generated from this mission.

The civil space cooperation between India and the US has been shaped under the framework of the Joint Working Group on Civil Space Cooperation, which was constituted as the follow-up to the US-India Conference on Space Science, Application, and Commerce held in Bangalore in June 2004. Since then, space cooperation has expanded to the areas of space science, earth observation, satellite navigation, natural hazards research, disaster management support and education. India and the US have signed various agreements and formed joint working groups to encourage data sharing and expert collaboration between the space agencies and academia. Following the fourth meeting of the India-US Joint Working Group on Civil Space Cooperation, in March 2013, both sides agreed to improve the use of earth observation data to promote sustainable development, carry forward the proposed cooperation in L- and S-band SAR missions, and to discuss on promoting compatibility and interoperability in satellite navigation systems. In addition, the working group has agreed to establish scholarship in

Aerospace Engineering at the California Institute of Technology every year.

Finally, India is implementing a Global Positioning System Aided Geo Augmented Navigation System (GAGAN) for civil aviation purposes (to augment GPS signals over the India region) under a commercial agreement with Raytheon, a US-based firm. Efforts are underway to ensure compatibility between the seven-satellite constellation of the Indian Regional Navigation Satellite System (IRNSS) and the US Global Positioning System (GPS)³⁸.

India and Russia also have a long history of space collaboration. However, the role of the USSR and then Russia in the development of India's space programme should not be overestimated and, more importantly, it never matched the high levels of cooperation attained by the two countries in other fields such as military procurements. India's first satellite, Aryabhata, was launched on 19 April 1975 from a Soviet launch site (Kapustin Yar range) on a Soviet Kosmos-3M rocket. Subsequently, Indo-Soviet cooperation enabled Sqn Ldr Rakesh Sharma, India's first and only cosmonaut, to visit space on board Soyuz T-10 in the year 1984³⁹. India could also initiate its GSLV (Geosynchronous Satellite Launch Vehicle) programme because the Russians sold cryogenic engines to them. However, in the early 1990s Russia came under US pressure and refused to transfer the cryogenic technology to India.

Recent space cooperation between Russia and India has met occasional hiccups. For instance, during the 2008 visit of Russian President Dmitry Medvedev in New Delhi, ISRO and Russian space agency Roskosmos reached an agreement on Joint Activities in the Field of Human Spaceflight Programme⁴⁰. However, nothing much is known about the progress of this project. In the same fashion, Russia was to collaborate with India to launch its second mission to moon, but it eventually withdrew from the project. On a more positive note, a recent successful joint programme was the 2011 launch of the Youthsat, a scientific-educational satellite.

This brief analysis of India's space collaboration with the US and USSR/Russia points to two very different cooperation dynamics, while highlighting the specific nature of the Indo-French partnership. Owing to Russia's own difficulties with its space programme, not much collaboration with India is likely to happen in the near future. On

38. This entire section is based on Ajey Lele and Munish Sharma, "Indo-US space cooperation: Synergies and differences", *South Asia Monitor*, 30 Sept. 2015, <<http://southasiamonitor.org/detail.php?type=sl&nid=9137>>, accessed on May 17, 2015.

39. Nivedita Das Kundu "Russia-India Space Cooperation The Sky is Not the Limit", *Diplomatist*, July 2014, <www.diplomatist.com/dipom07y2014/article014.html>, accessed on May 22, 2015.

40. M.K. Bhadrakumar, "India Russia regain elan of firendship", *Asia Times Online*, 9 Dec. 2008, <www.atimes.com/atimes/South_Asia/JL09Df02.html>, accessed on 17 May 2015.

the contrary, India and the US may come closer to each other, probably with a strong focus on the fields of sensors, space sciences and data sharing. In comparison with these two partnerships, the space collaboration between India and France stands as an on-going relationship of five decades and encompasses all major areas, such as satellite launching and designing, joint development of satellite systems and data management. The long-standing and wide-ranging nature of this space cooperation reflects a significant amount of political, scientific and economic investment from both sides in this relationship.

Prospects for further cooperation in space between India and France

Since the PSLV system has orbit and weight restrictions in respect of undertaking satellite launches, India has no option but to look for commercial launch services for putting its 4- to 6-ton category satellites into geostationary orbit. Arianespace has been the most reliable agency on which India had depended since the 1980s. India's Geostationary Satellite Launch Vehicle (GSLV) programme, which is meant to put heavy satellites into geostationary orbit, has faced significant delays owing to ISRO's failure to develop cryogenic technology for almost one and half decades. However, in 2014, India made substantial progress in its endeavour to build a cryogenic engine, with ISRO successfully launching a GSLV mission using an indigenously developed cryogenic engine. Once India makes its GSLV fully operational, its dependence on Arianespace will be reduced. India is paying a significant amount of money in hiring the launch services from the French agency. With the impending success of GSLV, this situation could change (at least partially) over the next few years and both France and India should adjust their cooperation programme accordingly. **India and France could join hands to seize a major portion of the growing global satellite launch market with Antrix and Arianespace working together. Both agencies should also engage in expanding various other emerging areas of space commerce, including space tourism.**

In general, technology is found changing the nature of dominance by the threat of arms. New systems are being developed by powerful military complexes, particularly automated mechanisms to destroy and kill and in a unidirectional way. In reality, the citizens and nations who are victims may not be able to retaliate as the enemies are far from the scene, controlling the campaign from great distances through satellites, surveillance, command and control. If this capability is monopolised by one country or by smaller groups of countries, they could exert a controlling influence over the broader

international system, irrespective of the values involved⁴¹. As being transparent democracies, major global economies and nuclear weapon states, India and France need to factor 'space' into their strategic calculus. **In the 21st century, the lines between the militarisation and weaponisation of space are fading very rapidly. Hence, it is important for states like France and India to debate these issues and present a joint point of view.**

Interestingly, this bilateral relationship has knowingly or unknowingly remained restricted to identifying space only as an instrument for socioeconomic development. India and France have worked together towards developing programmes that have social, scientific or commercial values. However, no major efforts have been made to join hands in various multilateral groupings addressing outer space issues. Also, no significant efforts have been made to present a mutually agreeable 'point of view' in various UN bodies debating space issues. No structured discussion appears to have happened amongst these two states on issues like the proposed International Space Code of Conduct⁴². On issues related to space security, France has so far found its comfort zone to be with the European Block, but it should expand its discussions to India on these critical areas. **States like France and India, which are against space weaponisation, should join hands together along with other important and likeminded states (if any) towards canvassing a space treaty mechanism.**

Today, in order to tackle the space debris menace effectively, there is a need to evolve a global Space Situational Awareness (SSA) network. France has proven expertise in telemetry and tracking devices and radar systems. **Both India and France should come together and use their good offices to engage other states and make a beginning towards developing a global SSA network.**

Defence is one arena where no interaction is evident amongst India and France towards recognizing space as an important element of security architecture. India was expected to join (and also make monetary contributions to) the 'in progress' European global navigational system project called Galileo. However, India was denied the 'military rights' with respect to Galileo and, hence, it decided against joining the European system⁴³. France, which exports state-

41. Raja Ramanna, "Multipolarity and Security", in *India and France in a Multipolar World*, Proceedings of a Seminar (16-17 February 2000) Manohar, New Delhi, 2001, p. 121.

42. During 2008 the EU has proposed an International Code of Conduct for Outer Space Activities as a transparency and confidence-building measure. This is a voluntary and non-binding mechanism and presently the consultation process is ongoing amongst various stakeholders and the fourth draft is under discussion.

43. Officially, there is no mention about the military utility of Galileo. This information was informally shared with the author by people with knowledge of the deliberations on this issue. It may be also noted that there is Galileo Public Regulated Service – 'PRS'. The PRS is an encrypted navigation service designed to be more resistant to 'jamming', involuntary interference and 'spoofing'. The PRS is primarily intended for

of-the-art military hardware to India, understands the importance of military navigation for India. In fact, Paris should have mediated amongst its European partners to ensure that India is offered a military quality signal on Galileo. In so doing, France would have prevented India from leaving the Galileo project. In December 2011, India signed a deal with Russia to receive precision signals from Glonass, the Russian constellation of navigational satellites. However, this agreement should not be viewed as India finding an alternative to Galileo in Glonass. Over the years, India has purchased the majority of its military hardware from Russia and Glonass has relevance from a compatibility point of view.

India and France, which have established a 'Joint Working Group on Terrorism', very well understand the importance of intelligence gathering to continue with their fight against terrorism. **Hence, India and France should jointly develop and deploy spy satellites for the purpose of gathering intelligence for counter-terrorism operations.**

During the April 2015 visit to France of Indian Prime Minister Narendra Modi, the Mars mission was identified as one area for future cooperation. **France and India could develop a joint plan for all future Moon and Mars missions and also undertake joint research towards understanding the nature of minerals available over there.**

Overall, this five decade-old cooperation and collaboration between India and France in the outer space arena has proved to be mutually beneficial. It has also generated significant amount of trust on both sides. One of the basic reasons for the success of this relationship has been the nature of the political engagement from both sides. It needs to be appreciated that the overall bilateral relationship has always been forward-looking and accommodative. Now, the time has come to take this collaboration to the next level to derive more scientific, strategic and commercial benefits.

use by EU Member State government agencies, including emergency services and police. Access to the PRS will be controlled through an encryption key system approved by Member States' governments. PRS will be accessible to clearly identified categories of users authorised by the EU and participating States. Please refer to <www.gsa.europa.eu/security/prs> and Richard North, "Galileo: The Military and Political Dimensions", 5 July 2004, <www.brugesgroup.com/eu/galileo-the-military-and-political-dimensions.htm?xp=paper> accessed on 21 May 2015.