REFLECTIONS ON INDIA'S SPACE PROGRAMME

T H ANAND RAO

There are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of purpose. We do not have the fantasy of competing with the economically advanced nations in the exploration of the moon or the planets or manned space flight. But we are convinced that if we are to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society.

— Dr. Vikram Sarabhai

As a country with growing development needs and profound security concerns, India is at the threshold of rediscovering itself as a space power. While doing so, India is faced with the dilemma of negotiating the delicate balance between the use of space for social upliftment and military use. In spite of the developments in counter-space technologies by the world leaders in space, India has managed to maintain a consistent approach in using space and space research for peaceful purposes, even after four decades of being labelled as a space-faring nation. It is interesting to note that India is the only space-faring country where rockets were developed exclusively as satellite launch vehicles and not modified from ballistic missiles, as has been

Group Captain **T H Anand Ra**o is Senior Fellow, Centre for Air Power Studies, New Delhi.

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the case with all other space-faring countries where ballistic missiles were developed first and then modified for launching satellites. Exploitation of space for socio-economic upliftment was, therefore, envisioned right from the inception stage of India's space programme. Despite having the third largest space budget in Asia[1], owning 3 percent of the world's operational satellites and being ranked sixth in the global space order, India, till recently, had no dedicated military satellites. A number of scientific, and technological applications, including tele-medicine, tele-education, disaster warning, search and rescue operations, mobile communications, weather and remote sensing being successfully implemented is testimony to the peaceful intentions of India's space programme. India has also leapt into space exploration with the 'Chandrayaan' and 'Mangalyaan' missions which have been largely successful.

While the success in space exploration, satellite launch, satellite and rocket assembly and space ancillary manufacture has boosted the credentials of India's space capability, the missing punch is in the absence of any defensive or offensive capability in India's critical space-based assets. There is an increasing concern about the vulnerability of these space assets to a discreet attack by an adversary which may temporarily or permanently incapacitate a satellite. China's Anti-Satellite (ASAT) weapon test in 2007, in which it destroyed a defunct weather satellite (FY-1C) at an altitude of 530 miles, using a KT-2 missile was a wake-up call not only for India but for the global space-faring community as a whole. The test clearly illustrated the challenges right in India's own neighbourhood. Though this was not the first time an ASAT was tested, it created an apprehension for the security of space assets.

1. "Government Spending in Space Programs Reaches $62 Billion in 2016", Euroconsult, at http://www.euroconsult-ec.com/30_May_2017. Accessed on May 17, 2018.

Space was thought to be a safe domain by the US and Russia which had scaled down their counter-space programmes after the Cold War era. The emergence of China with offensive space capabilities triggered an era of ASATs, causing concerns for weaponisation of space.

The US has openly stated its keenness to go all out to ensure freedom of operation in space in its National Security Strategy 2017, a bold and unambiguous statement to form a space force in the US Space Policy Directive-3 of June 2018, while China has continued development of soft kill ASATs, which has forced a rethink by other countries.

India continues to maintain a posture favouring use of outer space for peaceful purposes in accordance with the existing international laws governing activities in outer space, while the world's space powers have given space the highest national security priority. The US has openly stated its keenness to go all out to ensure freedom of operation in space in its National Security Strategy 2017, a bold and unambiguous statement to form a space force in the US Space Policy Directive-3 of June 2018, while China has continued development of soft kill ASATs, which has forced a rethink by other countries (on how to protect their space-based assets from such an attack in the future). India has to realign its space programme to cater to the space threat environment that exists in the current geopolitical dynamics. Is the traditional orientation of India's space programme holding it back from aligning with the space security requirements as are being undertaken by developed space-faring nations? A peek into the evolution of India's space activities over the years is necessary to assess the future trajectory.

OPPORTUNITIES, MILESTONES, SUCCESSES AND SETBACKS

The shifting of the Indian Space Research Organisation (ISRO) from the Atomic Energy Commission (AEC) to the then newly formed Department of Space under the Space Commission in 1972 was probably the opening of a gateway of opportunities for India's space ventures. Another critical decision was Dr. Vikram Sarabhai's initiative to leapfrog the process of development by acquiring and developing competence in advanced technology for resolving the peculiar situations faced by India at that time[2]. Focussing on space research and exploration would have been a time consuming and superfluous process, given the advances made by other space-faring countries. This effort paid dividends in the Satellite Instructional Television Experiment (SITE) in 1975 with the collaboration of the National Aeronautics and Space Administration (NASA) and, later, the use of acquired remote sensing data for various applications like estimating crop yield, famine assessment, disaster relief, location of fishing stocks, forest cover, etc. Landsat data, offered by the US, along with a ground receiver station in 1979, benefitted India to a great extent.[3] The focus on developing satellite applications clearly played a vital role of creating a sound backing for development of indigenous space infrastructure.

India's foreign policy of the 1970s-80s and its advocacy of non-alignment was beneficial in deriving technical assistance from not only the superpowers, but also from Japan, West Germany, France and other countries[4]. While the US facilitated contacts between Indian and NASA scientists in developing ground stations and working on the design of a first generation satellite system (INSAT), the Soviet Union provided access to its launch vehicles in a bilateral agreement for providing access to Indian ports for Soviet space tracking ships. Indian scientists worked with General Electric, Hughes Aircraft and experts at the Massachusetts Institute of Technology for designing satellite and associated space systems.[5] The availability of a Soviet launcher was a trigger for speedy development of India's first indigenous satellite—Aryabhata—which was launched aboard a Cosmos 3M rocket in April 1975. Though the solar electric power system of Aryabhata malfunctioned after six

2. V.S Mani, "Space Policy and Law in India and its Relevance to the Pacific Rim", *Journal of Space Law* 35, no.2, Winter 2009, pp. 618-619.
3. Daphne Burleson, *Indian Space Research Organisation (ISRO): Space Programmes Outside the US: All Exploration and Research Efforts*, *Country by Country* (Jefferson, North Carolina: Mc Farland & Co., 2005), p. 144.
4. Sundara Vadlamudi, "Indo-US Space Cooperation: Poised for Take-Off?", *The Non-proliferation Review* 12, no.1, March 2005, p. 200.
5. Ibid., p. 202.

orbits, it provided invaluable lessons for the design of the second satellite—Bhaskara-I—which had Soviet photovoltaic cells and better instrumentation.[6]

Launch vehicle development lagged behind the satellite programme, though tests on a four-stage solid fuel Satellite Launch Vehicle (SLV-3) began in 1979 at the newly constructed launch site, Sriharikota. SLV-3 technology was derived from the US Scout missile, though 85 percent of its components were domestically manufactured[7]. It was capable of placing a 40 kg payload in Low Earth Orbit (LEO). The first experimental flight of the SLV-3, in August 1979, was only partially successful, as it failed five minutes after launch and fell into the Bay of Bengal with an experimental satellite onboard. The SLV-3 was later successfully launched on July 18, 1980, from the Sriharikota range, when the Rohini satellite, RS-1, was placed in orbit, thereby making India the sixth member of an exclusive club of space-faring nations. The successful culmination of the SLV-3 project showed the way to advanced launch vehicle projects such as the Augmented Satellite Launch Vehicle (ASLV), Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV).[8]

With the success of the SLV-3 and with indigenously developed satellites in orbit, India was placed in the elite group of nations which had independent access to space. For the next stage of the journey into space, viz. launching a geostationary satellite, India received assistance from France in launching the Ariane Passenger Payload Experiment (APPLE), which entered geostationary orbit in June 1981. It was designed and built in just two years, with limited infrastructure, in industrial sheds. It gave ISRO valuable hands-on experience in designing and developing three-axis stabilised geostationary communication satellites as well as in orbit raising manoeuvres, in orbit deployment of appendages, station keeping, etc. APPLE was used for nearly two years to carry out extensive experiments on time, frequency and code division multiple access systems, radio networking

6. Brian Harvey, *The Japanese and Indian Space Programmes: Two Roads into Space* (London: Springer, 2000) p. 134.
7. Ibid., p. 136.
8. "SLV", at https://www.isro.gov.in/launchers/slv. Accessed on June 20, 2018.

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computer interconnect, random access and pockets switching experiments.[9]

India's capabilities in designing and operating communication satellites benefitted from cooperation with the Franco-German Symphonie satellite from 1977-79.[10] Also, India signed a contract with the Ford Space and Commerce Corporation in the US for the first seven INSAT systems[11]. This was a vital move in acquiring technology and skills required to indigenously build and operate satellites. INSAT-1A was launched by the NASA's Delta launcher in April 1982, thus, connecting the 31 ground stations built to connect India with the space network[12].

India could have benefitted more from the US expertise in space technology, but the Soviet occupation of Afghanistan in 1979 changed the US stance towards India, bringing a temporary setback to the Indo-US space cooperation. In the 1980s, the Soviet Union became a strong ally of India. Many deals in defence cooperation were inked which included purchase of military hardware on soft terms. The Soviet Union also offered to train and launch India's first astronaut aboard the Salyut-7 space station. After almost three years of training, India's first astronaut, Sqn Ldr Rakesh Sharma was launched into space on a Soyuz T-11 rocket on April 2, 1984, along with two other Russian cosmonauts. He spent 7 days, 21 hours and 40 minutes aboard the Salyut 7 during which his team conducted scientific and technical studies which included 43 experimental sessions. At around the same time, despite the political differences between the US and India, the Reagan Administration offered a slot onboard the space shuttle Challenger to fly a payload specialist and to deploy the INSAT-3 into orbit. But the unfortunate accident in which the space shuttle Challenger exploded after

9. "APPLE", at https://www.isro.gov.in/Spacecraft/apple. Accessed on June 20, 2018.
10. S Dhawan and U R Rao, "The Indian Space Programme", in *Proceedings of the Thirteenth International Symposium on Space Technology and Science* (Tokyo: Agne Publishing, 1982), p.23.
11. Vadlamud, n. 4, p. 202.
12. Dhawan and Rao, n. 10, p. 24.

launch in January 1986, and India's decision to independently launch its satellite, resulted in the shelving of the collaborative effort.[13] India's space destiny could have been different had the events not unfolded in this manner. In a sense, India distanced itself from the US in space cooperation, though it was a transient phase.

The PSLV is the third generation launch vehicle of India. It is the first Indian launch vehicle to be equipped with liquid stages. After its first successful launch in October 1994, the PSLV emerged as the reliable and versatile workhorse launch vehicle of India, with 39 consecutively successful missions by June 2017.

The need to develop bigger rockets that could put heavier rockets into orbit led to the progressive modification of the SLV-3 to the ASLV and PSLV. The ASLV was an SLV with two strap-on boosters which could carry a 150kg class satellite into a 400 km orbit. The ASLV proved to be a low cost intermediate vehicle to demonstrate and validate critical technologies that would be needed for the future launch vehicles like strap-on technology, inertial navigation, bulbous heat shield, vertical integration and closed loop guidance. The first successful launch was carried out in 1992 after two failed development flights in 1987 and 1988.[14] To carry bigger satellites into orbit, ISRO progressed to the PSLV which was capable of placing a 1.75 ton payload in a polar orbit of 600 km altitude and a 1.4 ton payload in a geosynchronous transfer orbit. The PSLV is the third generation launch vehicle of India. It is the first Indian launch vehicle to be equipped with liquid stages. After its first successful launch in October 1994, the PSLV emerged as the reliable and versatile workhorse launch vehicle of India, with 39 consecutively successful missions by June 2017. During the 1994-2017 period, the vehicle launched 48 Indian satellites and 209 satellites for customers from abroad. Besides, the vehicle successfully launched two spacecraft – Chandrayaan-1 in 2008 and the Mars Orbiter Spacecraft in

13. Harvey, n. 6, p. 165.
14. "ASLV", at https://www.isro.gov.in/launchers/aslv. Accessed on June 22, 2018.

2013 – that later travelled to the Moon and Mars respectively.[15] The growing success of the PSLV and technology proliferations into India's ballistic missile programme attracted curbs from the Missile Technology Control Regime (MTCR), which led to the US and other Western countries to cease technological cooperation with India.

The break-up of the Soviet Union in 1991 brought in new challenges in India's space journey. Financial and technical assistance provided by the US necessitated Russia's compliance with the MTCR. Moreover, military hardware and technology was only available on stringent financial terms. This affected the GSLV programme, as the contract with the Soviet commercial space agency, Glavkosmos, for the sale of cryogenic liquid fuel engines which was announced in 1991, was scrapped due to the sanctions imposed on Glavkosmos by the US for defaulting on MTCR guidelines. Though the deal was truncated to delivery of only finished rocket boosters, transfer of cryogenic technology was halted.[16] This is seen as an event which ensured indigenous development of cryogenic engines by ISRO, and as a blessing in disguise for the accelerated development of the indigenous cryogenic stages for the GSLV. Further, India's nuclear tests in May 1998 sealed any scope of revival of Indo-US cooperation in space for the following few years.

By the end of the last century, India was a nuclear and space power. The space programme was maturing, with India being in the league of space-capable nations. Despite advances made in space technology, the Kargil War of 1999 was deprived of any space-based intelligence in terms of imagery analysis that could have given the precise location of incursions in the Kargil heights. Many aerial reconnaissance missions were flown in the area by a variety of aircraft but the time lag involved in mission planning, reconnaissance sorties, imagery analysis and dissemination of intelligence made it a cumbersome process, and at times, irrelevant. Availability of timely satellite imagery during the Kargil conflict could have changed the course of

15. "PSLV", at https://www.isro.gov.in/launchers/pslv. Accessed on June 22, 2018.
16. Richard Speier, "US Satellite Space Launch Cooperation and India's Intercontinental Ballistic Missile Programme" in Henry Sokolski, ed., *Gauging US-Indian Strategic Cooperation* (Carlisle, Penn.: US Army War College, Strategic Studies Institute, March 2007), p. 194.

the conflict, or may be the conflict itself could have been averted if intelligence inputs had been available through satellite imagery.

Two events which changed the US policy on export control towards India were the terrorist attack on the World Trade Centre (September 2001) and the Chinese ASAT test in 2007. The first event brought India closer to the US in its "Global War on Terror" and the US began looking at India as an ally, and the consequent easing of non-proliferation sanctions. The Next Steps in Strategic Partnership (NSSP) agreement in January 2004 spelt out nuclear and space cooperation as two key areas for advancement, paving the way for the US giving concessions on export controls for NASA's cooperation in space science with ISRO. The results were soon seen in the Chadrayaan-1 mission of 2008, which carried a US instrument as payload and was successful in detecting traces of water vapour on the Moon. In later years, US-India cooperation extended to other areas in the civilian space domain, like the current NASA-ISRO Synthetic Aperture Radar (NISAR) satellite project which is expected to be launched in 2021.[17]

Commercialisation of India's space industry was another turning point in India's space journey, which was a follow-on to the success of the PSLV as a reliable space launch vehicle. Collaboration with foreign countries, while enabling cooperation in research and development also attracted many customers for availing India's expertise in space. ISRO has launched 237 foreign satellites till date for 28 countries,[18] which has brought India to the forefront as a responsible space-faring nation. Cooperation on mutually beneficial terms like the launch of the Israeli satellite TecSar-1 in 2008 gave India access to the satellite's high resolution imagery.

In recent years, India is seen to be diverging from its traditional focus on using space applications for national development to getting involved in the high prestige race for space exploration. The 'Chandrayaan-I' lunar mission brought in a new focus to India's space programme in 2008 as it was the first

17. "ISRO and NASA Jointly Working on NASA-ISRO Synthetic Aperture Radar (NISAR) Mission", Press Information Bureau, July 30, 2015, at http://pib.nic.in/newsite/PrintRelease.aspx?relid=123963. Accessed on June 27, 2018.
18. "Missions", at https://www.isro.gov.in/missions. Accessed on June 27, 2018.

time India had ventured beyond the Earth orbit. The 'Mangalyaan' Mars mission displayed India's acumen in space technology by its becoming the fourth country to have reached Mars. This was a big boost to the international reputation of India's space capabilities. But the Chandrayaan-I mission, even though successful, did experience technical glitches, which highlighted weaknesses in India's space technology. The spacecraft had to be boosted into a higher orbit around the Moon due to an unexpected overheating. The effectiveness of onboard scientific instruments and other payloads was, thus, reduced. Finally, it experienced attitude control problems and impacted with the Moon's surface in 2009. The data collected though, specifically of the traces of water vapour, is said to be of immense value to the scientific community towards further research on sustainability of life on the Moon.[19]

India is also venturing into manned space flight with its Human Spaceflight Programme (HSP). Technical assistance is being sought from Russia since 2008 towards designing the human capsule which is to be launched on a GSLV rocket.[20] A demonstration of the atmospheric reentry flight of a prototype crew module of the HSP was successfully carried out as part of an experimental flight on December 18, 2014.[21] On July 5, 2018, ISRO conducted a pad abort test for testing the crew escape system which is a critical technology towards making the human capsule operational. No timeline has been set for completion of this project, which suggests it is not a priority venture of the Indian space programme.

The success of the Chandrayaan-1 mission of 2008 and Mangalyaan mission of 2014 (Mars Orbiter Mission) set India apart from other space-faring nations in acquiring a reputation for furthering scientific research and exploration and civilian uses of outer space as a priority, while it could have utilised its technical expertise in developing military applications and counter-space programmes. The years 2016-17 comprised a remarkable period for ISRO with many successful missions being undertaken. The launch of 104 satellites in a single PSLV launch (PSLV-C37) on February 15, 2017, launch of the GSLV

19. James Clay Moltz, *Asia's Space Race* (New York: Columbia University Press, 2012), p. 132.
20. Ibid., p. 133.
21. "Human Spaceflight", at http://www.vssc.gov.in/VSSC_V4/index.php/technology/human-space-flight. Accessed on July 11, 2018.

Mk-III on June 5, 2017, Scramjet engine technology demonstrator (August 28, 2016) and re-usable launch vehicle-technology demonstrators (May 23, 2016) were feathers in the cap for ISRO. Future missions to be undertaken like the Chandrayaan-2, human space flight programme and GSLV-Mk-III missions look promising in scientific research, space exploration efforts and civilian use of outer space by India. However, the recent failed launches of ISRO, which include the loss of communication with the GSAT-6A(launched on March 29, 2018) and the failure of the payload heatshield of the PSLV C-39 (launched on August 31, 2017) to separate, resulting in the loss of the Indian Regional Navigation Satellite System-IH (IRNSS-1H) satellite within a span of six months, have resulted in some momentum being lost and need introspection.

INDIA'S MILITARY USE OF SPACE

As brought out in the beginning of this article, India never looked at outer space as a domain for war-fighting. The military applications are viewed as a byproduct of civilian applications owing to the dual use technologies involved. The requirement of having dedicated military space assets was first felt in the aftermath of the Kargil War. The Kargil Review Committee report of September 2000 recommended, "Every effort must be made to ensure that a satellite imagery capability of world standard is developed indigenously and put in place in the shortest possible time"[22]. Consequently, India's first spy imagery satellite, the Technology Experiment Satellite (TES) was soon launched in October 2001, followed by the Cartosat series of imagery satellites and the Risat (Radar Imaging Satellite).

During the Kargil War, one of the primary requirements for precision aerial bombing missions was the Global Positioning System (GPS) data for locating target positions and accurate navigation. India is believed to have requested the US for access to the military grade signal of the area, however, the US denied it. A need was, thus, realised to have an indigenous satellite navigation system. The IRNSS was, thus, born and has now been named

22. "Kargil Review Committee Report", Annexure B, p. 121, at http://www.vifindia.org/sites/default/files/GoM%20Report%20on%20National%20Security.pdf. Accessed on June 27, 2018.

The Chinese ASAT test was a reminder, not only to India, but also the world's space-faring community, that space assets are no longer safe in the arena of the global commons, and new players are emerging to compete with the US and Russia. China, being a neighbour and a potential adversary of India, it was reason enough to raise an alarm.

as the Navigation Indian Constellation (NavIC).[23] [24] The space and ground segments are functional, while the user segment will be operationalised soon.

While the turning point in India's military use of space was the Kargil War, the Chinese ASAT test of 2007 was another moment of realisation that dawned on the Indian space establishment. The space tracking network, being what it was, did not detect the event and the space community came to know about the debris littering ASAT test much later. Besides revealing the gaps in space tracking capabilities, the Chinese ASAT test was a reminder, not only to India, but also the world's space-faring community, that space assets are no longer safe in the arena of the global commons, and new players are emerging to compete with the US and Russia. China, being a neighbour and a potential adversary of India, it was reason enough to raise an alarm.

The Standing Committee on Defence, in its seventh report to the thirteenth Lok Sabha (Lower House of Parliament) in 2000 had recommended the development of an Aerospace Command as a part of the plan for modernisation of the Indian Air Force (IAF). The Ministry of Defence (MoD) was of the view that development in space technologies can be utilised by the IAF in the following ways:

- To build real-time situational awareness through space communication and space sensors.
- To link radar and other communications networks over the entire length and breadth of the country.

23. Yuji Kuronuma, "India Takes on China with its own Navigational Satellites", November 16, 2017, at https://asia.nikkei.com/Business/Technology/India-takes-on-China-with-its-own-navigational-satellites2. Accessed on June 28, 2018.
24. Ishan Srivastava, "How Kargil Spurred India to Design own GPS", April 5, 2014, at https://timesofindia.indiatimes.com/home/science/How-Kargil-spurred-India-to-design-own-GPS/articleshow/33254691.cms. Accessed on June 28, 2018.

- To assist in Ballistic Missile Defence (BMD).
- To gather real-time intelligence about enemy aircraft, missiles and space-borne threats.
- To prevent the enemy from using its space assets by resorting to jamming.

The first step towards integrating India's space applications with military requirements was taken in 2010 with the creation of an Integrated Space Cell (ISC) under the HQ IDS of the MoD. The ISC has had a coordinating role with the Service Headquarters and between the armed forces and the Department of Space and Ministry of Defence.

The committee again recommended in 2003 (thirteenth report) that there was an immediate need to form an Aerospace Command, but the proposal has not yet matured.[25]

Meanwhile, India launched a roadmap for space activities in the form of Vision 2020 for space or Defence Space Vision (DSV) 2020, steered by the Integrated Defence Staff Headquarters (HQ IDS) of the MoD. HQ IDS has the task of formulating a draft space doctrine. Intelligence, surveillance, reconnaissance, and navigation had been identified as the thrust areas in the first phase (2007-12) of this vision.[26] The defence Space Vision 2020 outlined the need to harness the satellite resources in a big way to boost Indian defence preparedness.

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25. Ajey Lele, "Indian Armed Forces and Space Technology", *India Review*, vol. 10, no. 4, October–December, 2011, pp. 379–393, at http://dx.doi.org/10.1080/14736489.2011.624023. Accessed on May 30, 2018, and at https://www.researchgate.net/publication/239789444_Indian_Armed_Forces_and_Space_Technology. Accessed on August 10, 2018.
26. Ibid.

the GSAT-7 (2013) for the navy, and the GSAT-6 (2015) for the armed forces.[27] Further, the Technology Perspective and Capability Roadmap (TPCR) of the MoD and Defence Research and Development Organisation (DRDO) lists several space-based capabilities envisioned for India's expanding space-based security needs.[28]

Further, the MoD is working towards raising three new tri-Service agencies in the fields of cyber warfare, space and special operations, as announced in July 2017, which is in line with the Joint Armed Forces Doctrine released in April 2017. Military space operations would be coordinated by a Defence Space Agency (DSA). The ISC would likely merge with the DSA and work closely with ISRO and DRDO for better utilisation and integration of space resources. This includes information sharing from individual satellites, and surveillance from other satellites which can then be shared with the concerned defence Service.[29]

NATIONAL SPACE POLICIES

India's space ventures have so far been government sponsored and directed towards extracting the benefits of space for socio-economic upliftment and scientific research. There was no need felt for stringent regulations within the government system of functioning, though India has abided by all international agreements and space governance policies. As a result, India remains one of the space-faring nations that has yet to enact a space legislation. The existing regulations are a policy on remote sensing data (Remote Sensing Policy Data 2011) and a guiding document for the implementation of the satellite communications policy framework (Norms, Guidelines and Procedures for the Implementation of the Policy Framework for Satellite Communications in India, 2000). ISRO functions under the directions of the Space Commission and the

27. Ajey Lele, "GSAT-6: India's Second Military Satellite Launched", August 31, 2015, at https://idsa.in/idsacomments/GSAT6IndiasSecondMilitarySatelliteLaunched_alele_310815. Accessed on July 10, 2018.
28. "Technology Perspective and Capability Roadmap-2018", at https://mod.gov.in/sites/default/files/tpcr.pdf. Accessed on July 10, 2018.
29. Sushant Singh, "Coming Soon: Ministry of Defence's Cyber, Space, Special Operations Divisions", October 16, 2017, *Indian Express*, at https://indianexpress.com/article/india/coming-soon-ministry-of-defence-mods-cyber-space-special-operations-divisions-4892404/. Accessed on July 11, 2018.

Department of Space (DoS), but with no space legislation in place. With private players emerging on the skyline, a necessity was felt to have a firm legislation to regulate space activities in India, and, thus, a draft Space Activities Bill, 2017, was put up in the open domain for comments. The legislation is likely to be passed by an Act of Parliament. China too is yet to enact legislation for outer space activities, more so because of its desire to open up space exploration to private companies. Presently, China has adopted two space laws and published three White Papers on its space activities. The laws deal with administration of registration and licensing of space objects launched from China. Other Asian countries that have forayed into space, like Iran, Japan, South Korea and Indonesia (soon to be a space capable country) have enacted space legislations.

ORGANISATIONAL STRUCTURE

ISRO was brought under the newly-created DoS in 1972. The DoS is placed directly under the prime minister who administers policy decisions through the Space Commission. ISRO is central to India's space efforts. While this is an outcome of pooling of talent at a single source, it overshadows the role of other organisations in the decision loop. A case in point is the tradition of appointing the chairman of ISRO also as the secretary, DoS Such an arrangement, while, on one the hand, contributes towards shortening the decision loop as well as efficient budgetary allocations, on the other, the puts a bias in allotment and prioritisation of projects. With the increasing role of private industry in space applications and space manufacturing, it would be prudent to segregate the overlapping roles of DoS and ISRO.

Military applications of space are presently undertaken by ISRO with a defence forces component contributing to the effort at the execution level. Agencies like DRDO, National Technical Research Organisation (NTRO) and Defence Image Processing and Analysis Centre (DIPAC) also have close liaison with ISRO for harnessing space applications. Such an arrangement may be sufficient for a limited space applications-based military utilisation of space. However, emerging issues like space situational awareness, space traffic management, debris avoidance, satellite defence and dependence on

Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) require a more active role for the armed forces. The organisation of India's space efforts, thus, needs to be more inclusive through an overlap between the DoS and MoD. This overlap can be optimally created by establishing a Military Space Command which has jurisdiction over all military space activities and is in sync with DoS and ISRO.

CONCLUSION

Military organisations worldwide have steadily increased reliance on space assets for various applications like communications, surveillance, navigation, meteorology and early warning. India's space capabilities are barely adequate to meet existing requirements for civilian space applications. The capacity for military space requirements is grossly inadequate considering the increasing reliance of military operations on space assets in an information-centric war-fighting environment.

Despite being a developing country, India has achieved the status of a space-faring nation, with its success in space ventures. Though the successes and milestones achieved are many, the missing punch is in the absence of defensive capability against deliberate attacks on space-based assets. The Indian space programme, though well defined, has yet to mature through a diversification of its ventures to encompass the entire spectrum of space capabilities. India has not favoured any dedicated military space assets and has had a remarkably peaceful orientation throughout its history of space ventures. However, the change in the space environment has put India in a dilemma.

Space is no longer a safe haven, and the space activities of many space-faring countries, including private players have demonstrated that freedom of operation in space would be a challenge in the coming years. The ASAT capabilities of potential adversaries, crowding of the space domain and the invisible threat of soft weapons needs to ring the alarm bells in India's Space Commission and Department of Space. What we get from space will ultimately depend on what we are looking for.