India and Weaponization of Space

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Abstract

The Indian space programme, beginning in the early 1960s, is a civilian space programme with emphasis on applications for development and societal values. In the process, the country has developed satellites for communications, earth observation and other applications, the means to launch them into orbit and has established the related infrastructure. Space science developments and international space cooperation and participation in the activities of the United Nations Office for Outer Space Affairs (UNOOSA), including a contribution to the Inter Agency Debris Committee, are hallmarks of the space programme.

However, space has ceased to be the sanctuary it once was and activities have established rapid trends to its militarization and weaponization. Under these circumstances, India has been increasingly concerned about the safety and protection of its space assets and has taken steps to address them.

Introduction

The initial philosophy and origins of the Indian Space Programme are well known and require no repetition. In the first four decades of its formation, the development of the space programme concentrated on societal application missions, the results of which are widely acknowledged.

After having chalked up more than 100 space missions focussing on Earth applications, India's space agency, the Indian Space Research Organisation (ISRO) is moving towards deep space probes and scientific missions, reusable launch vehicle technologies and other advanced concepts.

Space Accomplishments

Indian space accomplishments can be divided into clear phases. The 1960s were essentially the beginning years and included organisation, infrastructure establishment and the development of basic technology and learning. The following years were devoted to the development of application tools. Experimentation using leased satellites as a mass learning tool, launch vehicle technology, communication and remote sensing experimental satellites and training preceded indigenous development efforts. A roadmap which defined the communication and remote sensing capabilities, orbital placement requirements, tracking and related infrastructure, culminated in the development of a series of communication and remote sensing satellites as well as launch vehicles to place them in the desired orbits. By the year 2000 the systems had reached operational status, although the development of a Geosynchronous Satellite Launch Vehicle (GSLV), using a cryogenic upper stage, took a little while longer. At the same time, India started offering commercial launches on board its Polar Satellite Launch Vehicle (PSLV).

The Indian National Satellite (INSAT) system initiated in 1983 is one of the largest domestic communication satellite system in the Asia-Pacific region. According to ISRO, the INSAT system has more than 200 transponders in the C, Extended C and Ku-bands microwave frequency range, catering to telecommunications, television broadcasting, satellite newsgathering, weather forecasting, disaster warning and Search and Rescue services[1]. The telecommunications sector also provides mobile satellite services and

1 Vivek Raghuvanshi, "India to launch a defense-based space research agency," Défense News, June 12, 2019. Available at: https://www.defensenews.com/space/2019/06/12/india-to-launch-a-defense-based-space-research-agency/

caters to a large number of Very Small Apperture Terminals (VSATs). The societal applications of INSAT include tele-education using EDUSAT and telemedicine services. In addition, some of the satellites of the INSAT series provide meteorological services, including monitoring and warnings related to approaching cyclones and other adverse weather phenomenon. In early 2000, ISRO introduced the 4th generation of communication satellites called the GSAT series. These satellites were designed to meet the increasing capacity requirements, as well as service requirements, and catered to Direct to Home (DTH) needs and multimedia services. Satellites of the 2 ton class and 4 ton class can be launched by the indigenous launch vehicles GSLV Mk-2 and Mk-3 respectively. For heavier payloads, as well as schedule requirements, ISRO uses procured launches mostly using ESA's Ariane V. With the launch of GSAT-31 on 06 February 2019, ISRO has 19 operational satellites providing a variety of communication services.

In the field of earth observations too, ISRO operates a large constellation of satellites. According to the ISRO website, ISRO has thirteen satellites in sun-synchronous polar orbit and four in geostationary orbit.[2] These satellites provide data with diverse spatial, spectral and temporal resolutions catering to the needs of Indian and global users. Over the years, the resolution has improved and is now available at the sub-metre level. In addition, ISRO has launched Radar Imaging Satellites designated as RISATS. ISRO earth observation satellites provide valuable inputs for applications in fields such as agriculture, water resources, planning for the rural and urban sectors, environment, forestry, ocean resources and mineral prospecting.

ISRO also has deployed a Regional Navigation System, IRNSS (NavIC) capable of providing a position information service to users in India and over a region of 1500 km from the Indian mainland.[3] IRNSS provides Standard Positioning Service to all users and a restricted encrypted service to authorized users. The claimed position accuracy is better than 20m in the primary service area. All standard position, navigation and timing applications are available from the system.

Among the ISRO operational launch vehicles, PSLV is principally used for launching earth observation satellites. The vehicle can place payloads weighing 1750 kg in a 600 km Sun Synchronous Polar Orbit (SSPO). PSLV has been used on occasions for missions other than SSPO. With over 40 flights to its credit, the vehicle has proved to be extremely reliable and cost effective. Besides Indian satellites, the vehicle has been used for commercial launches also including satellites of 28 foreign countries, most of them in piggy back mode. GSLV Mk-II uses stages derived from PSLV and a top stage using cryogenic propellant. Satellites of mass 2130 kg have been placed GSO by this vehicle. The GSLV Mk-III is a totally new vehicle capable of placing the 4 ton class of satellites in GSO and is being earmarked for human space flight by ISRO.

ISRO currently has 50 operational satellites comprising communication, earth observation, navigation constellation and scientific satellites. In addition, it has carried out two exploratory lunar missions and a Mars mission. Former ISRO Chief, Kiran Kumar, while addressing delegates of an international seminar in November 2017, said „What we have today is 42 satellites in operation, still we are significantly short of the capacity needed, whether it is for earth observation, microwave technologies, communication, or navigation, we need probably more than double this number."[4] ISRO

2 *"Earth Observation Satellites", Indian Space Research Organisation, (n.d.), (accessed on 08 October 2019). Available at:* https://www.isro.gov.in/spacecraft/earth-observation-satellites

3 *"Indian Regional Navigation Satellite System (IRNSS): NavIC", Indian Space Research Organisation, (n.d.) (accessed on 08 October 2019). Available at:* https://www.isro.gov.in/irnss-programme

4 *"Need to double number*

has embarked on a capacity building exercise towards achieving such a target.

There is no official or agreed number monetary value associated with Indian space assets. According to Avinash Chander, former Chief of the Defence Research and Development Organisation (DRDO), the value of Indian space assets, as of December 2014, was $ 26 billion.[5] Between 2015 and 2019, India added 18 satellites and as such the value would have increased significantly from this figure. Considering further that ISRO is increasing satellite production and launch capacity, the value from space assets, downstream products and services can be estimated to touch $ 50 billion. Needless to say, this is an important asset, not just in terms of the monetary value, but in terms of the essential services that the assets render. Hence, the need for protecting the assets from harm has arisen.

of operational satellites: ISRO Chief", Economic Times, Nov 20, 2017. Available at: https://economictimes.indiatimes.com/news/science/need-to-double-number-of-operational-satellites-isro-chief/articleshow/61725644.cms

5 Gulshan Luthra, "Indian Space Assets are worth $26 billion", India Strategic, January 2015, accessed on (09 October 2019). Available at: https://www.indiastrategic.in/topstories3644_Indian_Space_Assets_are_worth_$_26_billion.htm

Co-serving Military Needs

The dual use nature of space technology obviously means that a range of military applications are also served. Communications, Earth Observation, Navigation and Weather Monitoring satellites all serve both civilian and military requirements. Some improvements like anti-jamming, encryption, thermal imaging, highly accurate navigation data will be required to serve the military requirements and these are not difficult to incorporate.

Major advances have been made in the area of small satellites and many application missions – both civilian and military - can be developed using such satellites. Small satellites are cheaper to build, cheaper to launch in both independent and piggyback mode, and can employ the latest technology. Small satellites are built in Universities, small firms and startups and have been used for earth observation and intelligence gathering missions.[6]

Indian defence services need their own secure communication links and have invested in dedicated communication satellites. GSAT-7 was the first such satellite launched in 2013 for the exclusive use of the Indian Navy. GSAT-7, also known as Rukmini is a multiband satellite capable of communications in the UHF, S-Band, C-Band and Ku Band.[7] Rukmini will be used by the Navy for secure real-time communication with its fleet of warships, submarines, aircraft as well as land systems. The 7 year design life of the satellite comes to an end in 2020 and the Navy has planned its replacement. The GSAT-7R satellite, costing about $ 227 million (including satellite, launch and ground infrastructure costs) is expected to be launched in 2020.[8] The satellite applications are similar to GSAT-7. Similarly GSAT-7A, launched in December 2018 serves the communication requirements of the Indian Air Force between its strategic platforms like the fighter fleet, unmanned air systems and early warning aircraft.

The images from the ISRO remote sensing satellite provide information that is also useful to the armed forces. The Cartosat series and the Radar Imaging Satellites (RISAT) provide information useful for surveillance. The

6 Rajaram Nagappa. "The Promise of Small Satellites for National Security", Report No. R33-2015, Bengaluru: National Institute of Advanced Studies, December 2015.

7 "GSAT 7 (INSAT 4F, Rukmini)", Gunter's Space Page (n.d.), (accessed 09 October 2019). Available at: https://space.skyrocket.de/doc_sdat/gsat-7.htm

8 Manu Pabby. "Navy to buy Rs 1589 crore satellite from ISRO", Economic Times, July 18, 2019. Available at: https://economictimes.indiatimes.com/news/defence/navy-to-buy-rs-1589-crore-satellite-from-isro/articleshow/70283927.cms?from=mdr

Cartosat satellite family have a resolution better than 1m and a revisit time of 4 days, which can be reduced to one day using orbital manoeuvres.[9] The satellites in 505 km orbit carry a Multi-spectral imaging system as well as a Panchromatic imager. The cameras are capable of ±26° steering and have enhanced imaging features.

A ISRO release describes the function of the satellite as follow[10]:

"The imagery sent by satellite will be useful for cartographic applications, urban and rural applications, coastal land use and regulation, utility management like road network monitoring, water distribution, creation of land use maps, change detection to bring out geographical and manmade features and various other Land Information System (LIS) as well as Geographical Information System (GIS) applications."

These features, particularly those related to "change detection to bring out geographical and manmade features and various other Land Information System" are of use to the defence forces. The defence forces also have their own dedicated capability for satellite imagery acquisition and analysis. This function is carried out by the Defence Image Processing and Analysis Centre (DIPAC). The defence forces also stand to gain from using the Restricted Encrypted service from the NavIC system and weather related data from ISRO meteorological satellites.

Protection of space assets

Threats to space assets exist from natural causes, unintended/accidental collisions and intended events. Natural causes include collision with micro-meteoroids and space weather related incidents. Unintended/accidental collisions have occurred between satellites and debris/non-functional satellites - some result in additional debris, which can endanger other satellites. Such unintended collisions include collisions with inactive satellites and catalogued debris, collisions with inactive satellites and uncatalogued debris and collisions between satellites. An example of this is the collision between active US satellite Iridium-33 and inactive Russian satellite Cosmos-2251 in February 2009. This collision created more than 2300 pieces of debris.

Note: The Inter-Agency Space Debris Coordination Committee (IADC) of the UN Office for Outer Space Affairs is an international forum of national and international space agencies for the worldwide technical/scientific coordination of activities related to space debris in Earth orbit issues and provides technical recommendations[11]. IADC provides guidelines for the mitigation of debris creation like passivation of the apogee injection liquid stage (by emptying the remaining propellant in the tanks), post-satellite life orbit management, collision avoidance relating to flight of launch vehicles, rockets and missiles and estimating the proximity of space objects. India follows all of the guidelines.

Other threats to space assets can be listed as under:

- Kinetic Energy Weapons: Any country with Medium Range Ballistic Missile capability can reach LEO altitudes. If equipped with a kinetic kill weapon and terminal guidance, these weapons can target LEO satellites.
- Co-orbital satellites can stay in orbit and can be activated to approach, manoeuvre and damage adversary satellite.
- Kinetic kills at GEO altitudes is technically feasible but more difficult to

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9 "CartoSat-2E", Spaceflight101, (n.d.), (accessed 10 October 2019). Available at: http://spaceflight101.com/pslv-c38/cartosat-2e/

10 "Cartosat-2 Series Satellite", Indian Space Research Organisation, January 12, 2018. Available at: https://www.isro.gov.in/Spacecraft/cartosat-2-series-satellite-2

11 Ettore Perozzi. "The Inter-Agency Space Debris Coordination Committee (IADC): An overview of IADC's annual activity", UNOOSA, 18 February, 2019. Available at: http://www.unoosa.org/documents/pdf/copuos/stsc/2019/tech-37E.pdf achieve

- Attack space related ground infrastructure.

- Jamming: of communications between satellite and the user. Jamming and similar electronic interference allow a benign method (creating no space debris) of denying the normal functions of space systems, accompanied by a difficulty of attribution. Commercial low cost jammers can be used to jam GPS signals.

- Spoofing: involves the manipulation of data by an attacker so as to appear real and normal, thus creating openings to avenues by which to interfere with satellite connectivity. Spoofing attacks can disrupt communications or position, navigation and timing functions.

- Cyber attacks on space and ground segments.

The paramount requirement for protection of space assets is knowledge of what is happening in space at any given time. That requires a good Space Situational Awareness capability. One must also be in a position to locate the threat as well as to determine the threat or attack source. Attribution in the case of jamming, spoofing and cyber attacks could be difficult, but an early determination of the source and attacker is needed for taking countermeasures. It would be appropriate to have the capability to defend and build in resilience but not to lose functionality and to maintain important space functions.

Space Weaponization - the Indian View

For a long time, India was opposed the weaponization of space. The Chinese Anti-Satellite (ASAT) test of January 2007 catalysed some discussion in India regarding the desirability of otherwise of ASAT weapons. While the undesirability of adding to the debris count by an ASAT test was recognised, the question as to what India should do if any of its space assets was targeted, remained an open question. In an address to the delegates of the International Space Security Conference organised at the Institute of Defence Studies and Analysis in November 2007, K Kasturirangan, former Chairman of ISRO had the following to say:

"While adhering to the principle of non-weaponization of space, India still needs to address the safety of current and future space assets from any potential hostile action, address any space access denial attempts, and address its commitment to using space for its legitimate development and security requirements."[12]

By the time of Chinese ASAT test, the Defence Research and Development Organisation (DRDO) had developed the Agni series of ballistic missiles with a range capability of 700 to over 3000 km. In April 2012, DRDO test fired the Agni-5 missile with a range of 5500 km. By this time, DRDO had also successfully developed a missile intercept (anti-ballistic missile) system to engage incoming missiles in the exo-atmospheric and endo-atmospheric phase. There was some confidence expressed that the technology could be extended for intercepting satellites in LEO as, even in a nominal performance trajectory, Agni-5 could reach a height of 600 km. DRDO was examining ways by which India could demonstrate a Direct Ascent ASAT (DA-ASAT) test and in Agni-5 they found the desired solution. The news magazine India Today reporting on the statement made by the then DRDO Chief, VK Saraswat, quoted him as saying:

"today we have developed all the building blocks for an anti-satellite (ASAT) capability[13]". Further, according to

12 Sandeep Unnithan, "India attains the capability to target, destroy space satellites in orbit," Times of India, 28 April 2012. Available at: https://www.indiatoday.in/magazine/nation/story/20120507-agni-v-launch-india-takes-on-china-drdo-vijay-saraswat-758208-2012-04-28

13 Sandeep Unnithan, "India attains the capability to target, destroy space satellites in orbit," Times of India, 28 April 2012. Available at: https://www.indiatoday.in/magazine/nation/

the publication, a top government sources was quoted as saying „DRDO will field a full-fledged ASAT weapon based on Agni and AD-2 balistic missile interceptor by 2014".

However, it must be noted that India had previously maintained a stand against the weaponization of space. India had been critical of the US Strategic Defence Initiative (SDI) and had voiced its opposition to the weaponization of Space in the UN Conference on Disarmament (CD) and other forums. As early as 1997, in response to a query on the topic, the then Minister of State for External Affairs had stated in the Rajya Sabha (India's upper House of Parliament) that:

"India's stand against use of anti-satellite (ASAT) weapons for prevention of arms race in outer space has been articulated in the relevant fora such as Conference on Disarmament in Geneva[14]. India has also proposed negotiations for an international treaty to ban anti-satellite (ASAT) weapons".

While expressing support for negotiations for a ban on ASAT weapons, the Minister also had added a rider:

"Government remains fully committed to taking all necessary steps to safeguard its security and national interest in accordance with its assessment of developments relating to India's security environment[15]."

Similar sentiments from Government functionaries were expressed periodically, including one by India's representative Jayant Prasad at the CD. Prasad stated:

"India is committed to the peaceful pursuit of space technology and to preserving outer space, a common heritage of the mankind, exclusively for peaceful uses. We share the concerns about the dangers of deployment of weapons in the outer space and believe that this will not be in our collective interest. We regard the Conference as the appropriate forum to deal with this issue[16]."

In the light of this, although DRDO had developed the building blocks and was ready with a kinetic energy weapon, clearance from the Government of India was not forthcoming for carrying out an ASAT test. Consequently, the Government approach was reflected in the revised statement of Saraswat, who stated that:

"India will not test this capability through the destruction of a satellite[17]. Such a test risked showering lethal debris in space that could damage existing satellites. Instead, India's ASAT capability would be fine-tuned through simulated electronic tests."

Saraswat elaborated on this by saying that the space security requires the mastering of a gamut of capabilities, including the protection of satellites, communications and navigation systems and denying the enemy the use of their own „space systems."[18]

The changing scenario

The end of the Cold War signalled a major change in the Soviet-USA dynamic. While developing tools for space exploitation, both in the civilian and defence domains, the two superpowers ensured that space did not become a contested territory. Space assets were used to mutually verify the compliance to the arms limitation treaties and both countries refrained from weaponizing space. President Ronald Reagan's Strategic Defence Ini-

story/20120507-agni-v-launch-india-takes-on-china-drdo-vijay-saraswat-758208-2012-04-28

14 "US High Tech for Space War", Unstarred Question No. 166, Rajya Sabha, answered on 20 November 1997.

15 ibid

16 "Statement by Shri Jayant Prasad, Permanent Representative of India to the Conference on Disarmament," Ministry of External Affairs, February 02, 2006. Available at: https://www.mea.gov.in/Speeches-Statements.htm?dtl/2138/Statement_by_Shri_Jayant_Prasad_Permanent_Representative_of_India_to_the_Conference_on_Disarmament_Geneva

17 Ibid 13

18 Amit Saksena, "India and Space Defense," Media Centre, Ministry of External Affairs, March 23, 2014. Available at: https://mea.gov.in/articles-in-foreign-media.htm?dtl/23139/India+and+Space+Defense tiative (SDI), also known as 'Star Wars' initiated in March 1983, queered the pitch. The main objective of SDI was to develop technologies to intercept Soviet ICBMs at different phases (boost, mid-course and terminal). Both space and earth-based Direct Energy Weapons as well as air and ground based interceptor missiles were part of the system.[19] The breakup of the Soviet Union in 1991 put a halt to further development efforts under SDI.

The 1990-91 Gulf War saw a major application of space assets as Force Enablers. The US-led coalition forces deployed space assets for force enhancement for terrestrial operations. Sixteen military satellites, reinforced with services from five civilian communication satellites, were used for command and control as well as for long distance communication purposes. According to sources, these systems provided high data rates equivalent to about 39,000 simultaneous telephone calls. Both optical and radar imaging satellites were employed for intelligence relating to order-of-battle and targeting as well as for damage assessment. Intelligence gathering satellites (ELINT and SIGINT) were employed for intercepting Iraqi military communications and air defence operations but no space weapons were used in the war. Space faring countries, especially Russia and China also, to some extent, possessed such a Force Enabling capability and capacity, but the US use of space in the Gulf War was an eye opener as to how space assets could be employed to aid and win a conventional war.

The Bush Presidency adopted an aggressive space outlook. According to the Nuclear Threat Initiative (NTI), with an alleged need to use space much more aggressively, both to combat rogue state missile proliferation and to reduce perceived US space vulnerabilities[20]. In addition, the US withdrew from the Anti-Ballistic Missile (ABM) Treaty in June 2002. No headway could be made on the discussion on banning space weapons in the CD due to US objections. In 2006, President Bush signed a new National Space Policy, which was a full revision of the then extant policy. The highlight of the new policy was a) it rejected future arms control agreements that might limit US flexibility in space and b) asserted a right to deny access to space to anyone "hostile to US interests". However, it was clarified by the administration that policy revisions were not a prelude to introducing weapon systems into Earth orbit[21].

It may not be unreasonable to infer that the reference to space denial in the US space policy triggered serious thinking in other spacefaring nations. China, which had achieved significant success in establishing its space programme, undertook actions to demonstrate its capability to thwart any space denial attempts. The result was a demonstration of a hard kill ASAT weapon test on 11 January 2007. The test involved a modified version of DF-21 ballistic missile targeting a defunct Chinese Feng Yun-1C (FY-1C) weather satellite at a height of about 800 km[22].

In February 2008, the US intercepted and destroyed one of its out-of-control satellites, USA-193, with a modified Standard Missile SM-3. The intercept altitude was 240 km and bulk of the debris was short-lived.

The US test in a way, set a benchmark that Direct Ascent Kinetic tests, if done at orbital altitudes below 300 km, may be acceptable as the resulting debris will be short lived. However, at

19 "Strategic Defense Initiative" Britannica (n.d.), (accessed 15 October 2019). Available at: https://www.britannica.com/topic/Strategic-Defense-Initiative

20 "Space Security and Bush Administration Policy: Results of the First Term," NTI, April 01, 2004. Available at: https://www.nti.org/analysis/articles/space-security-and-bush-administration-policy-results-first-term/

21 Marc Kaufman, "Bush sets Defense as Space Priority," Washington Post, October 18, 2006. https://www.washingtonpost.com/wp-dyn/content/article/2006/10/17/AR2006101701484.html

22 The intercept and the resulting breakup of the satellite created over 3000 pieces of debris which may last in orbit for decades.

this time India was still developing the longer-range versions of the Agni Ballistic Missile and, more importantly, India did not have any defunct satellite in the 300 km orbital belt. India's LEO earth observation satellites are mostly in the 500 km to 800 km orbits and Indian policy was, as mentioned earlier, not in favour of space weaponization. While the issue was a topic of much discussion and deliberation among policy planners in Government and Think Tanks, US, Russia and China were consolidating their capabilities and organisational structures. The approach adopted in these countries is summarized below[23]:

USA: The US is the technological leader and remains a major force in terms of space technology and original thinking. Technologies developed under SDI and the Cold War years, have provided the base on which to build the systems required in the current environment. The American approach assumes that war in space in the future is inevitable and the US must stay technologically ahead of others, be in a position to deter anyone from attacking their assets and deny others access to space if necessary. The US will lead with both hard kill and soft kill technologies. The US has carried out many experiments relating to close approach and rendezvous both in LEO and GEO. These experiments have also included autonomous rendezvous (DART and MUBLCOM) as well as a satellite servicing mission using a robotic arm, which successfully demonstrated the autonomous capture of a space object. The US has also deployed satellites under its Geosynchronous Space Surveillance Awareness Program (GSSAP) and carried out close approaches to eight satellites belonging to US and other countries (Russia, Pakistan, Nigeria and China).

In the Direct Ascent ASAT category, their Ground Based Interceptor (GBI) and ship-based ballistic missile (SM-3) defence systems have the potential to carry out direct ascent attack. The ship-based SM-3 was used to intercept the USA-193 satellite in February 2008 and can target satellites up to 600 km, while the Exo-atmospheric Kill Vehicle (EKV) on board the GBI can reach 6000 km. In terms of the soft-kill options, the US has significant capabilities in the areas of jamming, spoofing and cyber-attacks. The activities initiated in 2003 are funded under Counter-Communication Systems category.

Directed Energy Weapons (DEW) form the final category of systems. Ground-based laser development is quite mature, but the same cannot be said of space-based DEWs. It would appear that US has the capability to deploy ground-based laser weapon capable of illuminating/damaging satellites in LEO. The Mid Infrared Advanced Chemical Laser (MIRACL), capable of emitting a multi-megawatt beam in the IR spectrum, has been successfully tested on an orbiting satellite.

Russia: During the Cold War years, Russia had developed many counter-space technologies, including ASAT technologies. These technologies covered the entire gamut of counter space categories of co-orbital satellites, direct ascent, directed energy, and electronic warfare systems. From a period of lull following the breakup of Soviet Union, Russia has, over time, begun building up and updating these technologies in tune with the emerging geo-strategic scenario in space. As in the case of the USA, Russia now has adequate capability and experience in the design and development of counterspace systems.

Russia also has an active program of Rendezvous and Proximity Operations (RPO) – for technology development and possible in-space servicing. However, the weaponizing nature of this technology cannot be ruled out. Between June 2014 and October 2017, Russia carried out different

23 Brian Weeden and Victoria Samson, ed., "Global Counterspace Capabilities – An Open Source Assessment", Washington: Secure World Foundation, 2019.

RPO experiments using Cosmos series and Lunch spacecrafts. In addition, Russia has stretched its BMD experience to the development of the DA-ASAT, based on the Nudol and Air Launched Kontakt missile systems. Russia also has an adequate capability in electronic counterspace methodologies and may be working on an Air Borne Laser system.

China: Having successfully carried out the DA-ASAT test in January 2007 and repeated the intercept tests in 2010 and 2013, China may have operationalized the system using SC-19 missiles for intercepting LEO satellites. China may not, at present, have an operational DA-ASAT capability at MEO and GEO, although a test carried out in May 2013 is indicative of an interception capability at 10000 + km.

China has carried out a number of RPO experiments since 2010. These experiments have involved close approach and manoeuvres and one of the satellites has also carried a robotic arm. While it is not clear if the trials were carried out with the objective of gaining counter space capability, they provide the means to use them for such applications.

China does have a capability for electronic warfare and can target communication and GPS satellites. Chinese developments in Lasers and other Direct Energy Weapons has been reported and some of this effort could be aimed as countermeasure/counterspace applications. Based on a report in a Chinese journal, China had carried out a laser blinding test targeting a LEO satellite at an altitude of 600 km in 2005.[24]

Organizational Changes

China, Russia and US are fully conscious of the central role that space will play – as a Force Enabler and a Force Multiplier in any future conflict. They find it a necessity to integrate space with other branches of defence for improved operations and responses. In this context, all three countries have revamped the organisational structures of their armed forces and integrated them with space systems to different degrees.

The US Air Force Space Command was the agency tasked with managing the military in space. President Trump directed the creation of a 'Space Force' as a 6th independent military service branch, to undertake missions and operations in the evolving space environment, through a directive issued on 18 June 2018. Additionally, on 29 August 2019, a new US Space Command (SPACECOM) came into being[25]. The focus of the Space Force will be organizing, training and equipping, while SPACECOM focus will be on higher level warfighting[26].

Russia reorganized its military space force in 2015 by merging the former military space units of the Russian Air Force and Aerospace Defence Troops into the new Aerospace Forces. The move was prompted by the recognition of a shift in the focus of combat towards the aerospace theatre. The mandate for the Aerospace Forces includes conducting space launches, maintaining ballistic missile early warning capability, satellite control network, space surveillance network as well as air and missile defence.

In China, coinciding with the reorganization of the PLA, the Strategic Support Force (SSF) was created in December 2015 as the fifth military service. For this purpose, the existing space, cyber and electronic warfare units were all merged under the new unified command reporting directly to the Central Military Commission. The space elements of SSF include space launchers, space launch support, telemetry, tracking and con-

24 *Brian Weeden and Victoria Samson, ed., "Global Counterspace Capabilities – An Open Source Assessment", Washington: Secure World Foundation, 2019, 1-19.*

25 *"United States Space Force," Military (n.d.), (accessed 19 October 2019). Available at:* https://www.military.com/space-force

26 *Loren Grush, "The Trump administration stands up US Space Command as fate of Space Force is still undecided," The Verge, August 29, 2019,* https://www.theverge.com/2019/8/29/20837136/space-command-trump-administration-warfighting-dod-force

trol (TT&C) and Intelligence, Surveillance and Reconnaissance (ISR) functions.

Indian Response – Rationale and Position

The post-Chinese ASAT period saw intense debate in India about the repercussions of the test, its implications for India and possible Indian responses. The spent apogee stages of the Indian Polar Satellite Launch Vehicle (PSLV) were available as targets in LEO (500-800 km orbit), but the technology related to anti-ballistic missile interception was still evolving. Additionally, the issue of creating long-lasting debris at these altitudes was also a deterring factor.

India was aware of the demands for discussion on a ban on DA-ASAT tests and there was some concern that, India would be disadvantaged (as in the case of the Nuclear Non-Proliferation Treaty - NNPT) if such a ban came into effect. India's record of being a model space power would not be helpful in such a scenario. The US test of downing the USA-193 provided a template for carrying out a DA-ASAT test without creating long-lived debris.

On 28 September 2016, India carried out a surgical strike inside Pakistan territory on terror launch pads. Two days later, on 30 September India's radar imaging satellite RISAT-1 suffered a fragmentation event and went out of service[27]. The satellite had completed 4.4 years of its design life of 5 years and provided a 25 km swath with 3m resolution and 1m high-resolution in sliding spotlight mode. The reason for the fragmentation could not be explained and while similar fragmentation events have been previously reported, the proximity of the event just after a cross-border strike left the issue open to speculation.

Keeping in mind the developments and ambivalent trends in technology development discussed in the previous section, India decided to carry out a DA-ASAT test taking care not to leave long-lasting debris in space. Towards this end, India designed a 'Microsat-R' earth observation satellite which was placed in a 274 km sun-synchronous polar orbit on board the PSLV C-44 launch on 24 January 2019. The 740 kg Microsat R was described as an imaging satellite meant for military purposes[28] and was in a low enough altitude to serve as target for the DA-ASAT experiment.

It would appear that approval for the project was obtained in 2017 and the lead time was utilized for readying all the technology subsystems required for the test. These included radar systems to track the Microsat-R accurately, the Kinetic Kill Vehicle (KKV) and the vehicle system to boost the KKV. The KKV was derived from the ballistic missile defence programme and the carrier vehicle was derived from the K4 and PDV missile stages[29]. Mission Shakti, the DA-ASAT test, was conducted on 27 March 2019, with the interceptor missile launched from Dr APJ Abdul Kalam Island off the coast of Odisha.

The impact did create the debris field but this was expected to be short-lived due to the low height at which the interception occurred. The US Strategic Command's Joint Force Space Component Command (JFSCC) was tracking 250 pieces of debris subsequent to the impact. The orbit of the International Space Station was 100 km higher and no risk to the station was expected[30].

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27 *"RISAT-1 (Radar Imaging Satellite-1)," eoPortal Directory, (n.d.), (accessed 20 October, 2019). Available at:* https://directory.eoportal.org/web/eoportal/satellite-missions/r/risat-1

28 *"ISRO launches military satellite Microsat-R successfully," The Hindu BusinessLine, January 25, 2019. Available at:* https://www.thehindubusinessline.com/news/science/india-launches-military-satellite-microsat-r/article26087057.ece#

29 *Indranil Roy, "All you need to know about the PDV Mk-II: India's Satellite Killer," Delhi Defence Review, April 3, 2019,* http://delhidefencereview.com/2019/04/03/all-you-need-to-know-about-the-pdv-mk-ii-indias-satellite-killer/.

30 *"Mission Shakti: US tracking space debris from India's ASAT test, says Pentagon," The Hindu BusinessLine, March 30, 2019,* https://

On the same day, the Media Centre of the External Affairs Ministry of the Government of India issued a release in the form of Frequently Asked Questions explaining the test, its rationale, and reiterating India's belief that Outer Space is the common heritage of humankind to be used only for peaceful purposes[31].

The FAQ describes the test as a technological mission requiring a high degree of precision and technical capability. The test successfully demonstrated India's capability to "interdict and intercept a satellite in outer space based on complete indigenous technology." Justifying the kinetic kill test (in place of a fly-by), the release indicated that India had used the technology of a developed capability and one that was appropriate to achieve the stated mission objectives. Listing India's long standing and rapidly growing space programme, its accomplishments and plans, the FAQ reiterated "India's space programme as a critical backbone of India's security, economic and social infrastructure" and the responsibility of the Government of India to defend the country's interest in outer space.

Refuting any intention of entering into an arms race in outer space, the paper added:

"we (India) have always maintained that space must be used only for peaceful purposes. We are against the weaponization of Outer Space and support international efforts to reinforce the safety and security of space based assets."

It goes on to assert:

India believes that Outer space is the common heritage of humankind and it is the responsibility of all space-faring nations to preserve and promote the benefits flowing from advances made in space technology and its applications for all.

India is a party to all the major international treaties relating to Outer Space. India already implements a number of Transparency and Confidence Building Measures(TCBMs) – including registering space objects with the UN register, prelaunch notifications, measures in harmony with the UN Space Mitigation Guidelines, participation in Inter Agency Space Debris Coordination (IADC) activities with regard to space debris management, undertaking SOPA (Space Object Proximity Awareness and COLA (Collision Avoidance) Analysis and numerous international cooperation activities, including hosting the UN affiliated Centre for Space and Science Technology Education in Asia and Pacific. India has been participating in all sessions of the UN Committee on the Peaceful Uses of Outer Space.

India supported UNGA resolution 69/32 on No First Placement of Weapons on Outer Space. We see the No First Placement of weapons in outer space as only an interim step and not a substitute for concluding substantive legal measures to ensure the prevention of an arms race in outer space, which should continue to be a priority for the international community.

India supports the substantive consideration of the issue of Prevention of an Arms Race in Outer Space (PAROS) in the Conference on Disarmament where it has been on the agenda since 1982.

India is a signatory to the 1967 Outer Space Treaty, which it ratified in 1982.

India is not in violation of any international law or treaty to which it is a party or any national obligation.

The FAQ further affirms that the ASAT test is not directed against any country. It goes on to state, "India's space capabilities do not threaten any country nor are they directed against anyone."

www.thehindubusinessline.com/news/science/mission-shakti-us-tracking-space-debris-from-indias-asat-test-says-pentagon/article26685220.ece

31 *"Frequently Asked Questions on Mission Shakti, India's Anti-Satellite Missile Test conducted on 27 March 2019," Ministry of External Affairs, March 27, 2019,* https://www.mea.gov.in/press-releases.htm?dtl/31179/Frequently_Asked_Questions_on_Mission_Shakti_Indias_AntiSatellite_Missile_test_

At the same time, from the security perspective the FAQ goes on to say “the government is committed to ensuring the country’s national security interests and is alert to threats from emerging technologies. The capability achieved through the Anti-Satellite missile test provides credible deterrence against threats to our growing space-based assets from long range missiles, and proliferation in the types and numbers of missiles.”

Further Action

From a security perspective, the DA-ASAT test is a demonstration of a capability and is a strong projection of deterrence. A fly-by mission would not have demonstrated the capability as strongly and from that angle it is an assertive statement. A further demonstration of a capability to higher altitudes may not be essential – not much additional technology is required, but augmentation of the capability, in terms of bigger missiles and tracking requirement, would be necessary. While the GEO/MEO ASAT requirement can be addressed if needed, a kinetic kill is not the preferred option in terms of the debris creation and is undesirable, especially at the higher orbits. Investment in the development of other technologies therefore becomes essential. The technologies of interest would be ground-based DEWs, co-orbital satellites, deployable robotic systems, intelligence gathering and rendezvous and proximity operations. Most importantly, India would need some level of independent Space Situational Awareness (SSA) capability. India has limited capability in this area and is overly dependent upon the data issued by the US Space Surveillance Network (SSN). While the SSN coverage is large and provides data on all space objects, for the surveillance of critical systems and for performing RPO, one would like to have an independent means of obtaining this information. In this case, India will need to establish a minimum capability of its own and in cooperation with other countries with similar interests.

While the civil space sector in India is well established, the defence space setup is still in the process of evolution. Some time back, discussing space security in India, the author suggested the need for evolving a National Space Security Strategy[32]. Such a strategy should involve all the stakeholders – central government, defence forces, intelligence agencies, S&T (R&D institutions, academia and special labs), industry, international cooperation, existing and new treaties and agreements.

32 Rajaram Nagappa, “Space Security in India,” in Handbook of Space Security, ed. K.-U. Schrogl et al, New York: Springer, 2015, 465.

The Government of India has taken steps to create organisations which will address the defence space requirements. In April 2019, the Government announced the formation of the Defence Space Agency (DSA) and followed it up with the creation of Defence Space Research Organisation (DSRO) in June 2019. The DSA will command the space assets of Defence Forces including the military’s anti-satellite capability. It will also formulate a strategy for the protection of Indian space assets as well as assess space-based threats. The mandate of DSRO is to provide technical and research support to DSA.[33]

The Indian Space Research Organisation will continue to concentrate on civil space missions, although some elements of technology overlap with defence requirements can be expected. ISRO’s new missions include human space flight, the establishment of a space station and reusable launch vehicles. These missions will need technologies related to orbital manoeuvres, close approaches, rendezvous and docking, robotics and in-space repair to be developed. These technologies are of dual use nature

33 Vivek Raghuvanshi, “India to launch a defense-based space research agency,” Défense News, June 12, 2019. Available at: https://www.defensenews.com/space/2019/06/12/india-to-launch-a-defense-based-space-research-agency/

and once developed can also be adapted for military missions involving orbital manoeuvres and RPO.

The infrastructure, funding, necessary priorities and other systems need to be put in place to ensure a good start to defence space technology.

Conclusion

One can say that to some extent space is already weaponized and further, space weaponization trends are visible in the actions of the leading space faring nations. Technological developments and demonstrations carried out by some of the players confirm this. The USA-China rivalry in space, as well as the actions of Russia, will likely result in the intensification of weaponization trends. The USA, Russia and China have also reorganized their defence forces to sustain the nodal role of space in future wars.

In such a scenario, India has to be alert to threats from space postures of other players must and be in a position to respond to them if her space assets face any threat. India is committed to ensuring the country's national security interests through the creation of appropriate technologies and organizations. It should be noted that India's approach to space weaponization has never been proactive but is a reactive measure. It will not be surprising if the USA-China dynamic sets off similar reaction among other space faring countries like Japan, North Korea and South Korea.

Having said that, India is not in favour of converting space into a weaponized arena. India supported UNGA resolution 69/32 on 'No First Placement of Weapons on Outer Space' which India sees as only an interim step and not a substitute for concluding substantive legal measures to ensure the prevention of an arms race in outer space - which should continue to be a priority for the international community. India supports the substantive consideration of the issue of Prevention of an Arms Race in Outer Space (PAROS) in the CD where it has been on the agenda since 1982. India, in its capacity as a major space faring nation with proven space technology expects to play a role in the future drafting of international law on PAROS, including inter alia on the prevention of the placement of weapons in outer space.

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