Space of Tomorrow
A Need for Space Security

Srikumar Pullat[1]
Head, International Strategic and Security Studies Programme (ISSSP), NIAS

Introduction

The Anti-Satellite Test (ASAT), "Mission Shakti", conducted by India on 27 March, 2019 caught the attention of the world as well as the Indian audience. An indigenously developed ballistic missile was launched by Defence Research & Development Organisation (DRDO), to intercept and destroy an indigenous Microsat-R satellite, which was launched earlier by Indian Space Research Organisation (ISRO). The Direct Ascent Hit-to-Kill, intercept mission was completed in less than a minute, thereby demonstrating India's capability to neutralise threats from space-based resources deployed by any of our adversaries. The test was carried out in a Low Earth Orbit (LEO), thus limiting the potential duration of the resultant debris in space, as compared to the larger and longer lasting debris created by a similar Chinese ASAT test conducted in 2007. By conducting the test, India joins a select group of nations (USA, China, Russia) who have so far successfully demonstrated the capability.

The event evoked a mixed response from national and international community. The national audience received the news with pride and delight. Some sections of the international audience may have accepted the development with certain amount of admiration. However, several nations and organisations have expressed their concerns that such events will lead to an unhealthy competition among nations, leaving behind unmanageable levels of debris in the outer space.

Space Environment

It is an accepted fact that the space environment unfolding in the future is entirely different from what exists now and what was there in the early years of space activity following the first space launch of Sputnik satellite by USSR in 1957. The decades immediately after the second world war saw a 'space race' essentially between USA and USSR. The European Space Agency (ESA), consisting of 10 European nations, was set up in 1975. Today, more than 70 nations have invested in space, and this number will increase in the coming years. At present there are more than 2000 man-made satellites orbiting the earth. The space-faring nations will continue to launch satellites, in order to replace the existing ones, to service the ever-

[1]Professor Srikumar Pullat is the head of the International Strategic and Security Studies Programme (ISSSP) at the National Institute of Advanced Studies (NIAS). His area of research includes mission simulation for UAVs, systems engineering and systems analysis of aeronautical systems. He has served at the Aeronautical Development Establishment in DRDO for over three decades and led the team in developing the Nirbhay cruise missile in 2014.

increasing requirements, new experimental satellites, to refurbish supplies to space station(s), new inter-planetary missions and deep space explorations.

Starting with the satellite "Aryabhata", launched in 1975 from Kourou, the satellite launch centre of ESA, and the maiden flight of the indigenous Satellite Launch Vehicle (SLV-3), launched in 1979 from Sriharikota, the Indian satellite launch centre, ISRO has conducted more than a hundred spacecraft missions over the last four-and-a-half decades. These include launches of indigenously designed application satellites using European, Russian and American launch vehicles, using Indian launch vehicles like PSLV and GSLV for launching Indian satellites as well as satellites developed by other countries. The satellites launched by ISRO include those developed by them and by students. The prominent feathers in ISRO's cap include two re-entry missions (2007, 2014), two Chandrayaan missions (2008, 2019), the Mangalyan mission (2014), a world record 104 of satellites (2017). Currently, preparations are in full swing for the country's first indigenous manned mission called Gaganyaan planned for 2022. In the coming years ISRO is gearing up to conduct at least 18 launches every year.

At present India has more than 50 satellites operational in space, comprising of earth observation satellites, communication satellites, navigation satellites and scientific satellites. Depending on the application, the satellites are positioned in sun-synchronous polar orbits (SSPO), Geo-synchronous Orbits (GSO) or Low Earth Orbits (LEO). ISRO is also preparing to carry out the maiden launch using a Small Satellite Launch Vehicle (SSLV) from a new launch station coming up in Thoothukodi in Tamil Nadu. Small satellite launch vehicles are being developed by DRDO and private industry also. Start-ups and private entrepreneurs are adding to the indigenous satellite building capacity.

The past decade has also witnessed phenomenal developments in space activities with the entry of private players from several nations. With enterprises like SpaceX and OneWeb planning to launch large constellations of satellites, the number of objects in space is expected to rise exponentially. Private enterprises are also investing in asteroid mining and inter-planetary missions to tap the commercial prospects of these resources. Space tourism is another activity, with private players investing in the field. Issues of safety, reliability and liabilities, arising from space tourism need to be addressed at national and international levels. While space resources are expected to be global commons, these commercial activities contribute to significant increase in traffic congestion in space, consisting of Autonomous missions and Human missions. This, in conjunction with the problems created by space debris affects the safe operations of space-based resources.

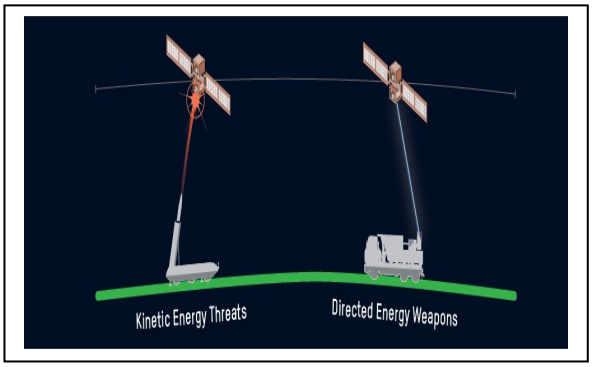
Need for Space Security

Space assets are vulnerable to different types of threats like co-orbital inspection and attack by other satellites, Direct Ascent interception by ground-based or air-launched missiles, ground-based, air-based or space-based Directed Energy Weapons (DEW), and Jamming, Spoofing and Cyber-attacks initiated from ground, Air or Space. Robotic technology, developed for peaceful uses like servicing and repair of in-orbit satellites and debris

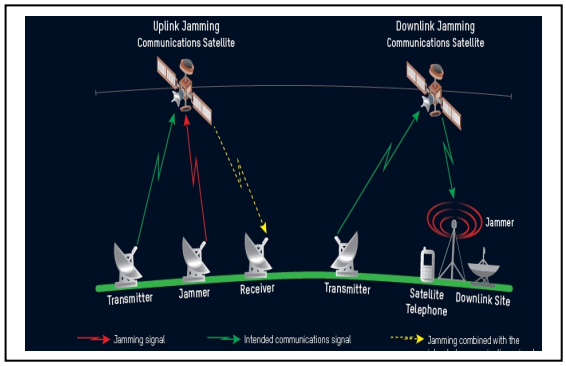
removal, can also be used for aggressive applications like capture of adversary's satellite. USA, Russia and China have carried out extensive Rendezvous and Proximity Operations (RPO) using their own space assets both in LEO and GEO.

The following are some of the threats to safe operations of space-based resources[2]:

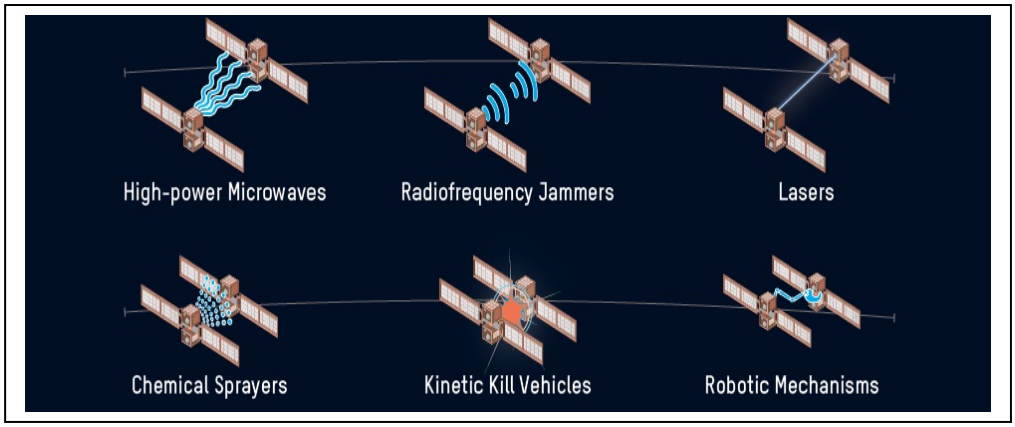
a) Cyberspace Threats - Adversaries can use offensive cyberspace capabilities in the Satellite Command, Communications and Data distribution networks to inflict damages on space-based and associated ground-based infrastructure.
b) Directed Energy Weapons (DEW) – like High-Power Lasers (HPL) and High-Power Microwaves (HPM) can be used to disrupt, damage or destroy equipment and facilities.
c) Kinetic Energy Threats – These Anti-Satellite (ASAT) weapons cause physical damage to satellites by direct hit or through proximity explosives.
d) Orbital Threats – are spacecraft which can deliver temporary or permanent damages to another spacecraft. They can use payloads for cyber-attacks, DEW weapons, Kinetic Kill, Chemical sprayers, and even Robotic Mechanisms.
e) Electronic Warfare (EW) – EW techniques like Jamming and Spoofing can be deployed to interfere with vital communication networks.



DEW and Kinetic Threats



Electronic Warfare



Orbital Threats

It is common for orbits and attitudes of satellites to be changed occasionally for operational requirements. In the case of earth-observation satellites, the satellite is sometimes brought

[2] "Challenges to Security in Space", www.dia.mil/Military-Power-Publications

down to a lower orbit over regions of interest to the user to capture better-resolution imagery. However, it is also possible that such operations are conducted with the intention to eavesdrop on others' satellites, or, even with the potential intention of damaging or capturing the satellite.

At present the only source of comprehensive information in the open domain, about all earth-orbiting satellites and other objects like space debris, is the North American Aerospace Defence Command (NORAD) Two Line Element (TLE) data. This data, which is available free of cost to all interested users, is stale by a few days. Most of the stakeholders use this data to predict relative positions of their satellites and debris object is the vicinity and, do evasive maneuver of the satellite to ensure its safety. There are amateur individuals and groups who monitor this data set regularly to keep track of activities of some of the satellites of interest to them.

There are reports of Russian satellite Luch-Olymp making close approach and spying on Franco-Italian military communication satellite Athena-Fidus in September 2015[3] and a recent report[4] (February 2020), about a Russian satellite tailing an American Spy Satellite.

At present India does not have the capability to monitor RPO type of activities and hence, no information is available whether any of our satellites have been the victims of RPO. It was reported[5] that India's radar imaging satellite RISAT-1 suffered a fragmentation event (solar panel shedding) and went out of service in 2016.

Successful and visible demonstration of ASAT capability by India is an essential component of deterrence. While it demonstrates our capability to defend our space assets in LEO from possible attacks, it is only a preliminary milestone in the overall goal of attaining capabilities to fight, win or deter a modern information-driven conflict, based on space capabilities.

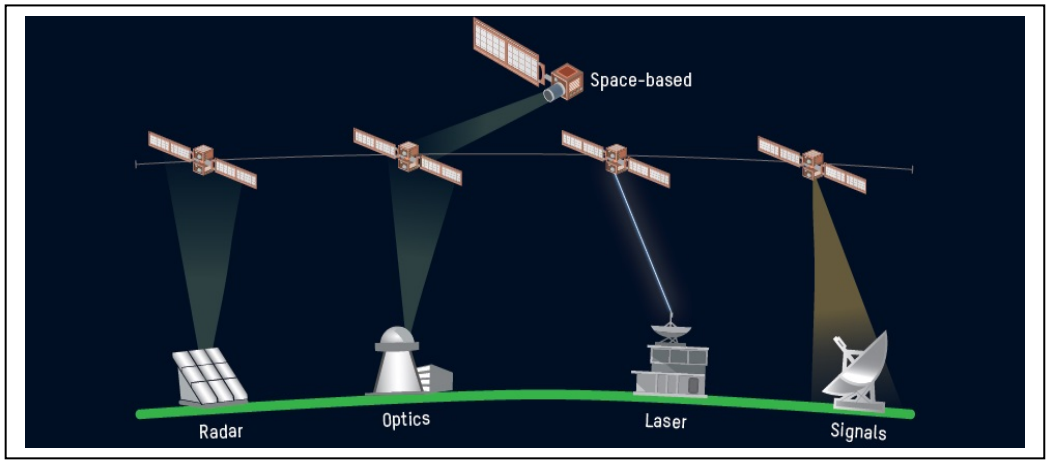
A NIAS report[6] and article[7] on the subject listed out some of the gaps in India's use of space-based assets as part of its military strategy. The article stresses the need for more number of optical observation of satellites, space-borne telescopes, space-based C4ISR assets linked with different communication satellites to provide real-time information to military units across India's large geographic space, space-based navigation services at a global level, access to global weather and space weather, data-relay services to synthesis information from various sources in real-time to assist strategic planning, small satellites with distributed functionalities and small satellite launch vehicles to provide 'launch on demand' services.

[3] bbc.com/news/world-europe-45448261
[4] https://www.time.com/5779315/Russian-spacecraft-spy-satelliet-space-force
[5] https://www.forum.nasaspaceflight.com/index.php?topic=47854.0
[6] "Space, War & Security – A Strategy for India", S Chandrashekar, R-36-2015 December 2015;
[7] "India's ASAT Test", Rajaram Nagappa, Mrunalini Deshpande and S Chadrashekar, ISSSP Reflections, No. 58, March 2019

Space based weapons have not yet known to have been operationalised by any nation. However the major military powers are addressing the issues related to development of ground-based and space-based components in the detection-to-deployment chain, like surveillance, data fusion, data dissemination, data processing, decision making, identification of appropriate weapon, its proper deployment, evaluation of an engagement and follow up required, if any.

Space Situational Awareness (SSA)

From space security considerations, nations need to monitor what is going on in space and above regions of their interest on Earth. They also need to monitor the events, at least in the vicinity of their space-based resources, including conjunction possibility with satellites, debris and other objects in space. This calls for capability to deploy earth-based and space-based surveillance resources, analysis of information gathered by these resources, and initiation of evasive measures. The capability of a nation to initiate offensive retaliatory actions will deter potential adversaries from initiating deliberate RPO activities in the vicinity of its space assets.



Space Situational Awareness

Space situational awareness is essential for keeping real-time watch on vulnerable assets and ensuring their safety. For this, it is important to keep track of satellite launches and orbital excursions by other nations which are likely to be a source of threat to our assets. This requires C4ISR resources for information gathering and processing, dissemination, and weapon systems for offensive actions. Operations of these ground-based and space-based resources and evaluation of information gathered through these resources should be synthesised properly for effective deployment.

ISRO has some capability with Multi-Object Tracking Radar (MOTR), which, at present, is essentially used for ensuring collision avoidance during the launch of its space transportation systems. ISRO is dependent on NORAD TLE data, and has developed software for Collision Avoidance (COLA), Space Objects Proximity Analysis (SOPA) and Close Approach Prediction Software (CLAPS) using the NORAD database.

For effective SSA capability we must ensure availability of required inputs in near-real time, in addition to information available from NORAD TLE data, for monitoring RPO activities of others, as well as for planning our own RPO activities. The need for having our own dedicated SSA capability therefore assumes urgency. The newly formed Directorate of SSA at ISRO is a right step in this direction.

Ground based long-range radars, optical and laser ranging telescopes as well as space-based sensors are essential for effective SSA capability. International cooperation will help in generation and sharing of data across the globe. Cooperation with countries like Australia and Japan will enhance India's data generation capability, especially in the Southern Hemisphere. It will be useful to have the capability for tracking activities in space using an off-shore tracking facility. Space-based surveillance resources can complement the ground-based resources to provide a holistic SSA capability. Many of the RPO activities have been observed and reported by amateur satellite trackers across the world. Astronomy Clubs can be encouraged in the country to create a posse of amateur satellite trackers.

The US has established a Space Force, which is essentially perceived as a step towards reasserting its dominance in Space on the backdrop of growing technological capabilities of China and Russia. Like US, China and Russia also have their Space forces. The Russian Space Force is larger than its Air Force. China's Strategic Support Group, created in 2015, is responsible for deploying and employing most of China's space capabilities.

The Indian Government, aware of the need to address the country's security requirements, has set up a Defence Space Agency. The recent appointment of a Chief of Defence Staff (CDS) underscores the importance attached to these initiatives. It is important to channelize the efforts of agencies like ISRO, DRDO, DSA and Military, along with active participation from the Industry, to optimize the effectiveness of the initiatives for Space Security.

India needs an effective Space Force or Space Command to deter aggression and prevent conflict in space. It is important to ensure synergy between various arms of the military for effective use of information gathered through resources based on land, in sea, in air and in space. The Space Force should be equipped to establish assets to support warfighting units from terrestrial and space-based threats and to defend the freedom to operate our space assets and initiate offensive action whenever and wherever required.

The nature of space is inherently international and therefore engagements in space have a significant influence on a nation's foreign policy. It therefore becomes crucial to assess the possible fallouts of actions in space and to develop policies and strategies to manage them.

The five treaties and five principles, created in the late '60s by the UN committee on peaceful uses of outer space (UNCOPUOS), currently govern the exploration and use of space by all humanity. However, given the evolving nature of technology and activities in space, the existing rules governing these activities require to be revisited and updated to address the future needs. It is important to ensure that policies we fashion, along with our space diplomacy with other countries and in various UN forums, be adequately informed and well supported by relevant policy studies.

Conclusion

Space is no more a safe sanctuary. It is becoming an integral part of security considerations of nations. Given the inherent dual use nature of space assets, it is difficult to differentiate between benign and potentially aggressive strategies and capabilities in space. The Congested, Contested and therefore, Conflicted nature of tomorrow's Space is throwing up Safety and Security challenges for all stakeholders. Actions in space, intentional, or otherwise, can trigger geo-political tensions and conflicts. The demonstration of Anti-Satellite (ASAT) and Ant-Access Area Denial (A2AD) capabilities by nations indicate the trajectory of space activities towards weaponization.

Space assets and related capabilities are force multipliers that enhance national power and prestige. Ensuring safety and security of these assets will drive the formulation and implementation of future strategic security considerations of nations.

About NIAS Course on Global Politics

The Global Politics course at the School of Conflict and Security Studies in National Institute of Advanced Studies (NIAS) provides an introduction to the contemporary world affairs. The primary objective of the course is to enhance the understanding of the contemporary global developments with an attempt to comprehend the larger picture while identifying trends on the world politics. The course focuses on providing an explanation and increases the understanding of the scholars in regional, maritime, space, securities, international economies, geopolitics and power politics and world order.

As part of the course, NIAS brings out the NIAS Quarterly on Contemporary World Affairs with issues such as global protest movements, changing world order and great power politics. The course publishes articles, commentaries and short insights on daily issues in international relations, politics and social issues across the globe.

The Course has initiated a special research series called The World This Week which is an academic initiative of the course. In this series, alerts are published every Sunday to provide its readers with a ready reckoner of major developments during the week. The Alert also provides an opportunity for the young scholars at NIAS and its partner institutions to follow and comment on contemporary global developments.