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Emerging Contours of Space Security: Options for India

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Space age began more than half a century ago - 59 years ago to be precise - when the former Soviet Union put the first man made satellite, Sputnik 1, into a low earth orbit on Saturday, 5 October 1957. Sputnik 1 was a football sized sphere, and was launched by a converted missile. India's foray started ten years later, when much of the world wondered why a poor country was venturing into an expensive hobby! Exploration into space began at a time when most advanced scientific research and exploration in the world were pursued largely from a military security perspective. In a world that was divided by competing ideologies of the two super powers, space exploration was seen as an indicator of prestige, power and supremacy.

The launch of the Sputnik 1 by the USSR was a huge shock to the USA. The fact that a converted missile launched the Sputnik gave rise to fears in the USA of a "missile gap"- a perceived imbalance in defence capability – which served to deepen the political Cold War of the late 1950s. As further achievements of the USSR followed, it created a huge paranoia about technological insecurity in the USA. Within five years, the Soviets had launched the first animal, the first moon probe and, in April 1961, Yuri Gagarin made history by becoming the first man in space. This event fired up the Americans into a national frenzy, and prompted the new President John F. Kennedy who announced the goal of a manned moon landing before the decade was over. It created one of the most ambitious ventures in human history. In just eight years, NASA amassed the necessary experience, and succeeded in pulling off the greatest organisational feat of the 20th century – winning the race to the Moon.

Space and National Security

In the immediate aftermath of the Second World War, nuclear weapons influenced much of global politics as the two Super Powers waged a Cold

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War. Realisation that a nuclear conflict could be catastrophic to both sides came in early 1950s with the invention of the hydrogen bomb and delivery rockets in the form of ICBMs. The driver from then on was technologies that could enable both sides to verify capabilities and monitor each other through surveillance and reconnaissance to enable deterrence stability. And this is where space provided the most optimal dimension.

In the intensity of the Cold War environment, military space systems played critical role in providing communications, weather monitoring, navigation, early warning, reconnaissance, as well as intelligence data and functions. Concerned about the possibility of an arms race in space, both the Super Powers facilitated the signing of the Outer Space Treaty in 1967, that banned the development of weapons of mass destruction. The treaty, however, did not seek to prevent militarisation of Space. As satellite technologies evolved, military space systems became critical assets for managing the deployment and employment of military forces on land, sea, and in the air. Space systems were seen as 'force multipliers' as they could be used in any and every conflict, ranging from lowest intensity conflict to nuclear war.

National security advocates argued for ASAT development in the late 1960s and 1970s, drawing a parallel with the denial of reconnaissance plane over-flights by SAMs (Surface-to-Air Missiles).[1] As capabilities in satellite surveillance, reconnaissance, communications, PNT (Position, Navigation, and Timing) became highly useful, the impact of space on national security began to assume enormous proportions. The relevance of space capability to national security was amply recalled years later by President Johnson when he referred to the Cuban missile crisis: 'if nothing else came of it (the US Space program) except the knowledge we've gained from space photography, it would be worth ten times what the whole program cost.'[2] Similarly, the importance of weather information and precise navigational data for effective military operations was first demonstrated during the Vietnam War.[3]

As space became a valuable military domain, military forces began to voice their requirements for space control, on the lines of the air power concept of 'air superiority'.[4] The 1972 ABM Treaty signed between the USA and the USSR was proof enough of the level to which space technology had been driven by the contours of national security. The two sides had significant levels of ongoing ASAT research, and the ABM treaty sought to bring in stability by freezing the ASAT capabilities. By then, the Soviet Union had tested a co-orbital anti-satellite system seven times, during the period 20 October to 3 December, 1971. Of these seven tests, five succeeded and two failed.[5] The Soviets resumed their ASAT testing in 1976. After their twentieth co-orbital satellite test, they announced a voluntary moratorium, and offered a final ASAT ban treaty, inclusive of banning weapons in space.

Space in the Economic, Technological, and Military Dimensions of Power

Most civilian applications of space technology have their origins in the military domain. Space is divided into near-earth space, where all utilities are based; and deep-space where explorations take place. We now use near-earth space for communications, navigation, terrestrial monitoring, deep-space observation, time-keeping, and direct-broadcast activities. We use near-earth space for imaging across different portions of the electromagnetic spectrum with less than one-meter resolution.[6] As space-based services are critical to everyday life, they have created higher levels of dependency and vulnerability for nations and their economies.

Some 170 countries now own, operate, rent, or finance the development of satellites.[7] Since the last 20 years, space has become increasingly crowded. As of January 2015, there were more than 1265 operational satellites in orbit, owned by some 80 countries, commercial ventures, and other entities, including universities.[8] The USA operates 528 satellites; China 132 satellites; Russia 131 satellites; and the remaining 474 satellites by the remaining countries. Rapid growth in the use of space services has created a fast growing global space economy. The biggest impact has been in telecommunications - mobile phones and televisions. Billions of people use smart phones or tablets, which use processors that link up with satellites for their position, navigation, and timing (PNT) functions. Similarly, satellite services enable assistance to natural disaster areas.

The total global space economy in 2014 was US$ 330 billion, up from 2013's US$ 302.5 billion, growing at slightly more than 9 per cent.[9] Commercial space activities constituted 76 per cent of the global space economy. The industry as a whole achieved a compound annual growth rate (CAGR) of seven per cent from 2005 to 2014, nearly doubling in size over the course of the decade.[10] The global space sector is a high-technology niche, with a complex ecosystem which employs at least 900,000 persons around the world.[11]

The acquisition and development of space capabilities remains a highly attractive strategic goal, and the number of countries and companies investing in space systems and their downstream applications, continue to grow. The space industry is concentrated mostly in advanced economies, and is a sizeable one. More importantly, it signifies the technology leadership of those countries, and this has ramifications for India's security.

Satellite technology and manufacturing is growing significantly. 208 satellites were launched in 2014, almost double the 107 launched in 2013. It included 130 new technology Cubesats, forming 63 per cent of the total launched. Most Cubesats were used for Earth Observation. Communication satellites formed 33 per cent of the total revenue generated, while military surveillance satellites accounted for 38 per cent of the revenue generated in 2014.[12]

Space at the Intersection of Security and Development

The concern for space security began to gain traction in the context of the rising dependency of nations on space-based services. Seen from the perspective of developing nations, space became an important driver of development. Space technologies enable developing nations to leapfrog their progress, and deliver socioeconomic benefits to larger segments of their population. New technologies have been developed to reduce costs and miniaturise satellites, leading to the design and development of microsatellites and cubesats. These small satellites make it easy for many countries to afford entering the space domain for their requirements. They weigh roughly between 1 kg and 700 kg, and cost somewhere between US$ 8 million and US$ 40 million.

The military use of space started as strategic capability. Monopolised by the two Super Powers during the Cold War, the military functions served to assist the decision makers by providing ISR services at the strategic level. As a result, users of these space services were the national leadership of the two Super Powers and their allies. These robust architectures revolved around intelligence, command and control, as well as communications structures, and operated at the strategic level. The 1980s saw the rapid development of technologies in computers, telecommunications, imaging, reconnaissance, and sensors. The results were evident in the 1991 Gulf War, which became the first space war as the large-scale utilisation of military and civilian satellites became necessary. Today, space is critical for national security, and at all levels of military operations: strategic, operational and tactical; and all the way down to the individual war fighter.[13]

The importance of keeping space free of power politics and preserving it as the sanctuary and common heritage for mankind was recognised early during the space age. A series of agreements, such as, the Outer Space Treaty and the ITU, etc., are in place to facilitate the efficient utilisation of space. The UN's Office for Outer Space Affairs (UNOOSA) is tasked with monitoring and keeping track of these agreements. The UN has initiated a study of space governance issues through various committees, such as committee for TCBM, UNCOPOUS, and GGE. The sustenance of space is seen as the core of the idea of security of space.

Space Security in the 21st Century: Challenges and Contours

As nations have become highly dependent on space-based services, the security of space-based assets is of prime importance. As a corollary, space faring nations have focused on strategies to deny space access and space-based services to possible adversaries in times of conflict. Threats to the security of space are seen in two forms: 1) threats that emanate from unintentional manmade actions and natural hazards; 2) threats from intentional manmade actions.

Orbital Debris

Space debris has been present ever since the beginning of the space age. However, it was of little consequence in the first three decades as activities were limited mainly to two actors: the USA and the former Soviet Union. Today, the number of actors who use space has increased exponentially. Space debris results from a large number of satellites being launched for utility and replacement, as also for the military testing of capabilities related to anti-satellite weapons. Travelling at speeds of 7.8 km/sec, even small pieces of space debris can destroy or severely damage a satellite upon impact.

The Space Surveillance network of the US Department of Defence (DOD) has catalogued more than 16,000 objects of approximately 10 cm in diameter, or larger. Roughly 23,000 pieces of debris of this size are being tracked, but not catalogued. There are more than 500,000 objects with a diameter larger than one centimetre, and several million that are smaller. Low Earth Orbit (LEO) is the most congested area, especially the Sun-synchronous region. Some debris in LEO will re-enter the Earth's atmosphere and disintegrate quite quickly due to atmospheric drag; but debris in orbits above 600 km will remain a threat for decades and even centuries.

In the context of a space debris threat, developed states have begun to articulate the need to ensure responsible behaviour in launching and operating satellites by new emerging space states. The recommendation is that the eight established space faring states (Russia, the United States, China, France (Europe), India, Japan, Israel, and Iran) control and regulate other emerging space states as to who could place objects in space.

A significant number/amount of space debris has resulted from national security related technology trials by major space faring nations: USA, Russia and China. In January 2007, China tested its ground-based ASAT system when it destroyed its weather satellite Fengyun (FY)-1C with an ASAT. The test resulted in a huge number of debris (nearly 150,000), most of which will remain in orbit for over 100 years. Unintentional collisions are another cause of debris. In February 2009, the inactive Russian satellite Kosmos 2251 and the US satellite Iridium 33 collided accidentally. Similarly, Ecuadorian satellite Pegasus collided with debris from a S14 Soviet rocket launched in 1985. The International Space Station had to be repositioned on several occasions to avoid collision with a large piece of debris.

Space Situational Awareness (SSA) is a vital technological capability that is required to address space security by tracking every object in space. In an effort to address the problem of space debris, a forum called the Inter-Agency Space Debris Coordination Committee (IADC) was formed in 1993 by the European Space Agency (ESA), and the national space agencies of the United States, Russia, and Japan.[14] On direction from UNCOPUOS, IADC developed a set of international debris mitigation guidelines in 2005. These were adopted by UNCOPUOS and endorsed by the UN General Assembly (UNGA) as voluntary measures with which all states should comply.[15]

Radio Frequency Spectrum

Radio frequency interference has emerged as a major threat to efficient and reliable communications operations, as a growing number of space faring nations and satellite operations are driving the demand for access to radio frequencies and orbital slots.

Tele-communications satellites operate from GEO orbits while satellites for remote sensing, navigation, etc. operate largely in LEO and MEO orbits. Most weather satellites also operate in GEO orbits.[16] The International Telecommunication Union, originally created in 1994, controls and governs international sharing of the radio spectrum and orbital slots used by satellites in GEO, both of which have been declared as limited resources. Crowded orbits have given rise to many cases of interferences. These interferences can take place with satellite communications, broadcast links, and ground stations. They result from natural or environmental factors, unintentional interferences, and intentional interferences such as jamming. Technically these interferences must be identified as 'acceptable', 'permissible', and 'harmful' in order to address them with appropriate strategies. Many actors, including the USA, have resorted to intentional jamming as a deliberate strategy on various occasions.[17]

Natural Hazards in Space

Natural hazards or threats to space activity can happen from various factors: Near-Earth objects (NEOs), which are asteroids and comets whose orbits bring them in close proximity to the Earth. A Potentially Hazardous Asteroid (PHA) is defined as one whose orbit comes within 0.05 astronomical units of the Earth's orbit, and has a brightness magnitude greater than 22 (approximately 150 m in diameter). Similarly 'Space weather', like powerful solar flares, can cause radio blackouts and the expansion of the Earth's atmosphere, which has the effect of slowing down satellites in LEO, causing them to move into lower orbits.

Space Situational Awareness

SSA capability exists with USA and Russia, the two foremost space faring nations. China has developed significant capability, and so also the European Union. In an increasingly congested domain, SSA constitutes a vital tool for the protection of space assets. While SSA enables the prevention of accidental collisions, it is also a major tool that enables military space security by creating a capability to distinguish space negation attacks from technical failures or environmental disruptions. Ideally, all countries must cooperate to address space security holistically, and as a global commons issue. This would require complete transparency and global sharing of SSA amongst all nations.

Satellite Navigation System

The satellite navigation system or the GPS (Global Positioning System) that started essentially as a requirement for the US military is now the most important space-based global utility. The GPS provides the most important PNT (Positioning, Navigation, and Timing) information for a variety of space applications. While the GPS as a global utility for civil applications continue to grow exponentially, its importance as a precision tool for military applications has become paramount. It includes navigation, target tracking, missile and projectile guidance, search-and-rescue, and reconnaissance. Dependence on GPS, an American system, for military applications creates strategic vulnerability for other major nations.

As a result, all space faring nations have or are creating their own independent PNT systems. This strategy ensures competitive availability of PNT services with multiple redundancies for the global market. The GPS is a system of a minimum of 24 satellites that orbit in six different planes at an altitude of approximately 20,000 km in MEO. Russia has revived its own system called GLONASS, which is similar to the GPS. It operates a minimum of 24 satellites in three orbital planes, with eight satellites equally spaced in each plane in a circular orbit with an altitude of 19,100 km. Russia has close cooperation and commercial agreements to provide technical assistance to China and India for assisting their own programs. Currently, GPS and GLONASS are the two fully operational systems.

Europe has commenced the deployment of its own system called GALILEO. It seeks to address the increasing requirements of civilian and commercial uses while ensuring strategic autonomy for meeting EU's security interests. Galileo is designed to operate 30 satellites in MEO in a constellation similar to that of the GPS. It is planned to become fully operational by 2020. China has commenced the deployment of its own PNT system called 'Beidou'. The Beidou system consists of two separate satellite constellations: Beidou-1, a limited test system that has been operating since 2000; and COMPASS or Beidou-2, a full scale global navigation system of 35 satellites, five in GEO and 30 in MEO. It is planned to be fully operational by 2020. Similarly, Japan and India are developing their own regional navigation satellite systems. The underlying reason for development of various systems is to reduce or eliminate the vulnerability that arises due to GPS dependence where access to signals is not assured, particularly in times of conflict.

Remote Sensing, Weather, Disaster Relief, and Search-and-Rescue

Remote sensing and other utility satellites are excellent examples of dual use satellites. These are critical global utility satellites. Data from remote sensing satellites helps to enable development programs, better management of natural resources, and many other Earth Observation functions, including weather forecasting, the surveillance of borders and coastal waters, the monitoring of crops, fisheries, and forests; and the monitoring of natural disasters such as hurricanes, droughts, floods, volcanic eruptions, earthquakes, tsunamis, and avalanches. The global management of weather data is done through the international cooperation of various national agencies. Similarly, the Group on Earth Observation coordinates Earth Observation data by creating the Global Earth Observation System of Systems (GEOSS). These satellites are also used to provide data for sensitive national security requirements.

Security Strategies and Emerging Technologies

The first major use of space for military operations has been through the extensive use of space systems for intelligence, surveillance, and reconnaissance (ISR). ISR became the most highly evolved process through the use of ISR satellites and Earth Observation (EO) satellites. Space systems are critical for enhancing battlefield awareness - including precise navigation and targeting support, early warning of missile launch, and providing real-time communications. GPS or PNT inputs are vital for precision weapons, most of which have evolved into long-range, fire and forget weapons, with centimetres accuracy. ISR inputs from remote sensing satellites have served as technical means for states to verify international non-proliferation, arms control, and disarmament regimes. Satellite communications of today have provided extraordinary new capabilities for the real-time command and control of military forces deployed anywhere in the world.

Ground-Based ASAT Capabilities

Anti-satellite weapons constitute the biggest threat since the Cold War. Various methods could be employed from ground facilities, like 'launching a payload to coincide with the passage of a satellite in orbit is the fundamental requirement for a conventional anti-satellite capability.'[18] By using advanced tracking capabilities, one could launch a payload of metal pellets or gravel to be launched into the path of a satellite by rockets or missiles.[19] All space faring nations have developed, or are continuing to develop, kinetic hit-to-kill technology, which involves the destruction of a target as a result of collision with an interceptor. Targeting satellites from the ground using any of these methods has been described as more cost-effective and reliable than space-based options.[20]

In 2008, the USA used a Raytheon SM-3 missile to destroy one of its failing satellite, USA-193, before it re-entered Earth's atmosphere, demonstrating its ability to reconfigure a missile to use against a satellite. In 2013, the Russian Duma called for the Russian military to restart its old program called 'Kontact', which is a development of an air-launched direct ascent ASAT system.[21]

In 2007, China demonstrated its ASAT, an advanced hit-to-kill capability. Amidst world condemnation, China called the test an experiment.[22] This was followed by another non-destructive test on 23 July 2014, which was called by its MOD as 'a test of land-based anti-missile technologies.' The system tested, SC-19, was the same system used by China in the 2007 test. The USA termed it as an unambiguous anti-satellite test, and that China had successfully placed LEO satellites at risk.[23] China's May 2013 launch of the Dong-Ning (DN-2) rocket indicates that its missile reach for ASAT is entering GEO orbital levels.[24]

Ground based lasers have been developed to disable satellites through techniques of 'dazzling', or degrading unhardened sensors on satellites in LEO. Ground-based lasers, tracking systems, and adaptive optics would allow laser energy to be accurately directed at a passing satellite. Low powered beams are used for ranging and tracking satellites, while high-energy beams are used to damage the equipment on board.

Space-Based ASAT Capabilities

A space-based ASAT capability - involving kinetic kill, directed energy, or conventional explosive techniques - would require complete control over foundational technologies, including manoeuvrability, docking, and on-board optics. Co-orbital systems have been tested and established by the two Super Powers during the Cold War. A major technique of space-based ASAT capability lies in mastering RPO (Rendezvous and Proximity Operations).

The USA, Russia, and China continue to test satellites on co-orbital manoeuvring that have significant impact on security. The US launched two GSSAP (Geosynchronous Space Situational Awareness Program) satellites in 2014 that have the capability to perform RPO. Small satellites, particularly microsatellites and cube satellites, are evolving with immense potential for use in 'space control' strategy, such as 'co-orbital manoeuvring' and 'space mines'. Russia has also set alarm bells ringing in the national space security circles by its small satellite operations. Starting in 2013, the operations of its small satellites have drawn considerable attention. While the object's functions and capabilities are largely unknown, it appears capable of precise RPO.

China's recent activities have confirmed suspicions about its space-based co-orbital ASAT capability. In 2010, two Chinese small satellites, SJ-06F and SJ-12, engaged in a series of manoeuvres that suggest a controlled conjunction, in which the two satellites "bumped."[25] Further such tests in 2013, with some satellites equipped with a robotic arm, also show China's continued interest in developing extensive capabilities for space control strategy.[26]

Emerging Cyber Threats

Space systems include not only satellites themselves, but also the ground stations that operate and control them, and the links between them. Ground stations monitor and control satellites, as well as communicate with the satellite. Telemetry, tracking, and command (TT&C) are part of the uplink and downlink controlling a satellite's function and monitoring its health.[27] Operators use specialised computers and computer programs - themselves complex information systems - to transmit information to and from spacecraft over a computer network.[28] Space forms a critical part of the cyber fabric, and is an attractive target for cyber attack. As a result, space security and cyber security are mutually interdependent. Space infrastructure, both military and civil, on the ground and in space, is becoming vulnerable to cyber attacks. Tracing the origin and attribution in a cyber attack becomes extremely difficult. The types of attacks that could be of concern are:

a) Taking actual control of a satellite, manoeuvre the satellite in an adversarial fashion; take control of the solar panels to disable the satellite, etc. As opposed to the old-fashioned way of a kinetic attack on a satellite, the new way in the cyber age is to 'fry' the satellite into total disablement.

b) The second part is to attack the navigation system satellites and corrupt their PNT signals. Spoofing or replacing the original signals, Timing signals or positioning signals, and/or both in combination.

Since militaries and governments are heavily dependent on these space services, a cyber attack could become catastrophic. It could affect national financial services and strategic infrastructure.[29]

National Space Security Strategies

Space security has become a complex issue where the interface between the concept of 'space as a global commons' and 'space as a critical COG of national security' is challenged by the conflicting requirements of the two sides. If India has to evolve a viable national space security policy, it will need to grasp the intent and the nuances of the strategies, capabilities, and practices of other countries.

USA

USA has the most advanced capabilities in space technologies, and thus is critically dependent on it. The USA has articulated its national space security strategy as derived from its national space policy.[30] It defines today's space as 'congested, contested and operationally degraded'. This definition lays down the foundation of its operational strategy of 'Space Control' and 'Global Strike'. Declared in 1998 as 'Space Vision 2020', it is defined in four clear objectives: 1) Space Control, 2) Global Engagement, 3) Full force integration, and 4) Global partnerships. The control of space has been defined as the most important objective of its national space security strategy. The control of space is sought to be achieved through five interrelated objectives: 1) 'assured' means to get to space and operate there, 2) 'surveil' the region of space to achieve and maintain situational understanding, 3) 'protect' critical space systems from hostile action, 4) 'prevent' unauthorised access to own and allies' space systems, and 5) 'negate' hostile space systems.[31] The US strategy has clearly defined its need to acquire control of space to ensure its freedom of action in space. A critical element of this capability is the element of SSA (Space Situational Awareness).

USSTRATCOM has negotiated SSA sharing agreements and arrangements with 51 commercial entities, two intergovernmental organisations (EUMETSAT and European Space Agency), and ten nations (Spain, France, Italy, Japan, Australia, Canada, South Korea, United Kingdom, Germany, and Israel - India does not figure in this list), and is in the process of negotiating additional deals. Through these sharing agreements, USSTRATCOM assists partners with activities such as launch support; manoeuvre planning; support for satellite anomaly resolution, electromagnetic interference reporting and investigation; support for de-commissioning activities; and space object conjunction assessments.[32]

The Geosynchronous Space Situational Awareness Program (GSSAP) achieved initial operational capability in October 2015. GSSAP enables USSTRATCOM to operate cutting edge capabilities for SSA.[33] The core of operational strategy (Space Combat) revolves around space denial operations, space strike operations, and space protection operations.[34]

Russia

Russia has developed and deployed space denial and space strike weapons. It is the first, and one of the three countries that have perfected both ground-based and space-based ASAT capabilities. After initial neglect in the 1990s, Russia under Putin has made the revival of its space capabilities and space industry as its highest priority. Russia has focused on upgrading its early warning satellites, sustained operations, and the upgrading of it GLONASS navigation system, C4ISR capability, signal intelligence, and its cyber operations. Russia operates a very advanced and comprehensive SSA architecture.

China

China's policy makers view space power as a critical element in the build up of its comprehensive national strength, and science and technology. The Chinese space program is clearly driven by military and security interests. China has integrated space into its core 'active-defence' strategy. It has established a high-resolution space-based C4ISR capability, and focuses on continued improvement of its SSA capability.

India's Options: National Space Security in the 21st Century

India's space capability has matured significantly over the last three decades. Its satellite launch capability is well established, with its PSLV vehicle clocking more than 50 launches with exceptional reliability and at an amazingly low cost. Its other infrastructure, involving control and monitoring stations, R & D laboratories, manufacturing infrastructure, and training, are extensive. At US$ 1.2 billion budget for 2015–16, ISRO is sufficiently well funded. ISRO's space strategy has almost entirely been focused on national development goals, and it has executed this strategy in the most admirable manner. Its recent scientific exploratory achievements of Mars and Moon missions have been significant, cost-effective, and have brought great prestige to the country.

For its growth strategy, ISRO has built significant collaborations with the agencies of other space faring nations in order to aid India's development. Accordingly, it has built significant capabilities in remote sensing, weather prediction and disaster management, telecommunications, and GAGAN - a satellite based augmentation system to aid navigation and landing in the region for world civil aviation, and now putting into operation the Indian Regional

National Satellite System (IRNSS) for India's PNT requirements.

As the Indian economy continues to grow at a high rate, it is already transitioning into digital governance standards, where its financial, strategic infrastructure, and governance are already dependent on satellite services. This will need a high rate of growth in India's space infrastructure. Inability to keep pace with these requirements has serious security implications. For example, India's television industry is growing at much faster rate, creating a huge demand for transponder services than what ISRO could cope with. As a result, nearly 75 per cent of the transponder requirement is hired from foreign satellites, leading to the loss of commercial revenue, loss of orbital slots, and brings India's GEO launch limitation into glaring focus. These issues ultimately reflect national security implications as it betrays the huge gaps in space capability as compared to, for example, China.[35] India's ISR requirements are met, partially, through dual use remote sensing satellites. The IRNSS will soon become operational by 2018, thus improving India's control of PNT sources, while at the same time increasing its dependency on the same.[36]

Much of India's military requirements for ISR are not fully met due to ISRO being heavily tasked with various development-oriented tasks. In addition, India will need to carefully preserve its freedom to access technology as well as take measures to ensure that its ability to access and exploit space is not curtailed by any international groupings. As one of the six leading space faring nations (USA, Russia, China, ESA, India, and Japan), India needs to be at the forefront of global space governance efforts underway. India's space security, therefore, depends on how India meets the emerging challenges. These are twofold:

a) The first challenge is internal. For historical reasons, India has become trapped in a prison of its own making. Indian space development began as a civilian program and has benefitted immensely from this effort to become successful in a hostile, denial regime dominated world. However, this approach has now become a severe constraint in meeting India's security requirements. It is now time to take a national security dominated view to evolve India's space strategy.

b) The second challenge is for India to play a proactive role in enabling an equitable and fair, global space governance architecture. In recent years, the issue of space governance has attracted significant attention. Effectively, this has divided the world into two groups: Europe and the USA on one side, while Russia and China make up the other side. Surprisingly, India's participation has been muted and not very clear. As a leading space faring nation, India needs to take a proactive role if it is not to be marginalised.

Given the above challenges a two-pronged approach, given below, is suggested as the way ahead.

Internal Strategy: National Security Approach

Indian space capabilities have attained a critical mass. Besides, India as a major economy of the world is a significant player in world affairs. While it is important for us to be well integrated into the global system as a benign power, it is only prudent to recognise that India will continue to be in a hostile environment for the foreseeable future. It is, therefore, important for Indian space policy makers to address the larger requirements of civilian space needs and military space needs. ISRO continues to be paranoid about being seen to be involved in meeting India's military space needs explicitly. They do support military requirements, but prefer to combine them with civilian programs - for example the Cartosat series. This approach is no more tenable. It is time to establish clearly specified objectives and strategies, bring synergy in research and development, and address the larger issues of developing our space economy. The following measures are suggested:

a) Create a civilian space agency and a military space agency, separating the two roles clearly.

b) ISRO should continue to address civilian requirements, research and development, space exploration, training, public awareness, international collaboration etc. This is much like the NASA model.

c) A military space division must be created to meet the hugely emerging requirements of C4ISR, defence communications, maritime surveillance, network centric warfare requirements, and others. Military space R &D could be led by DRDO, with support from ISRO and the users. A launch-on-demand for LEO satellites must be set up, preferably at the DRDO launch site at the Wheelers Island.

d) Space security strategy, which addresses the protection of our space assets, must be evolved. This could be addressed by a yet to be instituted tri-service Space Command. Space Command must also be responsible for cyber security, as space and cyber security are interdependent.

e) Opening up space commerce to the private industry will enable the growth of the Indian space industry. This will create vibrant space economy and space commerce, leading to innovation in the private sector, and address exports. Government funding support in the initial stages will be necessary.

External Strategy: Space Governance

There are efforts underway for adopting an International Code of Conduct (ICOC), a voluntary adherence model proposed by the European Union. It is strongly opposed by Russia and China, who have proposed a legal treaty to ban the placement of weapons in outer space or Prevention of Arms Race in Outer Space (PAROS). Both proposals have serious gaps and flaws. The UN mandated work - one under the Committee on the Peaceful Uses of Outer Space (COPUOS) and another called Group of Government Experts (GGE) - continue to explore possible areas of agreement towards space security. None of these mechanisms have explicit support from the major space powers: the USA, Russia, and China. All of them, including ESA and Japan, have made it clear directly and indirectly that their right to weaponise space for self-defence and active-defence is non-negotiable. The USA has made it clear that it will take all actions, including placement of weapons in orbit, to protect its assets in space. India is yet to take a clear position on these issues. A passive role could leave India out of the final outcome, and that could be detrimental to India's interests, much like the NPT turned out years ago.

a) India must actively support the 'Global Commons" approach to space security.

b) Viable space governance is possible only through legally binding treaties and agreements.

c) Implementation mechanism for space security in a 'global commons' approach is possible through an institutionalised body. This could be in the form of a body on the lines of the UN Security Council, without the ills of the veto system. This 'Space Security Council' should consist of all nine space faring nations.

Conclusion

Space has emerged as a critical centre of gravity. The use of space-derived inputs is a vital necessity for the conduct of everyday life on Earth. While civil and commercial space activities provide a range of applications, create employment, and promote technological progress, the use of space for military and intelligence purposes has become critical requirements for national security.

The fears of an arms race and power-politics for dominating space or establishing control and hegemony in space are very real. The emerging contours of space security are dominated by the contest between national security interests of states and the interests of the larger humanity. This contest is unlikely to ever end. In the meantime, India must preserve its freedom to access and exploit space for its security and development. Given rapid developments in technology and space capabilities, it is important that India steers itself into a position of strength in space, technologically, economically, and militarily, in order to support and usher 21st century space as a peaceful 'Global Commons."

Notes :

1 Gen John L. Piotrowski, 'Why the US Needs and Antisatellite,' *National Defence*, February 1990, p. 37. Also see Roger C. Hunter, *A United States Anti-satellite Policy for a Multipolar World*, School of Advanced Airpower Studies, Alabama: Air University Press, October 1995, pp. 2"4.

2 The *New York Times*, 17 March 1967. Quoted in Roger C. Hunter, *A United States Anti-satellite Policy for a Multipolar World*, School of Advanced Airpower Studies, Alabama: Air University Press, October 1995, p. 5.

3 According to General William Momyer, without the Defence Meteorological Satellite Program (DMSP) weather capabilities, most strikes would not have been launched. Charles C. Bates and John F Fuller, *America's Weather Warriors*, College Station, Texas,: Texas A&M University Press, 1986, p. 193.

4 In a speech on 29 November 1957, the USAF Chief of Staff, Gen. Thomas D. White said he '(felt) that in the future whoever has the capability to control space will likewise possess the capability to exert control of the surface of the earth.' Robert Frank Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force 1907–1964*, Maxwell AFB, Alabama: Air University Press, 1971, p. 280.

5 Nicholas Johnson, *The Soviet Year in Space 1983*, Colorado Springs: Teledyne Brown Engineering, 1984, p. 39. Quoted in Roger C. Hunter's *A United States Antisatellite Policy for a Multipolar World*, op. cit. p. 17.

6 James E. Oberg, 'Space Power Theory', at www.peterson.af.mil/SP1/overview.htm . Also see, Koelle, H. H.. 'Spaceflight in the 21st Century: Projections, Plans, Chances, and Challenges', *Journal of the British Interplanetary Society*, Vol. 51, 1998, pp. 251–266.

7 General William Shelton, Commander, Air Force Space Command. Presentation to the Senate Committee on 'Armed Services Sub Committee on Strategic Forces', 12 March 2014, p, 3. Also see, Eric Eric R. Sternn, 'Space in the National Interest: Security in a Global Domain', Washington D. C: The American Foreign Policy Council: Defence Technology Program Brief, no. 3, April, 2014.

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[9] Space Report 2015, www.spacefoundation.org/media/news-briefs/space-report-2015.pdf

[10] Ibid.

[11] OECD 2014, *The Space Economy at a Glance 2014*, OECD Publishing, p. 9. http://dx.doi.org/10.1787/9789264217294-en.

[12] Satellite Industry Association, *State of the Satellite Industry Report, 2015*, The Tauri Group, September 2015.

[13] Joseph Rouge, 'US National Security Space', in Ajay Lele and Gunjan Singh, (eds.) *Space Security and Global Cooperation*, Academic Foundation, 2008, pp. 43–49.

[14] IADC, '20 Years of IADC', An overview of the IADC annual activities, presentation at UNCOPUOS Scientific and Technical Committee meeting in Vienna, Austria, 4 February 2014, at http://www.unoosa.org/pdf/pres/stsc2014/tech-32E.pdf

[15] UNGA, 'Report of the Committee on the Peaceful Uses of Outer Space, Sixty-Second Session', A/62/20, 2007, p. 17, at www.oosa.unvienna.org/oosa/Reports/gadocs/coprepidx.html

[16] As of 31 January 2015, of the 1265 satellites in orbit, there were 669 in LEO, 94 in MEO, 465 in GEO, and 37 in Highly Elliptical Orbit (HEO). HEO is increasingly used for specific applications, such as early warning satellites and polar communications coverage, *Space Security 2015*, p. 33.

[17] On 18 November 2014, delegates at the annual World Broadcasting Unions – International Satellite Operations Group forum in Geneva established a working group to combat intentional interference to global satellite services. *Space Security 2015*, p. 35.

[18] *Space Security 2015*, p. 95.

[19] Bruce Deblois and colleagues estimate that the North Korean Nodong missile or a GPS-guided bomb could achieve the altitude and accuracy for this kind of attack. See Bruce DeBlois, Richard L. Garwin, R. Scott Kemp & Jeremy C. Marwell, 'Space Weapons: Crossing the U.S. Rubicon,' *20 International Security*, Fall, 2004, p. 61, at www.fas.org/rlg/041100-rubicon.pdf. Also see, *Space Security 2015*, p. 95.

[20] Steven Kosiak, *Arming the Heavens: A Preliminary Assessment of the Potential Cost and Cost-Effectiveness of Space-Based Weapons*, Center for Strategic and Budgetary Assessments, 31 October 2007, at www.csbaonline.org/4Publications/PubLibrary/R.20071031.Arming_the_Heavens/R.20071031.Arming_the_Heavens.pdf

[21] Brian Weedon, *Through a Glass, Darkly: Chinese, American, and Russian Anti-satellite Testing in Space*, Secure World Foundation, 17 March 2014, p. 32, at http://swfound.org/media/167224/Through_a_Glass_Darkly_March2014.pdf. The 'Kontact' program was on during 1984–89. Russia has not tested an ASAT since 1982.

[22] GlobalSecurity.org, 'Chinese Anti-Satellite (ASAT) Capabilities,' 18 January 2007, at www.globalsecurity.org/space/world/china/asat.htm; see also, Michael R. Gordon & David S. Cloud, 'U.S. Knew of China's Missile Test, But Kept Silent,' *The New York Times*, 23 April 2007, p. 1. 'China Says Anti-Satellite Test Did Not Break Rules,' *Space War,* 12 February 2007, at www.spacewar.com/reports/China_says_Anti_Satellite_Test_Did_Not_Break_Rules_999.html.

[23] Colin Clark, '"Chinese ASAT Test Was 'Successful:" Lt. Gen. Raymond,' 14 April 2015, at http://breakingdefense.com/2015/04/chinese-asat-test-was-successful-lt-gen-raymond/.

[24] Saadia M. Pekkanen, 'The new Race to Dominate Outer Space: All face "Serious Growing Foreign Threat"', Forbes Online, 27 November 2015.

[25] Brian Weeden, 'Dancing in the Dark: The Orbital Rendezvous of SJ-06F and SJ-12,' *The Space Review,* 30 August 2010, at http://www.thespacereview.com/article/1689/1.

[26] Dean Cheng, 'The PLA's Interest in Space Dominance,' Congressional Testimony before US-China Economic and Security Review Commission, *The Heritage Foundation*, 18, February 2015, pp. 7–9.

[27] Jana Robinson, 'Governance Challenges at the Intersection of Space and Cyber Security,' *The Space Review*,15 February 2016, p. 4, at www.thespacereview.com and https://www.readability.com/articles/vcwv2kfi

[28] Chris Babcock, 'Preparing for the Cyber battleground of the Future,' in *Air and Space Power Journal*, November-December 2015, p. 62.

[29] Patricia Lewis, 'Space and Cyber Security', Presentation in 2nd ORF-SWF Kalpana Chawla Space Policy Dialogue, New Delhi, 25 February 2016.

[30] National Security Space Strategy of 2011 defines 'the current and future strategic environment is driven by three trends – space is becoming increasingly congested, contested, and competitive, USA's National Security Space Strategy, Unclassified Summary, January 2011, at http://www.defense.gov/Portals/1/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf

[31] USSPACECOM Vision for 2020, at http://fas.org/spp/military/docops/usspac/lrp/ch02.htm#Control%20of%20Space. USSPACECOM was subsumed into the new created USSTRATCOM in 2002 by merging earlier Strategic Command and Space Command.

[32] USSTRATCOM Posture Statement, Statement of Admiral C. D. Haney, Commander of USSTRATCOM, before the House Committee on Armed Services Sub Committee on Strategic Forces, 24 February 2016, pp. 17–23, at https://www.stratcom.mil/files/2016_Posture_Statement.pdf.

[33] Ibid., p. 19.

[34] Michael R. Mantz, *The New Sword: A Theory of Space Combat Power, Research Report no. AU-ARI-94-6*, Alabama: Air University Press, May 1995, pp. 31–58.

[35] M. Matheswaran, 'India's Space Capability: Warning Signals amidst Success,' *South Asia Monitor*, May 10, 2015, at www.southasiamonitor.org

[36] ISRO Annual Report 2014-15. ISRO has already cracked the cryogenic technology, despite denial regimes. Its cryogenic based vehicle is in trial stages having done two successful launches, and is expected to be fully operational by 2017. This would give ISRO an ability to put 4 ton payload into geostationary transfer orbit. At http://www.isro.gov.in/sites/default/files/article-files/right-to-information/AR2014-15.pdf. In contrast, China tested its new set of launch vehicles, Long March 5, 6 and 7 in 2015, giving it an ability to put a 14 ton payload into geostationary transfer orbit.

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