Defence Space Options

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Introduction

Space can be defined as the new battlefield after Land, Sea and Air. It is the final frontier or the final goal, which every one desires to conquer or reach. Closely related subjects are Aerospace and Cyber-Space. In fact, Information Superiority is becoming more important than Space Supremacy. It is essential to differentiate between militarisation and weaponisation of space. However, weaponisation is not being considered as an option for India in this paper. Space is also an important element of Revolution in Military Affairs (RMA). It is important to consider space options for defence operations of the future and make long term and strategic plans accordingly. With Indian Space scene entering world class position and standards, defence should exercise its options.

US Concepts

The US Air Force Vision 2020 and Rumsfeld Commission report on Space (January 2001) emphasised: 'US needs Space Weapons for self-defense', 'Space warfare is inevitable', and 'First to deploy weapons in space seem reasonable and desirable.' The report also highlighted the risks from space debris (US tracks about 10,000 objects greater than 10 cm in size) and danger from collision with micro-debris (100,000 objects smaller than 10 cm size). 'Limit use of space by others' (Chinese, Russians and Indians), is a prominently recommended objective by and for the US.

The concept of American control of space is an old idea. Thomas White, Chief of Staff of the Air Force, aggressively and publicly told National Press Club on 29 November 1957, (after the launch of Sputnik on 4 October 1957) that the US must take control of space before the Soviets did. The following February, he elaborated at Jet Age Conference: "The US must win and maintain the capability to control space in order to assure the progress and preeminence of the free nations." He wanted other nations to join

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to ensure that outer space shall never be used for any purpose other than peaceful.

India and Space

Quarter of a century ago, Indian space scene consisted of Satellite Launch Vehicle SLV-3 and ROHINI satellite. Indian Space Research Organisation (ISRO) became a government organisation in 1975; ARYABHATA was completed in 1957; SITE 1975-1976 and 1977-1979 projects; communication satellites APPLE in 1981 and INSAT-I was ready for launch in 1982-1983; ASLV, PSLV and GSLV were conceived and on the drawing boards.

Dr APJ Abdul Kalam moved from ISRO to Defence Research and Development Laboratory (DRDL), Defence Research and Development Organisation (DRDO) in 1982 and initiated the Integrated Guided Missile Development Programme (GMDP). Projects on satellite-based surveillance, remote sensing and communications; networking were contemplated. There were some who talked about 'use and control of space.' Some others felt 'militarisation of space had commenced'.

The present national space and aerospace scene is sufficiently matured and promising. India builds world-class missiles, satellite launch vehicles and communication and remote sensing satellites. Agni and Prithvi missiles have reached operational status. Prototypes of Light Combat Aircraft (LCA) and Advanced Light Helicopter (ALH) had been flying regularly.

Relevance of space activities for India was aptly enunciated by Dr Vikaram A Sarabhai thus, "We are convinced that if we have to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society, which we find in our country." If national defence is considered as an important element of Indian society, benefits of space technology and related national strength have to be fully exploited, not only for operational efficiency but also for making life of the soldier compatible with contemporary society, adequately comfortable, and as safe as is technically feasible.

Space Based Military Options

Space based military options can be sub-divided into the following:-

(a) Secure Communications.

(b) Surveillance and Reconnaissance.

(c) Defence Geographical Information Systems (GIS) and Geodesy Support.

(d) Defence Meteorological Support.

(e) Designation and Targeting.

(f) Battlefield Damage Assessment.

(g) Guidance and Navigation.

(h) Tracking and Data-relay.

Out of these, only Secure Communications and Surveillance and Reconnaissance are getting some attention in the current plans. Surveillance and Reconnaissance can be further subdivided into the following:

(a) Photo Reconnaissance.

(b) Early Warning.

(c) Ocean Surveillance.

(d) Signal Intelligence (SIGINT).

(e) Imagery Intelligence (IMINT).

(f) Measurement and Signature Intelligence (MASINT).

Several transportable satellite communication terminals had been in use in the armed services since 1989; one road transportable terminal participated during the Republic Day Parade on 26 January 1990. Initially, these terminals used C-Band transponders and dish antennae of diameter three metre or six metre depending on the number of communication channels, and employed Single Channel Per Carrier (SCPC) along with secrecy. Bulk secrecy was also used for certain applications. Subsequently, Extended C-Band, Ku-Band, VSATs, S-Band Mobile and L-Band INMARSATs were put into regular use depending upon specific needs. For mountain meteorology applications using automatic weather stations in the Himalayas, Data Collection Platforms (DCP) of INSAT have also been used.

Despite potential advantages, as demonsrated by other advanced countries, India has not yet exploited X-Band (8-10 GHz) or Ka-Band (20-40 GHz) for man-portable terminals using small

diameter antennae (1-0.3 metre), narrow beams and anti-jam techniques; technologies for these are readily available in the country. Another area needing urgent attention is UHF (about 400 MHz) for Aero-Mobile role, particularly for combat aircraft.

Millimetre Wave windows at 35 and 94 GHz (low absorption bands), and Oxygen absorption band at 60 GHz (also for low interception probability beyond three to four km) also may have to be exploited for wide-band and high-speed communication links.

US Weaponisation of Space

While Weaponisation of Space is not being considered as an option in this paper, it is important to keep in view certain trends in the US. On 23 March 1983, Reagan announced his bold vision for an impenetrable missile defence shield that would render nuclear warheads impotent and obsolete : "I call upon the scientific community in this country, who gave us nuclear weapons, to turn their great talents to the cause of mankind and world peace." From the very beginning, Reagan's Strategic Defence Initiative (SDI) viewed Space Based Weapons such as X-ray Lasers, Chemical Lasers, Particle Beam Weapons, and Kinetic Kill Vehicles as better ways to destroy large number of incoming Soviet warheads.

Space Based Laser Integrated Flight Experiment (SBL-IFX) is an interesting example of Laser as a Space Weapon. It is a Joint Venture of Boeing, Lockheed Martin & TRW – all three were also working on Airborne Laser (ABL). One test vehicle in planned for 2013 and initial operational capability is scheduled for 2020. The operational system shall be a constellation of 18 to 48 systems in LEO using Hydrogen Fluoride (HF) Lasers of Mega Watt level with micro radian beam. HF and DF (Deuterium Fluoride) are the only ones that have demonstrated Mega Watt class lasers. DF was originally developed for MIRACL (Mid Infrared Advanced Chemical Laser) and also used for Tactical High Energy Laser (THEL). HF operates at 2.7 μm and DF operates at 3.8 μm. As against this, Indian capabilities are very modest. Laser Science and Technology Centre (LASTEC) has realised a 10 kW Chemical Oxy Iodine Laser (COIL) and a 25 kW CW Gas Dynamics Laser (GDL), and is working on a 150 kW CO_2 GDL with adaptive optics (five milli radian pointing accuracy) and automatic tracker for RPV type targets up to 3 km.

Directed Energy Weapons (DEW) using High Power Microwaves (HPM) can replace high explosives and reduce collateral damage; in recent times, investment trends for related S and T are increasing and decreasing for conventional precision munitions. While Laser Weapons produce narrow and precise beams, which can physically damage targets, HPM have broader beams, which can damage communications and battlefield electronics, erase computer memories, disrupt utilities and heat water in person's skin for crowd dispersion. Plasma Weapons are much slower but have higher mass and can cause significantly higher damage by creating bolts of lightning.

Space Weapons of the future include Brilliant Pebbles (network of 4,000 miniature satellites in low-earth orbits, that could fire high-velocity, watermelon-sized projectiles at incoming warheads, destroying them through the energy of impact and provide Anti-Satellite Capability); MHV (Miniature Homing Vehicle) which could be launched from F-15, not enter orbit but go up to 500 km to be able to reach and hit low-earth-orbit satellite; and 'Rods from God' (Tungsten rods, 20' long and I' diameter), stocked in orbiting platform / satellite guided to any place (similar principle used recently in Iraq near mosques, schools, hospitals). Other examples are FALCON (Force Application and Launch from the Continental United States), a Hypersonic Bomber, to be sent to upper atmosphere by a boost vehicle, cruise at 100,000' at Mach 12, to outrun any antiaircraft missile (they do not need foreign bases and are slated for demonstration in 2006); and Space Laser on Boeing 747, which could cruise at 40,000' and engage tactical ballistic missiles (if lased for three to five sec, oxidiser or fuel tank would explode).

SIGINT and ELINT

The first generation SIGINT satellite of the USA was GRAB. It was a 43 lb (basket ball size) LEO satellite launched in 1960 (declassified in 1998) for interception of Air Defence Radars. Subsequently, they launched RHYOLITE/AQUACADE (3rd generation) of 650 kg with 20 m dish to intercept Missile Telemetry, VHF and Microwave Links, Cellular Phones, Paging Signals, Data Links, etc. This was followed by ORION (5th generation), of 2700 kg and with 255 ft dish, which could intercept Wrist Watch Radios,

Antijam Downlinks and was used to detect Scud launches. Advanced ORION would use a 100m dish to provide higher sensitivity and sharper beams.

Russia launched EORSAT (ELINT Ocean Reconnaissance Satellite) for passive observation of Radios and Radars; a constellation of multiple satellites in two orbital planes to ensure over-flight of specific regions and increased probability of detection. They also used RORSAT (Radar Ocean Reconnaissance Satellite) for active search of ships in all weather conditions. Their early warning (GEO) satellite series called 'Oko' (eye) and 'Prognoz' were used to detect ballistic missile launches and could also detect submarine launched missiles.

The French have developed a technology test-bed called CERISE for ELINT applications. China had been using ELINT satellites since 1970; the most recent ones being Shenzhow-5 launched on 16 October 2003 (with their first astronaut Yang Liwei in the descent module), for 300-1000 M Hz monitoring with three log-periodic antennae for direction finding, triangulation and interferometre.

While nothing specific has been done in India in the area of space based ELINT, SIGINT or related fields, the required technologies are sufficiently matured through the Electronic Warfare (EW) programmes. India is almost self sufficient in the ESM (Electronic Support Measures) areas encompassing sensitive receivers, active antennae, fast scanners, direction finding, finger printing, signature analysis, etc. working up to 40 GHz. These technologies, along with Electronic Counter Measures (ECM) and Electronic Counter Counter Measures (ECCM) are being regularly used by the Army, the Navy and the Air Force. In fact, all our fighter aircraft are equipped with indigenous Radar Warning Receivers.

Surveillance and Reconnaissance

Space based Surveillance and Photo Reconnaissance needs are being adequately met through Panchromatic and Multispectral images providing resolution up to one metre. Stereo images can also be generated as per requirement. However, SAR for night-time and all-weather imaging is yet to be realised. Over the years,

there is a paradigm shift in the Surveillance Trends: from Detection to Target Recognition, Manned to Unmanned (UAV and Satellite), Single Sensor to Multiple and Integrated Sensors, Low RCS to Stealthy Targets, Dedicated Platform to Network Centric Systems, etc. Emerging concepts include Integrated Surveillance aimed at Battlefield Dominance through Information Superiority (Data, Images and Finger Printing). In fact, the move is towards C4ISR and digital battlefield.

In the US, Satellite Based Surveillance during 1959-1979 was film based, using Long Range Oblique Photography Systems (LOROPS) for up to three metre resolution imageries (satellites used were of Key Hole series: KH-1 to KH-9 called Corona, Argon, Lanyard, Gambit, Hexagon). These were supplemented by Charged Coupled Device (CCD) based Electro Optical (EO) sensors in Visible, near IR and Thermal Bands, providing resolution up to one m from 550 km and 0.5 m from 300 km altitude. Since 1984, higher resolution (10 cm) imageries were available through KH-11, KH-12 and CRYSTAL, weighing 14-18 ton including five to seven ton of fuel for orbit manoeuvring. Also available were LACROSSESR satellites for all-weather Imaging up to one m resolution, capable of petecting buried structures up to three m depth and submarines up to 50 ft.

The Nuclear Detonation (NUDET) Detection System (NDS) of the USA utilises special detection sensors in the constellation of 24 GPS Satellites. These are capable of detecting, locating and reporting nuclear detonations worldwide, 24 hours a day, in the earth's atmosphere or near space, in near real time. The system became operational in 1994 for tactical warning and attack assessments.

The GPS related concerns have been getting highlighted every now and then, particularly for defence and strategic needs. Requirements for an indigenous or regional GPS, with like minded countries, is a long felt essentiality.

The Satellite Based Missile Plume Detection system of the USA utilises DSP (Defence Support Programme using IR sensor (10.2 to 12.5 micron band with resolution of 100 m and 0.25 deg C) of SEWS (Satellite Early Warning System) to detect and report in real-time missile launches, space launches and nuclear

detonations. However, the UV sensor based work is part of the Strategic Defence Initiatives; and is expected to solve problems associated with confusion that can be created by decoy IR (heat) sources. Indian INSAT uses VHRR (Very High Resolution Radio Metre with resolution of two kilometre (also uses 8 km IR sensor and 1 km CCD Camera).

World over, military is increasingly using commercial satellite imageries and Satcom capacity, so much so that Government control is progressively reducing. Commercial satellite imagery market has reached $ one billion. It is speculated that all future surveillance may be done via satellites! The 1 April 2001 incident, related to US Navy spy plane along the Chinese coast, sparked new and increased interest in the use of satellites for surveillance. Perhaps, there was no need to put people, expensive equipment and diplomacy to such risk! "While satellite networks cost a lot of money, they do not cost any more than a spy plane and personnel and also don't cause an international incident to happen," said Mary Ann Elliott, President and Chief Executive Officer (CEO) of Arrowhead Space and Telecommunications Inc.

Cyber-Space

In the present context, cyber-space and related concepts and trends should be kept in view. There are debates on Digital Divide and ever increasing gaps between haves and have-nots. There are equally strong optimisms, treating the situation as Digital Bridge or Digital High Way! ITU's Digital Access Index, to measure availability of advanced telecommunications and computing technologies, places Korea, Taiwan and Hong Kong in the top ten, ahead of Canada, US and UK. Four of the top ten broadband economies are in Asia; in Korea, 23 per cent of the population is digitally connected and in Hong Kong, 18 per cent of the population is connected. It is interesting to note that internationalisation of Information and Communication Technology (ICT) has left behind England which was earlier having an advantage; unlike past, software in local language or mother tongue may soon start giving significant advantage and extra competence. Having established itself well in the software fields, India's and Indian Defence should be second to none in exploiting the potential advantages.

Concluding Remarks

Space and space technologies have opened up new opportunities for defence operations; the related options are unlimited; with imaginative plans, we can have cost effective, fully indigenous and self reliant solutions. Starting with SLV-3 to launch 40 kg in LEO in 1980, India has grown, and grown very impressively, to launch 4,000 kg with PSLV and 10,000 kg with GSLV. Today, India stands tall in matters of Space; we should be second to none in the exploitation of Space options for our nation-building, through defence or non-defence applications. The only odd element of concern is that, while our space segment is fully indigenous, somehow the ground segment is not keeping pace, and herein lies a challenge, both for the user and the industry. It is important to realise that 'if Defence is not in Space, it is not in the Race.'

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