Space Assets and their Integration with Land, Air And Maritime Warfare for enabling National Security Strategy Part-II

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PART-II

TENETS OF SPACE WARFARE AND MILITARY OPERATIONS

III

Tenets of Space Power

Codifying the tenets of space power is the next step in the Network Centric Warfare (NCW) development process. Tenets describe how "power can be used to achieve military objectives." They are the operational strategies that harmonize environmental constraints and the principles of war.

Tenet 1: Centralised Control and Decentralised Execution. Space capabilities enhance operations across areas of Interest. Space assets available to our nation include military, intelligence, commercial, civil and foreign. For this reason, space operations are generally best planned and controlled in a centralised manner. Centralised control and decentralised execution provides the necessary oversight and ability to direct and coordinate component space forces through mission-type orders, while allowing component forces the flexibility to determine how they will employ their resources to achieve the mission. Centralised control and decentralised execution also provides the commander the centralised oversight and control over forces via a daily tasking order, while allowing the Services, the flexibility to determine which tactics, techniques and procedures to use for a given space system and operation.

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Tenet 2: Flexibility and Versatility.

(a) Traditionally, most satellites have reduced flexibility due to limitations in size, weight, power, cost and accessibility. Although able to transition between support for both theatre and global missions, satellites tend to host single missions such as photo reconnaissance, communications, navigation, etc. Few satellites support more than one type of mission. Furthermore, space based assets are costly to manoeuvre and are not serviced in orbit. For example, it may not be practical to move a single geosynchronous early warning satellite out of one orbit and into another so that we can gain a better opportunity to image a particular area. However, increased flexibility can be obtained by either satellite constellations as a whole or by designing new satellite systems capable of providing multiple services.

(b) Satellites do offer increased options for the joint force commander. The synergistic application of land and space and space-based platforms increases the flexibility of the total force. For instance, traditionally, communications are limited to land-lines or aircraft relays. Navigation was primarily derived from ground-station antennas, beacons, and transponders. Intelligence, surveillance and reconnaissance (ISR) were provided mainly by aircraft. Today, space-based capabilities allow for additional means of communications, navigation, environmental monitoring and ISR. Space-based sensors along with air-breathing counterparts bring increased flexibility in force employment.

(c) Space forces, operate simultaneously at the strategic, operational, and tactical levels of war, increasing their versatility across the range of military operations. Missile warning satellites, for example, traditionally have been used for detecting intercontinental ballistic missile (ICBM) attacks on North America. Yet, they can also be used for detecting short-range ballistic missile (SRBM) and intermediate range ballistic missile (IRBM) launches for theatres. The US, Defence Meteorological Satellite Programme (DMSP) constellation, for example, not only provides weather information directly to theatre for the tactical movement of special operations forces, but also provides weather information for planning campaigns

and determining the types of munitions to be utilised. At the same time, downlinked DMSP data is used to update national weather forecast models for supporting the strategic national-level activities. Communications satellites also offer versatility as they support strategic direction and information between the National Command Authority (NCA) and combatant commanders down to operational and tactical level users of imagery. Consequently, there have to be higher level joint even inter agency control exercises.

Tenet 3 : Concentration. Space forces contribute to the military's ability to concentrate effects. Space-based ISR and information systems, combined with PGMs, have eliminated the need, as in past conflicts, for many aircraft to attack a single target. Today, a single aircraft can strike several targets. For example, during *Operation Allied Force*, the US B-2s were force multipliers because they struck an average of five individual targets per sortie. Similar to low density and high demand (LD/HD) assets, satellite lunch systems and other infrastructure for space operations require careful prioritisation and balance. Force levels sanctioned in yester years will bear little relevance to our future needs.

Tenet 4 : Priority. The use of space forces must be prioritised because the assets are finite. Space forces need to be employed where they can make the greatest contribution to satisfy critical national and theatre requirements. For example, secure space based communications bandwidth derived from space-based assets is limited, yet the demand continues to rise.

Tenet 5 : Balance. Space forces must be balanced against competing priorities. Most space forces have global capacity and coverage. Responsibility for commanding and controlling them must reside with those who have a global view and the means to execute this responsibility. Hence, need for a centralised authority for coordinating and prioritising the use of space forces.

Tenet 6 : Initiative. Initiative sets or changes the terms of battle by action and implies an offensive spirit in the conduct of all operations. Applied to the force as a whole, initiative requires constant effort to force the enemy to conform to commanders' operational purposes and tempos, while retaining freedom of action.

It means depleting the enemy's options, while still, having options of their own. Initiative is required of space forces to:-

(a) Achieve objectives.

(b) Take the offensive.

(c) Achieve unity of command.

(d) Maintain security.

(e) Surprise the adversary.

Tenet 7 : Agility. The tenet of agility arises primarily from concerns over the security of space systems. Agility is the ability of friendly forces to react faster than the enemy and is a prerequisite for seizing and holding the initiative. It is as much a mental as a physical quality. Agility can be both physical and virtual. Physical agility is the ability to move space forces or use alternate equipment in reaction to adversary's actions. Virtual agility is the ability to change operating characteristics without moving or changing equipment. Agility is the linchpin for the protection and preservation of space forces during hostilities, and without it, a space-faring nation risks losing its space assets during war. Agility includes two sub-elements. First, it is necessary to maintain a situational awareness to detect threats to space systems. Second, space operators must be prepared to react to threats as they arise. Contingency plans need to be well understood and exercised.

Tenet 8 : Synergy. The tenet of synergy arises from the tie between space and terrestrial forces. Synergy is the ability to "produce effects well beyond the proportion of each mission's individual contribution to the campaign". Space forces are inextricably linked to the earth and their operations provide a force multiplier to achieve desired objectives. The force multiplier effect of spacecraft providing information superiority is well known, e.g., the role of the Global Positioning System (GPS) in precision-guided munitions. Unity of command also has implications for synergy since some centralised control is needed to ensure compatibility and not to overwhelm the user with unnecessary information. If space forces operate in an uncoordinated manner, it can cause information overload and become a detriment to the combatant commander. Space systems work best when they are operated cooperatively rather than competitively.

Counterspace

Counterspace operations consist of those operations conducted to attain and maintain a desired degree of space superiority by allowing friendly forces to exploit space capabilities while negating an adversary's ability to do the same. Counterspace operations include two elements – offensive and defensive counterspace, both predicated on space surveillance and other intelligence.

Offensive Counterspace (OCS) operations preclude an adversary from exploiting space to his advantage. Should policy allow, OCS actions may target an adversary's space system, forces and information links, or third-party space capabilities supporting those forces, using lethal or nonlethal means. Possible methods include the use of deception, disruption, denial, degradation and destruction of space capabilities. The "Five Ds" represent a continuum of options, from spoofing the enemy to hard-kill of a space asset. However, there are tradeoffs along the continuum. At the destruction end of the continuum, space force can be confident that an adversary's space assets and the effect it produced have been eliminated. However, there may be undesirable collateral effects, such as added debris threats in orbit, or negative world opinion. At the deception end of the continuum, space force may have less confidence in achieving the desired effect, but have more confidence in not producing any adverse collateral effects. The five methods involve the following :-

(a) Deception employs manipulation, distortion, or falsification of information to induce adversaries to react in a manner contrary to their interests.

(b) Disruption is the temporary impairment of some or all of a space system's capability to produce effects, usually without physical damage.

(c) Denial is the temporary elimination of some or all of a space system's capability to produce effects, usually without physical damage.

(d) Degradation is the permanent impairment of some or all of a space system's capability to produce effects, usually with physical damage.

(e) Destruction is the permanent elimination of all of a space system's capabilities to produce effects, usually with physical damage.

Spacelift

Spacelift projects power by delivering satellites, payloads and material, to or through space. There can be three strategies and one emerging strategy for Spacelift.

(a) Launch to deploy achieves a satellite system's designated initial operational capability. This strategy uses a launch-on-schedule approach where launches are planned in advance and executed in accordance with the launch schedule.

(b) Launch to sustain re-places satellites nearing the end of their useful life, predicted to fail, or that have failed.

(c) Launch to augment increases operational capability above the designed operational capability in response to war, crisis, or contingency.

(d) Launch to operate is an emerging strategy to increase the useful life of space assets through schedules or on-demand launches providing space support such as refuelling repair.

Command and Control (C^2)

Today, space is integral to the command and control of forces. C^2 includes both the process by which the commander decides actions to be taken and the associated people and systems that implement the decision. These work together, enabling a commander to plan, direct, coordinate and control forces and operations. Satellite communications via the Military Strategic and Tactical Relay System (MILSTAR) constellation provide survivable communications for passing NCA strategic direction to subordinate forces. The Defence Satellite Communications Systems (DSCS) constellation provides communications flow between military tactical units and operational-level commanders. The Ultra High Frequency (UHF) follow-on constellation provides secure communications for naval operations. Also, space-based imaging and other ISR collection capability provide commanders and operational planners with vital intelligence for the command and control of military forces. For force protection, Defence Support Programme (DSP) satellites characterise the

stategic and tactical missile threat for rapid commander assessments and subsequent, counterattack decision making.

Intelligence. Intelligence provides clear, relevant, and timely analysis of foreign capabilities and intention for the purpose of planning and conducting military operations. The overall objective of intelligence is to enable commanders and combat forces to know the enemy. Space assets support intelligence collection and dissemination efforts by collecting and processing information on adversaries and subsequent dissemination to forces. Space-based systems are generally unobtrusive, and are an internationally accepted means of gathering peacetime information without violating national sovereignty.

Surveillance. Surveillance is the function of systematically observing air, space, surface, or subsurface areas, places, persons, or things, by aural, electronic, photographic, or other means. For example, the Space Surveillance Network (SSN) allows the United States to maintain awareness of the position, and characteristics of man-made objects in earth orbit. In the future, surveillance can also be achieved through over-head non-imaging infrared (ONIR) satellites placed in geosynchronous orbit providing theatre ballistic missile (TBM) detection, enabling increased theatre force protection.

Reconnaissance. Reconnaissance complements surveillance in obtaining, by visual observation or other detection methods, specific information about the activities and resources of an adversary or potential adversary. In addition, reconnaissance may focus on securing data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. Multispectral and, in the future, hyperspectral imagery obtained from space assets provides a new dimension to imaging the battlespace.

Navigation and Timing. The function of Navigation and Timing is to provide accurate location and time of reference in support of strategic, operational, and tactical operations. Navigation and Timing help all military forces to precisely manoeuvre, synchronise actions, locate and recover downed aircrew, and perform many other tasks. Space assets are becoming the foundation upon which the Armed Forces navigate. However, potential adversaries can exploit GPS navigation for their own

operations, as well as field their own space-based navigation and timing systems.

Counterland. Counterland involves those operations conducted to attain and maintain a desired degree of superiority over ground operations by neutralising enemy ground forces. For air interdiction (AI) and close air support (CAS) missions, space assets provide battlespace situational awareness. Space-based C2 assets help commanders communicate, direct, and control their AI and CAS missions.

Countersea. Countersea is a collateral function that extends the application of air and space power into the maritime environment. Currently, space ISR assets make their greatest contribution to countersea in the realm of sea surveillance. Future OCS assets may play an important role in countersea operations. For example, they may degrade or eliminate adversary's abilities to observe the numbers, locations, or activities of friendly sea forces.

Sustain Operations. Once space systems are included into operational war plans, every effort must be made to sustain their operations. It may be more important to the commander to continue receiving space support he is familiar with than testing something new in the heat of battle. Space forces must be used wisely so they will be available throughout the conflict. Sustaining space operations will reduce the fog and friction of war. Sustainment of operations include defensive operations, replenishment strategies, and maintaining reserve capabilities.

Operational Art. Operational art comprises the capabilities or techniques military organisations develop to maximise the effectiveness of their forces. It is rooted in operational experience and seeks to animate the tenets of power. Operational art elements can be either backward-looking, or forward-looking based on what experiences are considered most important to the organisation. The attempt here is to articulate a forward-looking doctrine and prescribe what should work in the future to make space forces as effective as possible in the Indian context.

Doctrine is intended to guide the organisation for training, equipping, end employment of military forces. Doctrine guides these activities by codifying military judgment in a form that is usable by developers and planners. A readily usable form of doctrine is found

in implementation strategies to guide acquisition and employment activities. These strategies assist in the translation of policy directives into force structure and employment concepts. Implementation strategies can be categorised as either force-development or force-employment oriented. Both types of strategies should reflect the application of the operational art to space missions.

IV

THREAT PERSPECTIVE

Global threat perceptions are going through a radical change. The threat emanates from space too! From an Indian centric view, China (coupled with Pakistan), the USA and Russia are the main challenges. Developments, both in China and Pakistan, need to be analysed from the military threat perspective. The capabilities of the USA also have to be realistically factored in.

China: Militarisation of Space Programme

It was in mid 1950's that China initiated its nuclear warfare development programme. This was coupled with the search plans for space. Achievements in space commenced with launch of China's first satellite in 1970. It launched three satellites with one rocket in 1981. It commenced geo-synchronous satellite system in 1983 and by 1986 it had launched 18 satellites. The launch of DFH communication satellites series have contributed toward China becoming a major force in Space Programme. China launched more than 30 satellites between 2001 and 2005. Technological assistance from European countries has been coming to China regularly. The US waived sanctions against China for post missile technology transfer to Pakistan and Iran, which in fact has boosted its space programme. China got technical support from western countries with its first military space programme in 1955. It went commercial in 1986 by capitalising on the black period in the USA after the accident of Challenger series forcing the USA to use Chinese launch facilities. The military implications of these achievements are enumerated below :-

(a) **Micro Satellites.** The PRC has been exploring the possibilities of micro- satellites, which are smaller than most satellites and, therefore, less expensive. A satellite in this category, Tsinghua was launched on 28 June 2003, by a Russian booster. It was a joint project of Tsinghua University

of Beijing and Surrey Satellite Technology Limited (UK). It is a 50 Kg bird and its launch has put China into the selected bracket of countries that can design and operate micro and nano-sized satellites. This success has implications for both China's scientific programmes as well as for enhanced military satellite capabilities. It is equipped with a CCD camera that can image objects up to 39m in three spectral bands. (In India too, Anna University at Madras has completed a micro satellite project of 30 kg. Our Armed Forces should also get involved in such projects.)

(b) **Electronic Intelligence.** China on 16 Oct 2003 launched Electronic intelligence (ELINT) Module with three downward looking antennas for detecting signals from ground.

(c) **Command and Control Networks.** China launched its first military communications satellite in January 2000 as part of the People's Liberation Army Command and Control network linking forces for combat. These will be netted to airborne and ground based sensors to give ballistic missile, cruise missile, aircraft and ships a seamless tactical-to-strategic targeting capability. This is supposed to be China's first advanced technology spy satellite. Studies are under way to develop a Global Mobile Satellite Information System (GMSIS), which would provide personnel hand-held communications via 18 to 24 satellites in medium orbits. China is developing a new generation of photo-reconnaissance satellites, the FSW-3 series, which will provide one metre resolution. The Chinese national Remote Sensing Centre also receives imagery from US LANDSAT, French SPOT, Israeli EROS and Russian remote sensing satellites. So far they have developed three models of recoverable reconnaissance satellites (FSVVI/2/3) and launched 18 of them for military operations. These capabilities when applied in our region will obviously facilitate China's military operations against India.

(d) **Multiple Military Roles.** China understands the monopolistic space exploitation by countries that 'control' satellite technologies and hence is engaged in development of indigenous substitutes. Over the last 30 years China has gradually developed a multi-functional, multi-orbit space infrastructure composed of various satellites. These would play multiple military roles.

(e) **PRC Research.** The PRC has conducted research since the 1950s, including biological and life support research, for placing astronauts into orbit. Pursuant to its 921 Project, the PRC's plan since the 1980s has included concepts, for Space Shuttle-like spacecraft, recoverable capsules, and a space station. These have military implications. They would be able to train their spaceman and manage the environment from the perspective of military missions.

(f) **Increasing Space Launch capabilities.** In 1996, two PRC astronauts began training at the Gagarin cosmonaut Training Centre, Russia, for its manned space programme. PRC is the only third nation, after Russia and the United States, to have placed men in orbit in their own satellite programme. China launched its first long-distance rocket carrier, on 18 May 1980. China launched its first unmanned spacecraft Shenzhou I, on 20 November 1999. China opened 21st century with Shenzhou-2 spacecraft launch thus demonstrating growing capability. The extended mission of SZ-2 orbital module has shown that China is capable of maintaining an orbiting platform for a prolonged period. Such a capability is an important step torwards China's eventual goal of establishing its own permanent manned presence in space. China is pushing ahead with a plan to put its astronauts in space and has also reiterated its goal, for their Space Flights for Lunar and Mars Explorations. The long March 2EA is likely to replace long March 2E as Chinese heaviest launch vehicle. The 800 ton booster, measuring 50m in height will be capable to lift an 11.8 ton load into LEO. It is also developing 800 ton, 4 stage booster launch vehicle with a capacity of lifting 23 ton pay load to LEO/ 11 ton into GEO. In a long term scenario this would have military implications of dominating the space environment which in turn would cause military domination of the battle space on earth.

(g). **Space Weapons.** It is another field which may be banned but nations are carrying out secret research and trials. Enough documents have already revealed strides in Anti-Satellite Weapons (ASW) system by the USA and Russia. These weapons could be based both on kinetic and chemical energy. Some of the systems which appear to be under trial are 'Rail guns', or Directed Energy Weapons'. (DEW), like 'Particle

Beams' High Powered Microwave or LASERS'. The PRC is also believed to be developing space-based and ground-based anti-satellite laser weapons. Such weapons, would be of exceptional value for the control of space and information. It is assessed that the PRC is moving towards the deployment of such weapons. Based on the significant level of PRC-Russian cooperation on weapons development, it is possible that the PRC will be able to use enclear reactors to pump lasers with pulse energies high enough to destroy satellites. In addition, Russian cooperation could help the PRC to develop an advanced system using laser to track and image satellites. PRC has the technical capability to develop direct ascent anti-satellite weapons.

Over the last few years, china has been diligently developing its space infrastructure with greater emphasis on indigenous technology and has emerged as a force to reckon with in military space. Reports indicate that China has completed ground tests for an advanced anti-satellite (ASAT) weapon called 'Parasitic Satellite' China is developing ASAT systems with both long and short-terms strategic objectives. The long-term objectives are probably to break the US monopoly in this field. China understands that compared to the US, it lags far behind in terms of assets and technology in the space arena and hence the best way to challenge the sole space superpower is to possess offensive anti-space-based weapons. It is also in the process of building lasers to destroy satellites.

The PRC is believed to be developing a new, rocket that will be able to carry larger payloads into orbit. Enhanced capabilities for lifting heavier payloads would undoubtedly enhance military capabilities in space. PRC papers have discussed the use of cryogenic liquid propellant engines for this future rocket. One of the engines the PRC could use is the RD-120. The PRC is known to have acquired at least one of these engines from Russia during the 1990s. The RD-120 is a liquid oxygen/kerosene engine that is used on the second stage of the Zenith rocket, which is used on the multinational Sea launch programme. Difficulties with the development of the new engines for this rocket may have prompted the PRC to focus, in the nearer term, on the proposed Long March 2E(A) and Long March 3B(A) versions of the Long March rocket that will utilise improved strap-on boosters to achieve greater payload-to-orbit capability.

Observations Pertaining to Chinese Developments

An analysis of the developments in China testify it's growing military capabilities in space. The summary of observations are as below :-

(a) Control on China's space programme rests with the Central Military commission.

(b) China considers space holding the strategic balance of power, in any future security matrix.

(c) China is programming full spectrum, end to end research, design, trial, manufacture, producing and testing system for both satellites and launch vehicles.

(d) Space is fast becoming a hub in China's military strategy. They now enunciate a battle field 'Supremacy Theory' which has following key components :-

(i) Information Warfare.

(ii) Fusing military and manned missions.

(iii) Improved resolution to 0.6 metres.

(iv) Plan military satellite controlled orbit lasting for six days or more.

(e) As shown at the Hanover Expo 2000, China plans multiple military mission capabilities to enable monitoring targets on earth at least twice a day.

(f) Accelerate launch of micro-satellite probably with military mission.

(g) Build competency for launch of satellite in just 16 hours.

(h) Build to use ASW from existing configuration of ICBM which will allow interception in the polar orbit used by many US satellites.

(j) Launch more satellites to augment the existing capability of their 'Beidon Navigation Test Satellite' system (China's GPS navigation system).

(k) China has invested US $ 200 million in the EU-Gallillo navigation system.

(I) China is advocating treaty to ban Space Weapons. However, it makes no bones about working on ASW or Kinetic Energy weapons or Jammers or parasite satellites or HPMs which are ground based.

Pakistan : Second Experimental Satellite BADR-B

Under SUPARCO's programme for development of indigenous capability to design, develop, fabricate and launch of low cost satellites in low earth orbit, work on Pakistan's Second Experimental Satellite, BADR-B was initiated. The success of BADR-1 mission had given the confidence and the infrastructure developed during that mission provided a base line upon which further activities of BADR-B satellite development were based. In addition to objectives laid down for Badr-I, BADR-B had been designed to meet other useful objectives as well. BADR-B, indigenously developed by SUPARCO, was placed in a low earth (1000 km) sun-synchronous orbit, with a design life of over two years. Weighing about 70 kg, its mission objectives were:-

(a) Indigenous development of tow cost satellites and creation of necessary infrastructure for systems, which can be launched in space.

(b) Acquisition of know-how and technology for taking pictures of earth from specialised digital camera.

It encouraged participation of the country's academic and scientific community in the peaceful uses of space telecommunication. BADR-B was launched in 1999 through the Russian Space Agency. It was to carry the following four experiments (payloads):

(a) Earth Imaging CCD Camera.

(b) Battery End-of-Charge Detector.

(c) Radiation Dosimeter.

(d) Store-and-forward Communications.

Pakistan is concerned that new technologies developed in connection with space weapons, such as lasers and particle beams, could be applied to conventional weapons. Weaponisation of space could, entrench the inequitable use of outer space to the detriment of developing States. However, Pakistan's case is unique as its

strategic alliance with China gives adequate satellite coverage capabilities. It can be foreseen that their space collaboration with China is likely to be on the lines of the nuclear nexus.

Military Threats: World View

The US is the world leader followed by Russia in space technology. In fact, Rumsfeld (former Defence Secretary) feared that 'space could be the next Pearl Harbour for the US'. In 2002, after report of the Rumsfeld space commission, President Bush withdrew from the 30 year-old Antiballistic Missile Treaty (ABM) with Russia, which banned space-based weapons.

The US has had space-based weapon systems on its drawing board for years, including miniature satellites that can attack other satellites, high-powered lasers, and even a space plane that can drop weapons from orbit. Even Russia is understood to have carried out ASW and AASW tests.

China, quite clearly, is doing a balancing act on the space front. Overtly, it is spearheading an international movement to ban conventional weapons from space alongwith Russia and a few other countries. At the same time, as reports suggest, it is discretely developing anti-space-based technology and formulating tactics in order to target American military assets. China understands the critical advantage the US had in the 1991 Gulf War as well as in Kosovo, Afghanistan and the recent war in Iraq. China's PLA feels that if a conflict breaks out in the Taiwan theatre, it can neutralise or destroy the US space assets, and deny the Pentagon the asymmetric advantage in space. China's development of military space capabilities impinge on India's security. The datum line of analyses dictate the necessity for India too becoming pro-active on this front.

The Bush Administration has made arrangements in the defence budget for space-based weapons to defend satellites, strike ground targets and defend against missile attacks. However, the major hurdle in getting the new space initiative off the ground would be convincing the Congress to approve its enormous price tag, which is tentatively estimated at between 220 billion and one trillion. If Bush manages to pass this hurdle successfully, then it could be the beginning of the biggest and costliest space arms race in the post-Cold War era. Taking a lead, India should start developing concepts for protection of space assets.

V

WAY AHEAD FOR INDIAN ARMED FORCES

Force-Development Strategies

Force development strategies should address issues related to the acquisition of space forces. In our case we are already lagging far behind China. Many important characteristics of space forces are determined during the acquisition phase because follow-on operational innovations will be significantly constrained by the design of the space system. Force-development strategies are intended to describe general capabilities space forces need.

Modular Design

(a) Modular design is the ability to mix and match different payloads between different types of space systems. It applies equally to the space, control, and user segments, although the emphasis is often placed on the space segment since it is more difficult to change once it is launched.

(b) Modular design is also concerned with adding ancillary payloads to spacecraft. Many of the operational art elements advocate equipping all spacecraft with multiple subpayloads. This idea is referred to as a multi-mission capability. It envisioned a capability to: "defend friendly space systems by avoiding or surviving attack and to promote deterrence by having the ability to detect, identify, and neutralise threatening enemy systems."

(c) The term multi-mission was not used here since it now carries a different connotation. Multi-mission is often taken to mean combining primary spacecraft payloads such as adding an imagery mission to a missile warning spacecraft. This may be a good idea, under certain circumstances, but it is not generalisable to all space forces.

(d) Modular design on the other hand emphasises the ability to add general warfighting capabilities as an adjunct to primary spacecraft mission.

Commercial Standards

Many of the functions required of military space forces are common to commercial users and there is often no reason to have

unique military standards. This idea has been around for some time and was the subject of an acquisition reform. In 1994, Secretary of Defence, USA, issued a policy memorandum stating "the use of military specifications and standards is authorised only as a last resort, with an appropriate waiver." While commercial standards are being pursued by the acquisition community for the potential cost savings involved, this strategy also offers many force employment benefits.

Adopting commercial standards should make space forces more responsive in implementing these operational art elements:-

(a) Standard Interfaces.

(b) Interoperability.

(c) Data Fusion.

Fielding space forces in this manner will facilitate integration of space forces into theatre operations and theatre Battle Management, Command, Control and Communication (BMC3) systems. It will make space forces more flexible to operational demands by allowing greater interoperability between service components and commercial user equipment. It should also facilitate rapid dissemination of space-derived information to terrestrial forces.

Force Employment Strategies

Force-employment strategies differ from force-development strategies in that they arise from use of the forces rather than their design. For example, a space system can be designed to be manoeuvrable, but if an attack warning is never received, the spacecraft will not respond to defeat the threat. Employment strategies can also allow space operators to possess capabilities not originally considered when the space system was designed.

Operational Security

Most space systems are cloaked in a veil of secrecy. A comprehensive plan can help prevent attacks on our space forces by making it more difficult for an adversary to launch an attack. It can create uncertainty as to the true nature of space operations and deny the adversary needed targeting data. Although the benefit to some space systems may be negligible, but it can be particularly effective in protecting high-value assets.

Real Time Situational Awareness

Instant awareness is concerned with maintaining the commander's situational awareness of space and enabling him to respond effectively to an adversary's actions. Most attacks on space forces can occur in a few minutes to hours. Short warning makes it imperative to detect and respond to an attack as early as possible. Even if it is not possible to protect the first system attacked, countermeasures can be implemented to protect likely follow-on targets. Instant awareness is supported by two operational art elements:-

(a) Attack Detection.

(b) Space Surveillance.

Decisive Action

Decisive action is the ability to expand space operations to meet increased demand, sustain space operations in the face of attack, and to retaliate against an adversary's actions in space. Decisive action is supported by the following operational art elements:-

(a) Manoeuvre.

(b) Autonomy.

(c) Training.

(d) Interoperability.

(e) Exploit Others.

(f) Launch on Demand.

(g) Reserve Modes.

Expanding Operations

Operational demands may require space forces to support more users than originally envisioned. An ability to exploit civil or commercial space systems may be vital to provide these capabilities quickly. A launch on demand capability may be equally important to expand space services by either deploying additional or new forces. Regardless of the technique chosen, space forces must be able to satisfy surges in user demand.

Sustaining Operations

Space operators must anticipate attacks on their space forces during times of increased user demand. This will require defensive measures for all space forces. Military space forces should have a survivability advantage since many of the operational art elements, such as, manoeuvre, autonomy, and reserve modes will be features of the systems and should enable these forces to defeat or withstand attacks. Civil commercial assets available will probably be more vulnerable and defensive measures which can "umbrella" these systems from attack should be employed. Possible examples include: providing attack warning, destroying the attacking platform, and intervening with other space assets to confuse or blunt the attack.

Retaliatory Operations

Retaliatory options are needed to ensure that a balance of power can be maintained in space. As space forces become even greater force multipliers, the temptation to deprive an adversary access to space grows. The US currently would suffer the most from losing its space forces so it maintains an ability to retaliate effectively if those forces are attacked. The threat of a decisive US response to space attacks may be sufficient to deter an attack.

Graceful Degradation

Graceful degradation is the ability of space forces to absorb the loss of space assets in a pre-planned manner and extend the time; space services are available to terrestrial forces. It should be a characteristic of both individual space systems and space forces as a whole. The following operational art elements contribute to a graceful degradation capability:-

(a) Interoperability.

(b) Exploit Others.

(c) Data Fusion.

(d) Reserve Modes.

(e) Robustness.

Space Asset Models

Space assets architecture can be constructed for various

contingencies, ranging from benign to hostile scenarios covering limited and wide area as per the battle plan.

Architecting the NCW Models

We can go for either modular approach or create unique space assets and network which are area and mission specific. The former approach is the preferred option, as it will give overall economy, flexibility, better assurance level and simpler logistics. Some of the futuristic Models are discussed in subsequent paragraphs.

Modular

Dual Use : Model A. In this case, all future pay loads including civilian space pay loads should try to be dual use i.e. civil and military applications. These capabilities be further augmented by a supporting military mission, which can be launched on demand. Obviously, this approach would be very cost effective but would require interface with ISRO. This is viable option as ISRO has already declared and invited partnership with the Indian Industries. This would require a new space policy. A representative from the Armed Forces should be included as member in the National Space Commission. This aspect be also examined and added to the report of the recently published PM's Task Force.

Mission Specific: Model B. This methodology would imply purely military missions. There will not be enough redundancy causing mission failures. However, it would enable dedicated architecture for supporting terrestrial battle. It would be on the lines of space Assets Models (SAM) for various military options on contingencies, for air, land, and maritime operations. Some have already been worked out and are contained in the Defence Vision document. It would require correct interface and networking between the three Services whilst developing the projects. Thus there is a necessity of formalising the integrated Space Cell through a sanctioned PE at the earliest.

Mixed Application: Modei C. A holistic examination leads to the necessity of adopting a mixed Model 'C'. To enable this to happen, there is a necessity of an inter-services inter-departmental and ministry interface at various levels. The optimum result in India's case may be achieved by this approach. This would also allow

evolution of many concepts till the time we mature to raise an 'Unified Space Command' whose location could be decided on existing command and control infrastructure built for space satellite command at Bhopal. It would imply following a mixed application approach.

The future projects of building the 'NCW' capabilities through space assets be accordingly shaped and engineered. Again the role of Headquarters IDS becomes primary for developing this 'Networked Approach' to military problems.

India should plan a space college. This could be progressed under the umbrella of the Indian National Defence University (INDU) which is under raising. The location could be Bangalore. This would enable focused studies on impact of space assets on Air, land and maritime warfare capabilities. Focused studies on minimising Network Centric capabilities should be part of this institution.

Conclusion

Space dominance would be essential for effective control of operations in future conflicts-both symmetric and asymmetric. India needs to build capability for theatre level space dominance in the near future which could expand to regional level. Space dominance not only includes the ability to use own space assets but also the ability to deny the use of space to the adversaries. Therefore, for effective space dominance, we not only require robust space assets and corresponding ground infrastructure, but also the counterspace assets like ASAT capability.

Though, India is amongst the elite Space Club with capability to not only design space payloads but also the launch capability, in the recent years China has made fast progress in this field with the help of Russians. China's space programme is directly driven by the PLA with required budgetary support and it is presently progressing at a fast pace and has ambition to compete with the US. The Chinese developments are also beneficial to Pakistan being its strategic ally. Therefore, India too needs to give the required thrust to indigenous developments. For this purpose a consortium of DoS, DRDO, Industry, and Academia is required to be formed which could give impetus to indigenous developments. Till now India's space programme has been mainly driven by the civilian requirements, and now there is need for Defence to take

the lead and steer the consortium through a Tri-Service Space Command under Headquarters IDS based on the Defence Space Vision 2020 crafted by it. Education, training and research and development on space technology must be systematically adopted to raise space warriors. Further, strategic and operational plans for using satellites in next generation warfare must be worked out.

The implementation of a roadmap in the field of communication, navigation and imagery capabilities through space needs to be vigorously pursued. Analysing imagery for change detection and correlation to extract intelligence is a priority area. India also needs to reduce its dependence on GPS through expansion of IRNSS. In case of space based communications, the networks need to be built around the indigenous NMS and adequate security overlay provided.

India also needs to look at the ASAT capabilities being developed by our adversaries and provide protection to Space based assets and their corresponding ground segments. In addition, India also needs to develop ASAT capabilities. Since, we support a ban on weaponisation of space and ASAT weapons, we must develop soft kill technologies like DEWs, Jammers, etc for denying space to adversaries, when required.