SEMINAR REPORT ON

SPACE: FOR NATIONAL SECURITY

12 April 2016

Centre for Land Warfare Studies
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The Centre for Land Warfare Studies (CLAWS), New Delhi, is an autonomous think tank dealing with contemporary issues of national security and conceptual aspects of land warfare, including conventional and sub-conventional conflicts and terrorism. CLAWS conducts research that is futuristic in outlook and policy-oriented in approach.

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SPACE: FOR NATIONAL SECURITY

TABER, MANEKSHAW CENTRE, NEW DELHI

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EXECUTIVE SUMMARY

- Space is the fourth arm of warfare and integrated into military concept of operations. **Global acceptance of militarisation of space** – utilisation by armed forces in support of strategic and tactical operations. (Para 9)

- **National Space Policy.** India needs a specific and doable space policy in reaction to the changing regional and global scenario, for more synergistic actions towards space security and for securing our interests in the domain. It should enunciate the role of various agencies. Articulation of space policy would provide greater coherence of action, more rational resource allocation and act as an international Confidence Building Measure. (Para 16, 17, 18, 19)

- Proliferation of cheaper technology has **increased the number of participants**. There is greater potential for accidents adding to the Space debris. (Para 11)

- **Commercialisation** and business interests play a major role in defining the employability and security, making space contested and competitive. (Para 11)

- India lags advanced nations in **technologies for capability building and national security**. Developing core sectors and technologies should be a national endeavour. (Para 11, 23 (a))

- **Space Control**. Advanced space faring nations seek an assured access to space and denying the freedom of action to the adversary. (Para 10)

- Few space faring nations, including China, are developing **Anti Satellite (ASAT) capabilities**, both destructive and non destructive. Some technologies developed for peaceful applications have inherent ASAT potential. (Para 12, 13)

- Satellite systems, including ground stations and data links, need protection against ASAT attacks to ensure continued availability of services. (Para 14)

- Current **outer space regime** is inadequately equipped to handle the growth of the Earth based weapons and the dual use technologies. Most space faring nations are content with the extant regime and the emphasis has shifted to confidence building measures and non enforceable soft laws. (Para 15, 16)

- **Indian space program**. Absence of a long term acquisition plan has resulted in capacity shortfall towards national security requirements. Dependence on international services is counter-productive. Hence, enhance capability and capacity in space. (Para 20, 21, 22)

- **Launch Capacity**. Sufficient infrastructure upgrade is required to meet national requirements and international commercial opportunities. (Para 22 (d))

- Capacity of ISRO and DRDO needs enhancement. Greater interaction among agencies and end users would optimise development. (Para 23 (b))

- **Smaller satellites** employed in constellations, are being explored globally for innovative commercial and security applications. They provide advantages in terms of costs, weight reduction and development times and can complement larger satellites' missions. (Para 24, 25)

- Developing smaller satellites to augment national space requirements needs to be pursued in collaboration with private industry. (Para 24, 25)
- Dedicated quick launch capability for small satellites could be utilised to develop Launch on Demand capability to augment constellations or replace damaged satellites at short notice for redundancy against ASAT engagements. (Para 25)
- **Industrial base** to support space activities provides economic benefit as also assured availability of components. Private industry's participation mandatory. (Para 23)
- **Defence Space Agency** would control and coordinate defence assets including dedicated launch services for military and would also look after the doctrinal and training aspects. Manning by armed forces' personnel along with domain experts and scientists. Needs promulgation in the National Space Policy. (Para 26)
- Adoption of counterspace abilities best achieved through establishment of a **Joint Space Command.** (Para 27)
- Development of **ASAT capability** that can be demonstrated is a political decision. Along with deterrence value, it would preclude denial of this capability in the future through prejudiced international regime. (Para 28)
- **Space Situational Awareness (SSA)**. Need to enhance SSA capability through infrastructure and international collaboration to protect own assets in space as also for space control. (Para 29)
- Long Term Integrated Roadmap for the Armed Forces with specifics of capabilities and capacities required including interfaces between various agencies and the relevant procedures. (Para 30)
- Focus on building the required **infrastructure** and conducting of requisite **training** of personnel. Initiatives should continue in the absence of ideal organisational structures.(Para 30, 32)

DETAILED REPORT

Introduction

1. Space based assets have become integral to all aspects of national growth and security. They continue to maintain their strategic relevance while their employment in support of military operations continues to grow. Space technology is developing at a rapid pace, revolutionising the domain through smaller satellites and other innovative applications. Technological proliferation has resulted in increased participation in space and its commercialisation. These have resulted in unique novel challenges to space security and the sustainability of the space environment.

2. Indian Space Research Organisation (ISRO) has had a commendable civilian space program with some dual use potential. With the tacit acceptance of use of domain for national security requirements, there is a requirement to work towards optimal capability building and management of resources. Whilst developing capability to support various national aspirations is important, it is equally important to protect these assets from attacks that would either disrupt their operations or destroy them – thereby denying capability. Such an effort would be best achieved through suitable national policy that would lead to establishment of the requisite organisation and infrastructure.

3. With an aim to debate multiple issues related to Space and its exploitation for national security, Centre for Land Warfare Studies conducted a Seminar on 12 April 2016 themed "Space: for National Security". The seminar brought together experts in various fields related to Space, senior veterans and specialist officers from the three services and HQ IDS. The seminar was successful in bringing forth concerns of the various agencies with respect to the current and future deployments in space in support of national security objectives. The seminar was conducted in two sessions, followed by a panel discussion.

- **Session I**: Global Space Capabilities, Policies and Doctrinal Issues
- **Session II**: Space Security: Leveraging Technology
- **Panel Discussion:** Exploiting Space for Military Operations

4. The following issues were presented and debated:

(a) Capabilities of advanced space faring nations and their employment philosophies to meet national security objectives.

(b) Policies followed by these nations to protect their interests in the domain and their global implications.

(c) Technological and Policy options to protect satellites and to ensure safety of operation.

(d) The broad contours of a futuristic National Space Policy.

(e) How are the futuristic technologies and associated applications changing the strategic landscape in space?

(f) The implications of advancing technology on Anti-Satellite capabilities

(g) Requirement of involving other governmental or nongovernmental agencies to establish an integrated industrial base for building capability and capacities in space.

5. The panel discussion focussed on exploiting space for national security and military operations and the internal challenges of the Armed Forces. Owing to the sensitivity of the subject, participation was restricted by invitation only and Chatham House rules were enforced. The issues discussed were:

(a) What is the roadmap/ action plan for optimum asset development to address service centric as well as integrated capability building?

(b) Counterspace capabilities and role of Armed Forces.

(c) What are the doctrinal and organisational imperatives for optimum utilisation of the domain for combat enabling and combat support functions?

(d) How responsive is the current civil-military interface to the services' requirements and are there any changes required? What are the

organisational changes required for better integration and control of the space assets.

(e) The infrastructure requirements and training and HR management for optimal exploitation of space based assets and towards counterspace capabilities.

6. The Keynote address was delivered by Mr Satheesh Reddy, Scientific Advisor to Defence Minister. The panellists who took part in the discussion were:

- Lt Gen GS Katoch, PVSM, AVSM, VSM (Retd), former DG Perspective Planning
- Gp Capt Ajay Lele (Retd), Institute for Defence Studies and Analyses
- Gp Capt Puneet Bhalla, Senior Fellow, Centre for Land Warfare Studies
- Dr Rajeswari Rajagopalan, Senior Fellow, Observer Research Foundation
- Lt Gen Davinder Kumar, PVSM, VSM and Bar (Retd), former Signal Officer in Chief
- Dr. Surendra Pal, Vice Chancellor, Defence Institute of Advanced Technology
- Lt Gen VK Saxena, PVSM, AVSM, VSM(Retd) former DG Army Air Defence
- Mr Narayan Prasad, Co-Founder, Dhruva Aerospace
- Lt Gen Vinod Bhatia, PVSM, AVSM, SM (Retd) Director, CENJOWS
- Lt Col N K Chaudhary Integrated Space Cell, HQ IDS
- Cmde DS Gujral, Principal Director NSO, IHQ, MoD (Navy)
- Col Rupesh Sehgal, Dir Space, IHQ, MoD (Army)

7. The salient observations and corresponding recommendations of the seminar are given in the succeeding paragraphs.

8. Developments in space came about as a result of the Cold War rivalry between the USA and USSR. Against a nuclear backdrop, both nations were in a race to prove their technological superiority and potency of their weapons. National pride was a strong motivation. The first Gulf War saw space being used for military purposes such as communication, intelligence and navigation and their employment for security purposes has continued to increase. Civilian and commercial applications have also seen an upward trend over the years. Today, space based capabilities and applications are key aspect of national prosperity and national security, which as per the contemporary definition includes energy security, food security, water security, so on and so forth. Communication satellites are proving to be conduits of information required for myriad national social, economic and other civil applications. Global Navigation Space Systems (GNSS) are enabling location based services while the timing function provided by the system is being employed by critical infrastructure such as the power networks.

Military Use of Space

9. Space based assets have become pivotal to strategic security and play an essential role in conduct of 21st century military operations. They are being employed by armed forces for a variety of functions including military surveillance and reconnaissance, to provide widespread communication, meteorological inputs, global positioning and precision weapon guidance and targeting. Lately space based communication has been utilised for remotely controlling operations of unmanned aerial vehicles (UAVs). Leading space faring nations of the world have described space as the fourth arm of warfare and are integrating space based assets in their concept of operations. There is a global acceptance of militarisation of space – that these assets would be utilised by armed forces in support of strategic and tactical operations. Use of these services and applications is also beneficial as it allows better identification of targets and provides better accuracy to smart weapons, thereby reducing the probability of collateral damage.

10. **Space Control**. Advanced space faring nations are heavily dependent on space and seek an assured access to the domain at all times. They also realise the importance of superiority and supremacy in space. Overtly or covertly, they seek dominance and space control - the ability to maintain degree of freedom of action for the friendly forces to exploit the domain and deny the same to the adversary. Control of space will become as important as that of the land, air and sea.

11. Developing countries are beginning to appreciate the need of space for their economic and social development and are willing to invest in it. Also, the huge number of space based applications is leading to an increased interest in the domain. Emerging technologies such as miniaturisation, nanotechnology and additive manufacturing are revolutionising the domain, bringing in novel capabilities and applications. Advancing technology that is also cheaper has led to its proliferation and most mid level countries now have the potential to develop their own space programme. The commercial potential of the domain has attracted private players who are investing in technologies and services in a big way. Technology advancement is allowing smaller teams or individuals to invest in the sector and this is being referred to as NewSpace. For example, there are 21 different launch vehicles of less than 1000 kilogram payload capability under development globally, most of them by private entities, which would challenge the business of PSLV in the future. Major space faring nations are resorting or reverting to dual use satellites for a large part of the security requirements. Commercialisation and business interests would play a major role in defining the space employability and security in the years to come. With more than 60 players in outer space and the number continues to increase, space is becoming more congested. The race for the limited orbital space, radio frequency spectrum and a larger share of the market is making the domain more contested and competitive. Increasing number of actors also means greater potential for accidents that could add to the already critical level of Space debris.

Space Security

12. Satellites are vulnerable to a number of natural and manmade threats. With growing dependence on space for national security, the space

systems also become lucrative targets. Satellite operations can be targeted through different means to disrupt, degrade or destroy.

(a) **Direct Ascent Kinetic Energy Anti-Satellite (KE-ASAT) weapons**. KE ASATs evolved as a progression from the Ballistic Missile Defense (BMD). China has conducted a number of tests, ostensibly for its ballistic missile program, which have ASAT potential with capability to target even the higher Earth orbits, where most navigation, communication and Early Warning satellites reside.

(b) **Co-orbital ASAT**. Cheap micro-satellites placed into orbit could be ordered to either collide with a critical orbiting satellite or their proximity could be used for electronic warfare measures. Small manoeuvrable satellites that can move around other satellites to inspect or to service them can be used for such attacks. China has displayed the ability to make satellites manoeuvre and rendezvous in close proximity and even capturing another satellite with the aid of mechanical arms. Again, the apparent purpose is to develop capabilities for its manned and future space station programs but these could equally be employed for ASAT purposes.

(c) **Pellet Cloud Attack**. Such attacks would destabilise the whole space environment and thus would only be resorted to by rogue nations or non state actors to gain an asymmetric advantage against superior powers with high dependence on space.

(d) **Directed Energy Weapons**. These could be used to target the satellite sensors or to damage or destroy the satellite itself. China has been repeatedly accused of having employed such weapons against satellites, temporarily blinding them.

(e) Attack using **Electro Magnetic Pulse** that would damage or destroy the satellite electronics leading to its partial or complete failure.

(f) **Electronic Attack on Satellite Links**. – Satellite links could be

jammed or used to take control of satellites. They could even be infiltrated to gather critical information. GPS based GNSS receivers are prone to spoofing and jamming.

(g) **Information Warfare (Cyber) attack**. Cyber attacks could be used to disrupt the system or obtain critical information.

(h) **Attacks on critical ground stations** could be carried out to deny control facilities to critical satellites.

(j) **Space Debris**. The rising space debris is a bigger threat to space operations than the ASAT technologies being developed because it is more persistent and also more prevalent.

13. Since the Chinese Anti Satellite (ASAT) test of 2007, ASAT capabilities are being developed (with some of these having been demonstrated too) by some space faring nations such as US, China and Russia. These include both hard kill (damage or destruction of the satellite) and soft kill (temporary disruption of satellite functionality) options. Additionally, most of the technologies being developed for peaceful applications in the domain have an inherent ASAT potential. Such capabilities in the hands of rogue nations or non state actors could be extremely dangerous.

14. In face of the threats to satellite systems, countries that are dependent on space can no longer delay developing means to deter & defend against hostile acts in, through & from space to ensure continued availability of services. Satellites need to be protected against the potential ASAT attacks such as EMP and radiation. India should continue with its efforts in the global arena to prevent weaponisation of space. At the same time it must invest in securing its space systems.

15. **Space Regime**. There is only one treaty mechanism, the Outer Space Treaty of 1967, which addresses the issue of placement of weapons in space and even that only addresses issues related to Weapons of Mass Destruction. The regime is inadequately equipped to handle the growth of the Earth based weapons and the dual use technologies. The concept of space security is still at an embryonic level and could have varied interpretations

depending on a country's national interest and its technological prowess in the domain. This has lead to differing views among nations on the elements of space security. In this uncertain situation, most space faring nations with diverse capabilities are content with the extant regime. There are efforts by Europe, Russia and China in the field of international peace and security but each has its own limitations. The emphasis now is on confidence building measures and soft laws that highlight the intent rather than possession. This might prove insufficient to control the development and deployment of ASAT capabilities.

16. **International Cooperation**. Greater use of space would entail more regional and international cooperation. Geo-political imperatives which are terrestrial in nature impact international cooperation in space. While desirable, there is a need to define international rules of engagement to prevent proliferation of technology and capability to rogue nations and objectionable non state actors.

Space Policy

17. Space policies are essentially viewed as a medium to highlight the progress and present a roadmap for the future. There are issues which are related to sustainability, stability and free access to space, requiring the country's space policy to have certain elements of foreign policy, defence policy, industry's interests and science policy. The declared US Space Policy explicitly seeks complete freedom of action in space to fulfil its national security and foreign policy interests. They aim to achieve full spectrum dominance in space so that their access to the domain cannot be restricted. Russia's space policy is essentially a subset of their strategic doctrine with their Ministry of Defence being responsible for various space activities. China has come out with three White Papers on space, which detail and justify the activities done in the past and the plans for the future. There is no mention of the ASAT capabilities. In Europe, there is a document which deals with space security and other related aspects. This document essentially talks of science innovation, industry and other related issues. Malaysia, a nascent space farer has limited interests in the domain and this is evident in their policy documents. While nations seek to be more

proactive and futuristic in their policies, except for the US, most other national documents emphasise a civilian mandate.

18. India does not have a declared space policy but it has forever emphasised the use of space for peaceful purposes and for socio-economic applications. The same has been India's stand at various international forums and it has been critical of other nations' efforts at militarising space and testing anti-satellite capabilities. In recent years the competition among major space powers has escalated and along with the advanced military space programmes in the region, countries are also acquiring ASAT capabilities that are inherently destabilising in nature. The changing regional and global scenario demands a more proactive position and certain policy characteristics which are more security-oriented.

19. The need of the hour is for synergistic actions at national, strategic and tactical levels towards furthering space security and to ensure continued availability of own space based applications. The absence of a National Space Policy has been an impediment in defining a viable process and institutional framework for securing our interests in the domain. It is time the formulation of a specific and doable policy gets greater political direction. Such a policy should clearly enunciate the agencies implementing it, as also those that would spearhead the Research and Development. Articulation of space policy is also very important because it brings about greater clarity and greater coherence in what our objectives are and how we need to pursue our space policy. The greater clarity would allow more rational resource allocation, both in terms of finance and human resources. It would also give impetus to building and operationalising capability needed to deter and defend against hostile acts in, through and from space. A declared policy will also act as a great international Confidence Building Measure.

Indian Space Program

20. Indian Space Research Organisation (ISRO) has remained the primary facilitator of space based assets in India. It has a number of achievements to its credit – the consistency of its Polar Satellite Launch Vehicle (PSLV) and its missions to the Moon (Chandrayan) and Mars

(Mission on Mars). While some of the assets have been deployed for security purposes and there are also dual use platforms, the space program has primarily been for socio economic development. ISRO has responded positively to national security requirements by building capability when demanded. However, these have mainly been in response to specific situations or threats and not as part of a long term plan. For example, the TES was built after the Kargil War and the RISAT satellites were procured/ built after the 26/11 Mumbai attack. Such one off effort has provided immediate capability but in the absence of successive deployments as part of a long term plan, it has suffered from a capacity shortfall towards national security requirements.

21. In the absence of a supporting industrial infrastructure, ISRO continues to be dependent on imported components to support its missions. Therefore, it is wary of including defence applications and cooperation with defence agencies into its mandate. It wants to continue building and launching satellites for civilian purpose that would have dual application for military. Its GAGAN (GPS Aided Geo Augmented Navigation) system provides an accuracy of less than 2 metres with 95 percent reliability and the system can be utilised by the armed forces for navigation purposes. Although meant primarily for civil aviation purposes, the system can be innovatively utilised for security purposes. ISRO's seven satellite IRNSS (Indian Regional Navigation Satellite System) should be complete with the last launch on 28 April 2016. Already, the system has provided much better positional accuracies than the GPS and the timing accuracy offered is 20 nanoseconds. The system has encryption facility for restricted users. With the addition of four more satellites to the constellation in the future, more areas of interest will also be covered. These satellites have been provided hardening to make them suitable for supporting India's strategic launch capabilities. Efforts are on to make the system interoperable with other space based global navigation systems such as GPS and GLONASS.

22. Despite these successes, when compared to other advanced nations and China, we lag in terms of technologies which they have developed in space for the defence and security of the nation. With the armed forces upgrading their arsenal with platforms and technology that are heavily

dependent on space for their effectiveness, these assets would be the key enablers in all our future operational and war fighting planning. A major limitation is inadequate number of satellites in space to meet the national requirements. Some of the shortcomings are:

(a) **Intelligence, Surveillance and Reconnaissance**. Satellites are required to provide imagery of critical areas to the forces in varied resolutions and this data is to be fused to obtain a comprehensive picture. The area of interest for the forces, unlike that of civilian applications, is across the borders. The Earth Observation satellites orbiting around the poles do not provide optimum coverage of the desired areas of the adversary in the North. The time between revisit over the same is area is around four days and this is grossly inadequate, especially during crisis situations. Consequently, even though India boasts of the largest constellation of imagery satellites in the world, the armed forces have to resort to purchase of imagery to meet their requirements. These shortcomings were brought to the fore during the Uttarakhand disaster and during the Chinese standoffs.

(b) **Communication**. Due to limited capacity, critical national services are dependent on leased transponders on foreign satellites for communication and computer networking. The availability of these services is not assured during times of hostilities or crisis. Developing capability to exploit higher frequencies for space communication would provide more capacity and reduce reliance on foreign satellites. This would save money to the exchequer and provide more resiliencies.

(c) **Electronic Intelligence (ELINT)**. India has also developed the ELINT capability for the armed forces but we need to build this capability in space. It requires better formation flying and a better accuracy of the signal quality. China has 3 such constellations.

(d) **Launch Vehicle**. The limited launch capacity of ISRO is a technological bottleneck. Although the PSLV is a proven workhorse,

the annual launch rate of four to five (as against China's 15 to 20 launches per year) is insufficient to meet the national requirements. The global space industry is expected to be worth $300 billion. India's share in this is less than 3 percent, mainly because of the limited launch capacity. The GSLV's cryogenic engine has been successful but has to prove its reliability and GSLV-III is still under development. Against India's 2.5 launchers, China is developing more than eight types of Launch Vehicles to support various classes of satellites. There are more than 21 different launch vehicles being developed globally for payloads less than 1000 kgs and these would challenge the PSLV in the future.

23. Some of the recommended steps for harnessing the nation's technological prowess towards space capability and security are:

(a) There has to be national effort in developing core sectors and technologies. Futuristic technologies such as nanotechnology, additive manufacturing and others hold a lot of cross domain potential and require national investment. These developments should be part of the national technology development roadmap.

(b) Augmenting capabilities calls for increased capacity of our R&D agencies such as ISRO and DRDO, building upon their core capability. There has to be greater interaction between these agencies as well as users to eliminate duplications and optimise development.

(c) India needs to develop an industrial base to support space activities. Importing components for the space programme has only benefited other nations economically. The dependence has been a major reason for ISRO refraining from overtly associating itself with military agenda as such components come with riders and might not be available in case of hostilities.

(d) Private industry's participation in developing space segment and user equipment, and their maintenance should be encouraged. For example, there is a requirement of more than 1 lakh IRNSS receivers for defence applications that could be fulfilled by private companies.

Handing over of the PSLV operations to the private sector is a step in the right direction.

(e) There is an urgent requirement to increase launch rates and to develop dedicated launch capability for micro/mini satellites. Such a capability can also be utilised to develop Launch on Demand capability to augment constellations or replace damaged satellites at short notice.

Small Satellites: Application for National Security

24. Miniaturisation of technologies and ever improving efficiency has enabled development of small satellites that are also very capable. A CartoSat series satellite that weighs around 700 kilograms provides 0.7m pan and 2m multi-spectral resolution. A SkySat satellite, weighing just 125 Kg satellite is capable of 1.1m pan visual and 2m multi-spectral visual along with HD video. Besides the weight reduction, cost benefits also accrue from using a smaller logistical trail and human resource involvement. Further, these satellites use utilise Commercial off the Shelf (COTS) components that in recent times have been successfully tested in orbit with NASA even releasing a list of COTS components being successfully used in space. Current capabilities however cannot equal those of larger satellites and smaller satellites would complement rather than replace the larger satellites in orbit. Smaller satellites are best employed in constellations and with better capabilities, such constellations are being explored globally for both commercial and security applications. Some of the applications and the advantages they offer are:

(a) A constellation of such satellites you can cover large swaths of areas with better resolutions and refresh rates. Small satellites can be built at much cheaper costs, so that the cost of a constellation would be lesser than the single large satellite that it seeks to replace.

(b) Communication constellations could wirelessly relay data from terrestrial sensor networks – ground or UAV based – in real time for varied applications.

(c) Small satellites have also been employed by the French and the Chinese for gathering Electronic Intelligence (ELINT) on enemy radar systems. These have bearing on tactical employment of forces to avoid enemy radar coverage.

(d) Their employment for Automatic Identification of Ships (AIS) is already underway and this could assist in coastal security as part of a larger security network.

(e) A modular concept would allow the satellite bus to be tailored to specific roles at short notice, thereby bringing down time to launch. The reduced timelines in turn would enable Launch on Demand (LoD) capability for augmentation or reconstitution of satellite constellations.

(f) Small satellites have proven ideal test beds for future technologies.

(g) Larger numbers in constellations provide redundancy against ASAT engagements.

25. There are many more missions that this class of satellites can be employed for, based on ingenuity. Their lifespan is an important consideration for their employment and most contemporary small satellites have an operational life of between two to five years.

26. **Defence Space Agency**. Harmonising national space capability to further military and commercial interest needs to become critical element of current national strategy. ISRO has a civilian mandate and there is a requirement to establish a lateral organisation to look after the national security requirements. The existing structure of having an Integrated Space Cell & respective Service Space Cells is inadequate and favours compartmentalised approach. The Integrated Space Cell is mainly an interface with various agencies for planned procurement. There is a requirement to graduate to a more inclusive institutional structure that would have much more coherent approach towards how we maximize our options in the area of military and space security policy. Such an organisation would control and coordinate defence assets including dedicated launch services

for military only satellites, for which appropriate infrastructure would have to be developed. Additionally, it would look after the doctrinal and training aspects and also pursue technology advancements and future requirements. A central point of responsibility and authority would better help in planning & coordination of national assets in ensuring national security. Manned by personnel of the three Services along with domain experts and scientists, it would also enable the Armed Forces to play a more active role in ensuring security of the domain. Its charter should include coordination with R&D agencies such as ISRO and DRDO and also with the operational agencies such as NTRO with an aim to look at the requirements of Space holistically. Such an umbrella organisation needs to be promulgated in the National Space Policy.

27. **Space Command**. In an increasingly hostile environment, there is a need to adopt offensive counterspace operations to deny the faculties to the adversary when needed. Services are the correct agencies to shoulder the responsibility of space based applications that would support both offensive and defensive operations. Whilst the DSA is suited for building the military space capability, implementation of space security measures and national space security policy would be best achieved through the establishment of a Joint Space Command that would function with active support from other stake holders such as ISRO, DRDO, NTRO etc. Setting up of space command should not be prejudicial to the responsibilities of each service towards their current or futuristic concept of operations and service specific space requirements which need to be built and integrated towards each users' effectiveness or its force enhancements.

28. **ASAT Capability**. Development and demonstration of ASAT capability is a political decision. One reason for demonstrating this competence is the lesson drawn from the NPT regime, wherein the Nuclear Powers came together to deny the legality of nuclear capability to other nations. A similar template could be applied to the ASAT technologies in the future. A more compelling argument is that of deterrence – that the capability should be demonstrated to deter other nations from undertaking any misadventure in space.

29. **Space Situational Awareness**. (SSA) capability is required to protect own assets in space as also for space control. India is still in a very nascent stage in this arena. It should enhance its capability as also enhance international partnerships for sharing of SSA data.

Armed Forces

30. The Armed Forces need to identify a long term integrated roadmap for developing space based capabilities as well as capacities that would ideally support their operational doctrines and increase their effectiveness. This should include the specifics in terms types of payload, the kind of technology, the numbers required of each type, their overlaps and the required redundancies. Payloads for Signal Intelligence and multispectral and hyper-spectral imaging should be emphasised upon. They need to focus on building the required infrastructure and conducting of requisite training of personnel. Modular spacecraft structures, Launch on Demand and Mobile Launch capabilities must be explored to put micro or nano-satellites with specific payloads into orbit. At the same time there is a requirement to build secure ground stations and data links. These initiatives should not be inhibited by the absence of ideal organisational structures, which would take time to evolve.

31. During the Uttarakhand disaster, there was a perceptible delay in getting relevant data imagery of the affected area. Interfaces between various agencies and the relevant procedures need to be streamlined so that the desired services are obtained in time.

32. **Training**. Creation, operationalisation and maintenance of space assets needs sophisticated high end technological skills and expertise which we lack as of today. Users of space have to have background knowledge, comprehensive understanding of space tools as well as capabilities that these render which would include operational planning, execution and assessment. There is a requirement for a tiered approach to training – providing appropriate training at the apex, middle level and lower level of the environment. The current training emphasis is on imagery interpretation and communication. There is a need to graduate to courses that emphasise

on technology and military operations to create pool of manpower that is capable of using space based tools with the warfighting functions. Such courses would include those conducted in-house, at civilian training institutes in the country and even specialised courses at foreign institutes. Retired scientists from ISRO could be employed for training of military personnel. This would contribute to better understanding among the scientific community and the men in uniform and help the cross pollination of thought process. Knowledge enhancement should be supplemented through research at think tanks and conferences/ seminars/ panel discussions and workshops.