SPACE BASED JOINT C5ISR CAPABILITY BUILDING

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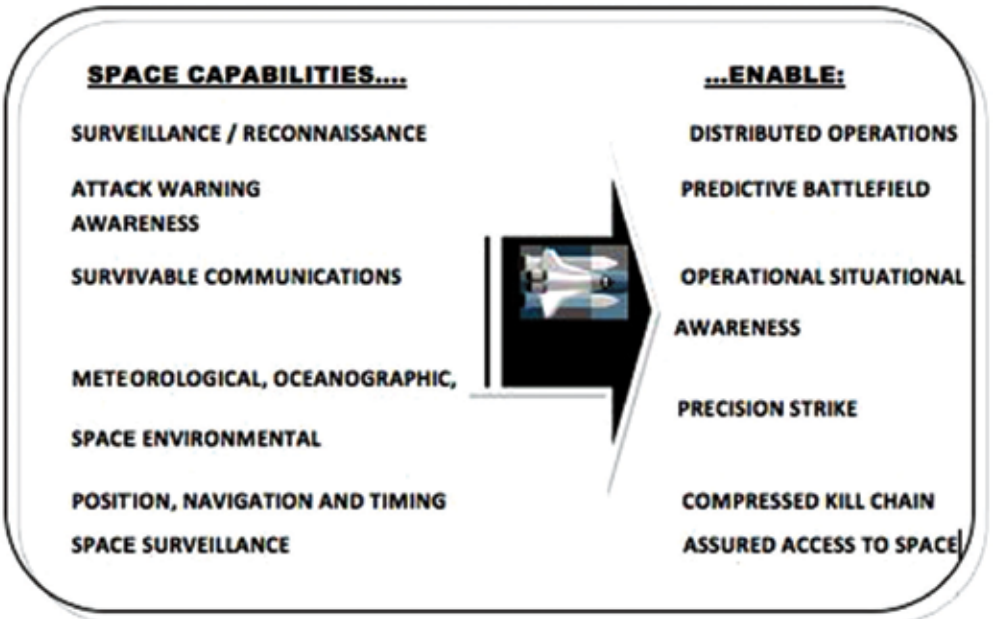
"Future global rivalries would keep nations in an attritional posture in a wide range of fields…i.e. economical, technical knowledge, scientific breakthroughs and energy rivalries in a protracted infinite time scale. The concept of wars would become outdated to be replaced by spontaneous short and decisive engagements. However, netwars may create a new dimension of warfare in the 21st century requiring combined Space, air and specialized ground operations in a protracted time frame."

***Rig Veda 1200* – 900 BC**

Joint Force Capabilities in Future Conflicts

The future wars will be fought in all seven domains - land, air, sea, sub-surface, space, cyber and cognitive domain in a network-enabled environment. The key determinant of success in future conflicts across the entire spectrum will be astute leadership empowered by information superiority, decision dominance and a compressed kill chain under disruptive conditions. This would result in higher favourable exchange ratios enabled by shortened OODA loop. The net desired outcome will be victory at least cost and minimum time by dominating the key factors of time, space, force and information. The joy of its outcome will be to get the right information, at the right time, at the right place to the right person without information overload through an integrated C5ISR(Command, Control, Computers, Communications, Combat Systems, Intelligence, Surveillance and Reconnaissance). Accordingly, the four core decisive joint force capabilities in future battle space will be - Information Dominance (Information), Shared Situational Awareness (Space), Decision Dominance (Time) and Joint Force Synchronisation (Force). In short, we need a knowledge-based; decision-oriented, networked, joint force space enabled C5ISR capability.

The exploitation of space-based capabilities and generation of space assets have transformed contemporary warfare with very significant improvements in situational awareness, distributed operations, predicted battle space awareness, and precision strikes in a network-enabled joint force environment. The resultant kill chain of *"find, fix, track, target, engage and assess,"* has been markedly reduced. Space systems have thus graduated from their role of being *"force enhancers"* to assets that are *"force enablers"*.



Strategic Military Surprise - An Indian Faultline

Military strategic surprise has repeatedly haunted the Indian security apparatus since independence due to a lack of political, military, and technological fusion. Historically, a strategic surprise is contextual; it is conditioned by the particular problem and its existential nature and the culture, time, weakness, geography and desperation of the protagonist. Nevertheless,the lack of strategic foresight and passivity in the erstwhile Indian context led Pakistan and China to repeatedly exploit the fault lines and off balance India by strategic military surprise. The key issue remained the lack of C5ISR capability, parochial single service outlook and lack of strategic envisioning in the absence of a national security strategy. The key challenge for the military thus remains '*pre-empting rather than reacting* 'to restore an adverse situation and *'denial rather than defence'* of its national territory. From a military point of view, military surprise creates spatial, temporal, moral and psychological dislocation

and responses thereto prove costlier besides national embarrassment. A repeated lesson repeatedly lost sight. The saviour has always been the prowess of our junior leadership and regimental system which too is being tinkered with in recent times by those having little idea of matters military.

The prevailing fragile situation on our disputed borders mandates an integrated C5ISR architecture to generate superior situational awareness leading to predictive battlespace dominance as part of our joint force capability. The recent joint force structures of Space, Cyber and Special Forces along with the raising of the Defence Space Agency (DSA), discussion on impending tri-service integrated theatre commands,and GoI space reforms beyond ISRO to establish the Indian Space Association (ISpA), Indian National Space Promotion and Authorization Centre (IN-SPACe), New Space India Limited (NSIL)are earnest steps in the right direction. Yet the effort remains sub optimal in empowering the joint force C5ISR capability holistically, otherwise marred by service silos and gaps in civil-military fusion.

Indian Joint C5ISR Capability Construct and Challenges

Joint C5ISR capability is a potent weapon as a tool to achieve battlespace asymmetry. This capability would not only pre-empt and deter an adversary but would also assist to generate favourable combat ratios in time and space, enabled by superior shared situational awareness and joint precision engagements. The desired outcome will be effective credible deterrence and force multiplication effect in battle. While some progress has been made in systems and data interoperability, the defence forces still lack a common joint C5ISR architecture that efficiently operates across all domains, multiple platforms and sensors seamlessly. The present system is also more focused on the need to know rather than the need to share. The existing challenges and inhibitors are multi-parentage, lack of integration, accountability and duplicity in the system. Besides, there is the challenge of existing platform-

centric focus, and desired net-centric synergy, along with stimulus to processing, exploitation, and dissemination methods. These challenges have resulted in a sub-optimal C5ISR grid with limited capability, capacity, coverage, connectivity and ability to overcome constraints of weather and terrain. Thus, the need is for enhanced richness, reach and interaction in our Joint C5ISR architecture both along the LC (Line of Control) and LAC (Line of Actual Control).Thus, it is important to understand the C5ISR fundamentals and generate a focused approach to its capability manifestation.

Key Fundamentals Joint C5ISR

The object of Joint C5ISR is to champion the concept of “need to share” over the concept of “read to know”. Its key imperatives thus entail:-

- C5ISR is a General Staff function that is command-led and staff executed. Thus, C5ISR must be led, not managed.
- C5ISR goal must adapt to address problem-centric requirements and not a resource-centric approach. The ultimate aim is sensors irrespective of organisation, shooters independent of platforms and decision-makers irrespective of geographical locations.
- Joint C5ISR must dilute inter-service lines and shun a compartmentalised rigid approach. C5ISR must be joint theatre specific in keeping with the terrain, weather and operational needs specific to a theatre requirement.
- ISR (Intelligence, Surveillance and Reconnaissance) must be addressed holistically with a single parentage and not the present culture of developing `I’, the `S’ and the `R’ in compartments with little synergy. The need is to transform from a loose confederation of separate specialists and

reporting chains into an integrated joint service enterprise with single parentage.

- The heart of the C5ISR or its jugular vein is the communication or networks. Pervasive and persistent C5ISR is only possible if there is pervasive and persistent communication with seamless interoperability.
- C5ISR will only be empowered if we shift from a platform-centric approach culture to a network-centric approach. The outcome will be a factor of networking sensors, decision-makers and shooters.

Joint C5ISR Capability Development Focus

The focus for an integrated and joint forceC5ISR capability manifestation must hone on the following:-

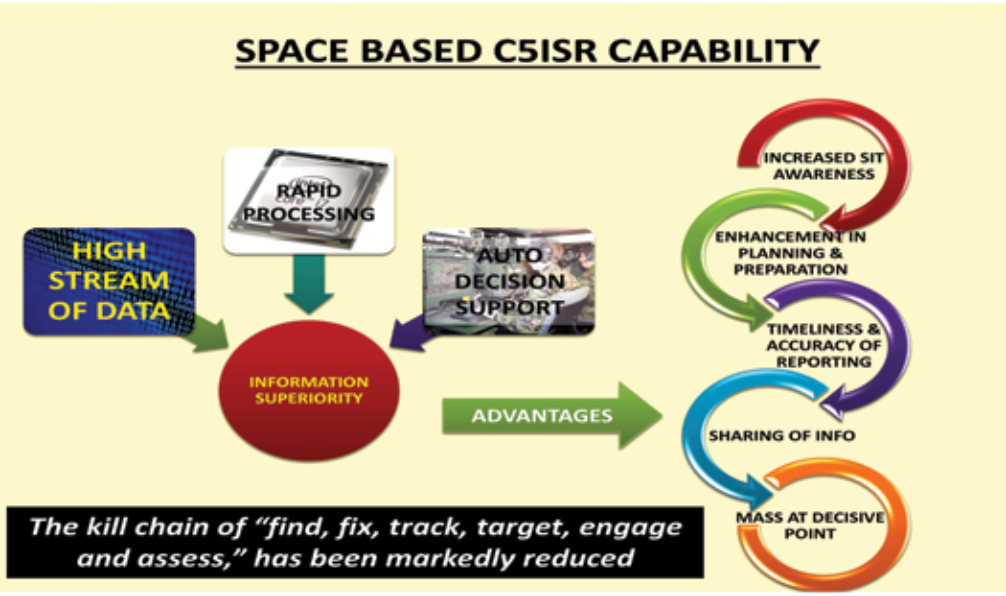
- **Critical Capability**. Persistent and pervasive, all-weather, all-terrain layered surveillance and fused intelligence for force multiplication effect at the cutting edge.
- **Capability Thrust**. Achieve seamless and secure information superiority across the battle space dovetailing state of the art technology with zero tolerance time.
- **Capability Mix Solutions**. A continuous multi-tiered, multi-domain, multi-intelligence and time-sensitive C5ISR grid.
- **Layered C5ISR and Networks.** Persistent, flexible, inter operable, affordable and survivable.
- **A Geo fused C5ISR data cloud.** With standard protocols at the apex level and data fusion centres for relevant needs at the lower level.

- **Multi-layered, secure, dynamic and robust communication backbone with terminal connectivity and plug n play concept** with a mix of both top-down and bottom-up approaches for Joint Service C5ISR optimization.
- **Human Capital.** Network agile, mission-orientedand focused C5ISR process mandates matching human resources, training policies and empowered structures. Above all, it requires a culture of jointness and tri-service synergy.

Space a Critical Enabler of Joint Force C5ISR Capability Generation

Space-based capability is an increasingly important enabler of the economic and military power of a nation. In the 21st century, Space power has evolved into a separate medium of warfare transforming from a combat support role to a warfighting domain. Thus, from the concept of '*Space Support'*, nations have graduated to the concept of *'Space Power'*.

India has shown progressive growth in its space capabilities both for civil and military applications to be a global space power. The concept of Pushpaka Vimanamin Indian mythology is akin to spacecraft and inter-planet astras or Space-based weapons, where guidance was through the mind of the commander. Interestingly, while the rocket was invented by the Chinese in 972 AD, it was the Indians (Tipu Sultan) who used it devastatingly for the first time against the British in the battle of Guntur in 1792. Since then, techno-military capabilities in Space have emerged as a major force multiplier and Space assets have become critically important in the security calculus of nations. Thus, while controlling the high ground had been a rule of warfare ever since the dawn of civilisation, the military advantages of this final frontier have become increasingly pronounced particularly in the field of C5ISR architecture.



Planning Imperatives for C5ISR Space Segment

Space-based sensors perform ISR that contribute to battle space awareness in all domains ranging from electro-optical, IR, SAR, and Hyperspectral to ELINT/COMINT, providing an opportunity to address a wide EM spectrum and provide inputs unhindered by weather, ambient conditions or operations on the ground. Satellite Constellations for C5ISR need to be based on a layered architecture with layers for persistent surveillance, broad area coverage and a high-resolution layer. The design characteristics of these layers need to ensure capability for both tactical and strategic C5ISR functions. Further, the integration should not be limited to just Space-based C5ISR systems but also corresponding air and surface-based systems because pursuing independent C5ISR capabilities would amount to defeating the basic concept.

The planning of this C5ISR Space segment should include:-

- Sub metric resolution for the High-Resolution layer and viable military resolutions for the broad area coverage and persistent surveillance layers.

- Varied local times of satellite passes.
- Inclined orbits for better coverage at certain latitudes.
- Number of constellations to ensure revisit capability to meet operational imperatives.
- Multi-sensor and joint service satellites to economise on numbers.
- Use of small satellite constellations to build in redundancy against adversary's counter-space operations.
- Develop a quick launch capability as part of the operationally responsive strategy with an aim to Launch on Demand (LoD) for critical areas in emergencies.

Space Based C5ISR Matrix

Space capabilities span all six warfighting functions, yet the most critical capability generation remains its C5ISR force multiplication effect. Its holistic capability generation matrix must ensure the mantra of - *"See the Battle space with Clarity, Communicate with Certainty, Navigate with Accuracy, Operate with Assurance, Acquire with Agility and Strike with Precision,".* These capabilities must manifest as under:-

- **Space Enabled Command and Control.**
  - Robust SATCOM and Space-Based ISR for full situational awareness of own forces and assets to facilitate distributed collaboration and planning among geographically dispersed elements.
  - Secure and Reliable wide-area SATCOM coverage for enabling battlefield commanders to exercise command over widely dispersed combat elements.

- **Space Based ISR Capability**.
  - Space platforms with EO / IR / SAR / hyperspectral / MTI surveillance and coverage between unsecured areas of responsibility, to give an unprecedented view of the battlefield. Generate ELINT, Multi/Hyperspectral Imagery and Dark Period Detection capability.
  - Develop Persistent surveillance, sub metric (0.1m) resolution, revisit every four hours, all-weather capability and enhanced repeat passes at varied timings. Develop strip instead of spot imaging.
  - Attain near real-time data dissemination with a demand to the delivery cycle of not more than four hours. A data relay system based on Geostationary satellites for quick transmission of acquired data from satellites to the ground earth stations with requisite bandwidth.
  - Operationally Responsive Space with enhanced focus on Launch on Demand(LOD) concept to supplement the present Launch on Schedule concept. Build Stockpile for short notice LOD to suit the operational environment.
  - Manning and Training – Develop Domain Specialisation with a mix of uniformed and civil specialists.
  - Need for high-resolution geo synchronous surveillance satellite for northern borders. It is critical to review the present orbital path and inclination for an optimised look in capability.
  - Move from service-specific satellites to Joint Military Satellites with dynamic sharing. Develop oceanic reconnaissance capability to meet the expanding area of interest and maritime reach.

- Develop Cluster of Satellite Capability as under:-

Satellite Class	Constellation Size	Capability per year	Remarks
ELINT cluster in one launch (300-400 kg each)	3 clusters of 3 satellites each	1 cluster of 3 satellites	Critical requirement – could be mounted with other payloads
EO / SAR EO-500 kg, SAR-1500 kg	12 satellites (6 SAR, 6 EO)	4 EO / SAR satellites	Critical for all-weather capability
LEO small satellites constellation (100-150 kg each)	24 small satellites	8 satellites	Complements dedicated ISR satellites

- **Manoeuvrability.**
  - Interoperable PNT system for precision timing and manoeuvre through threat sensor coverage gaps.
  - Near Space Platform ISR capabilities working in conjunction with integral UAVs to provide a virtual covering force to the operational commander.
  - Using Space SIGINT, ELINT and precision fire power with a manoeuvre to create a virtual high-speed lane through the battlefield.

- **Protection.**
  - Space assets to provide early detection of battlefield events, such as missile and rocket launches.
  - Tactical Space Effects to generate the form of spoofing or deceiving adversary intelligence-gathering satellites, denying communication access, disrupting or destroying adversary ground segment nodes.
  - Denying adversaries, the ability to use Space to

command assets and conduct ISR activities to protect information and decision-making superiority. This would include defensive and offensive space-based capability.

- Protection against cyber measures.

- **Precision Engagement.**
  - Future Space weapons capable of delivering precision attacks anywhere on the battlefield at short notice can be used to destroy hardened targets or even to create disruptive effects such as disabling urban power and information infrastructure grids.
  - Near Space capabilities to allow future combat systems to target adversaries deep into the battlefield. Potential targets can be engaged with conventional systems or battlefield lasers that may use the near Space platform as a repeater to redirect laser shots over the horizon.

Approach to Space Based C5ISR Capability Generation

Space is now the eyes, ears and voice of the modern military commander. The sovereignty and security of the nation will rest on the fact, of how it exercises Space control over the entire battle space. Future military Space operations must be treated with the same "developed-for-war" approach that today is applied to operations to joint force application. Space systems must be developed with readiness, sustainability, modernisation, and force structure in mind. Towards this end, an "Integrated Tri-Service Space Command" including functions of ballistic missile defence to meet the growing need of controlling cum exploiting Space assets is imperative. This structure should evolve Space strategies and "Joint Space Doctrine for Space Domination" that logically ties Space power theory, policy, and Space strategy together

and most importantly in a synergetic and joint operating environment.

The time has come to think about a focused institutionalised and time-stipulated approach to generating Space enabled military capabilities so that becoming a 'Space Power' does not remain a mere cliché. The Indian Armed Forces must, therefore:-

- Leverage Space operations and Space systems in all military operations with a focus on force enhancement and defensive Space control.
- Leverage current Space-based capabilities and maximize potential future Space activities.
- Articulate requirements to ensure fielded capabilities meet the needs of the Armed Forces.
- Institutionalise and train "Space Warriors" at the leadership and execution level.
- Organisational structures to exert influence in the national security Space community to achieve its vision.

The uppermost need is to integrate the intra and inter-service C5ISR capabilities. This would apply equally to *"Headware"* - doctrines, skills, training, people and processes; *"Software"* - GIS, data, automation and clouds; and *"Hardware"* - equipment, communication and infrastructure. A Joint C5ISR Philosophy essentially enabled by Space assets must be evolved to harness shared situational awareness blurring intra and inter-service compartments. The ownership must be taken by the newly founded Department of Military Affairs under the new CDS for a time-sensitive implementation. It should include the *'Joint C5ISR Doctrine'*, as an overarching framework, common data formats and data dictionary, common GIS with geo-referenced data, common coordinated digital maps and software, standard protocols, policies and procedures, as also joint encryption system moving towards quantum.

There is also a need for generating both threat-based theatre-specific *'joint problem statements'* by end users and simultaneously *'space technology capability demonstrators'* by space organisations, scientists and Private Industry as the drivers for C5ISR procurement. The requirement and desired capabilities must be sensitive to the operational environment viz weather, altitude, terrain and counter capabilities of the adversary. These must include surveillance challenges of border management, monitoring of infiltration, transgressions and intrusions. Additionally, they must forewarn any infrastructure development including depth areas leading to future capabilities, monitoring border training areas for a coherent picture of adversary's tactics, intentions and mobilisation plans, and shaping the battle space for Intelligence Preparation of Battlefield. Each theatre and sector must thus generate operational problem statements to be addressed by a focused and time-sensitive C5ISR capability development. Simultaneously while the space industry finds indigenous technological solutions to the above, they must be more proactive and invest in space R&D for next-generation military or dual-use technologies and space-based disruptive technologies to empower joint warfighters of the future.

The power of dual-use technology in Space and civil-military fusion for C5ISR must be harnessed to optimise national capabilities. The boundaries that separate civil and military space assets are getting blurred and most of the applications have dual-use capabilities. This mandates greater inter-play and joint participation between the government and commercial space agencies. With increasing private-sector participation and legislation cum reforms, the space industrial ecosystem in India is growing at a faster pace beyond the boundaries of ISRO. It thus provides an opportunity for the Indian Space sector to engage with the global space economy to maximise its gains and the potential of its strong capacity to build satellites and launch vehicles. The need is for greater support and hand holding of the private space sector and moving beyond an ISRO-centric model. The doctrinal imperative is

to harness this high ground with a whole of nation approach in terms of a *'National Defence Space Strategy'* to empower national security with an indigenous character. The key enablers for the future will be adequate funding, vibrant R&D for technology infusion, civil-military fusion, space diplomacy and exploiting open source intelligence.

Lessons from the Ukraine conflict have demonstrated the role played by private actors in monitoring the troop's movement and providing satellite imagery during the conflict. The commercial high-resolution satellite imagery provided by companies such as Planet and Maxar Technologies allowed unprecedented transparency to the West and in turn Ukraine. However, while commercial high-resolution optical imagery is available, all-weather SAR imagery is more limited and thus the importance of civil-military space fusion. The Ukraine war also highlighted the importance of developing an indigenous space access system while leveraging the global civil commercial sector.

Conclusion

Space-based C5ISR plays a critical role, not only in maintaining superior situational awareness but in conducting operations to prevail in today's war and fight to win future wars. However, the challenge remains in addressing the cultural, cognitive, doctrinal, fiscal and physical domains, to manifest Joint C5ISR into a time-sensitive indigenous desired capability.

India should presently adopt an integrated approach and continue to launch military and dual application satellites instead of present service specific or civil-oriented with enhanced military utilization under a declared 'Integrated Space Programme'. The focus should shift from defensive Space control missions with dedicated military Space assets and incrementally further build up indigenous offensive Space control and force application capabilities, both as a deterrent and a strategic capability. At the same time, India should collaborate with

other developed space power nations as part of ‘Space Diplomacy’ to develop niche disruptive technologies in pursuit of a futuristic space programme. Simultaneously, indigenization and R&D including private sector participation must get a stimulus. As India races into this new military frontier under ever expanding and perilous threat envelope, its trajectory must gain momentum with supporting doctrines, structures and capabilities. Space-based C5ISR is indeed the final frontier that India must conquest for the protection of its vital national interest.

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