Space Controlled C2 (Command & Control) Battles

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1. Are the war clouds of the third world war looming? Many countries are already at war such as Russia, Ukraine, Israel and Palestinian Hamas, while others like Iran, Yemen, Taiwan, China, North Korea, Pakistan and Afghanistan are in a warlike situation that could break into full-blown conflict within or with neighbors. Such expanding conflict zones have one thing common – the Military Industrial Complex which is ready for business. US, Russia and China are at technological warpath where Defence Industries are mass producing systems and weapons that would enable deep and precision strikes. The strategic technologies have had a revolutionary impact on the modern battlefield that a nation like India should be bracing up. As the range of artillery guns, missiles and other delivery platforms have enhanced, there is a greater need for precise targeting and C2 (Command and Control) Systems.

2. This would largely be enabled by space assets of the country itself or depending on the military groupings and alliances, such space support can be enabled from outside even by private sector. It has been seen how space control, communication and targeting has been facilitated by SpaceX of Elon Musk. Advanced integration would be necessary for obtaining meshed intelligence, focusing on multi-sensor payloads and analytical platforms. There is a certain role of evolving landscape of military remote sensing, highlighting the significance of combining Synthetic Aperture Radar (SAR) and Electro-Optical (EO) sensors on single platforms. Such integration calls for the role of data fusion, AI integration, and edge computing in enhancing intelligence gathered from space assets. Collaborative efforts between the defense sector, academia, and the private sector are a keystone to address complex military needs effectively.

3. The key technologies such as advanced missile and gun systems would be using smart ammunition for smart guidance or autonomous targeting. These would need spacecraft in near-space, aerospace and long-range vectors to have on board data fusion, AI integration, quantum computing, and IoT sensor networks. These technologies enable and optimize the capabilities like communications, navigation, ISR, situation awareness, targeting, and early warning. This kind of warfare needs intimate support of the industrial ecosystem as also terrestrial and non-terrestrial network that is achievable in utilizing advanced technologies like satellite miniaturization, AI and quantum computing for military applications, emphasizing the importance of capacity building in the satellite data sector.

4. For any country to prepare for the challenges, it is essential that military of the nation ensures industry readiness to tackle the challenges of modern defense

and intelligence, highlighting the dynamic nature of operations. "Informationized warfare harnesses the synergy of advanced spacecraft technologies, data fusion, AI integration, edge computing, and quantum computing, forming the bedrock of national security." There is a critical role of space technologies in enhancing precision and depth in military operations, exploring the challenges and requirements for integrating space capabilities into defense strategies. It is thus important to integrate space technologies such as satellite reconnaissance, GPS-guided munitions, and satellite communications to revolutionize battlefield operations. The vast expanse of areas like the Indian Ocean Region poses significant challenges for maritime surveillance, necessitating the deployment of advanced Earth observation satellites and ELINT (Electronic Intelligence) satellites for wide-area maritime surveillance.

5. The need for prioritizing investments in space capabilities, including military Earth observation, MILSATCOM (Military Satellite Communications), and Space Situational Awareness (SSA), was emphasized to fill capability gaps compared to global standards. The application of AI and advanced analytics in processing and analyzing satellite data for actionable intelligence is significant. This includes automating data analysis for feature detection, change detection, and generating insights for military decision-makers. Concerns regarding data security in open-source models and the potential for tampering were addressed, underscoring the need for safeguarding critical data while promoting collaborative research and development.

6. In a space based high tempo operations it is critical to managing space control and information through the lens of Mosaic Command and Control (C2) systems, underpinned by robust ground infrastructure. It emphasizes the transformative potential of Mosaic Warfare, which shifts the traditional linear kill chains to a dynamic and integrated "kill web" approach. This strategy aims to aggregate diverse sensors, systems, and data sources to outmaneuver adversaries by leveraging the redundancy and resilience provided by space assets. Central to the discussion is the role of advanced technologies such as AI & ML in enhancing decision support systems, enabling real-time data analysis, predictive intelligence, and refined decision-making processes. Secure and reliable communication through laser technology, offering high-speed data transfer capabilities critical for the seamless execution of Mosaic C2 operations.

7. It is important to analyze the industry challenges, particularly the need for regulatory exemptions for satellite equipment testing to foster innovation and growth within the sector. By integrating optical links, AI, ML, and efficient ground control systems, the panel underscored the collaborative effort required between ground and space infrastructure (deploy-on-demand satellites) to develop a comprehensive network-centric warfare capability. "Space is considered the new frontier of warfare, with adversaries operating beyond conventional means." The deep and precision wars need efficient C5-I2-STAR2 (Command, Control, Communications, Computer, Cyber, Information, Intelligence, Target Acquisition, Reconnaissance, Robotics) systems for effective command and control. Therefore there is a pressing need for investing in R&D and Key manufacturing capability. Certain important issues that need to be considered by our industry while undertaking indigenization, as also certain points for adoption by the policy makers and strategists, are as follows: -

(a) **Develop Multi-sensor Payloads:** Focus on creating satellites that can house multiple sensors to provide comprehensive data regardless of environmental conditions while having universal interfaces enabling modular plug-and-play integration across defense platforms and assets.

(b) **Embrace Decentralized Decision-Making:** Empower tactical commanders with decentralized control for faster and more effective decision-making in dynamic operational contexts.

(c) **Adopt Mosaic Warfare Strategies:** Transition from traditional kill chains to a more resilient and adaptive kill web framework to enhance operational flexibility and effectiveness.

(d) **Modern Warfare Concepts and techniques:** Explore the potential of both, infantry and signal bots, for strategic purposes, emphasizing the importance of modeling behaviors and utilizing specific knowledge domains. There is a need for careful design, control, and programming of war-fighting machines to ensure effective utilization.

(e) **Integration:** Foster integration systems between ground and space infrastructure, incorporate advanced technologies like spatial multiplexing, transmit beam forming, etc. to develop an effective kill web and network-centric warfare capabilities.

(f) **Enhance Data Fusion Techniques & Leverage AI:** Invest in technologies that allow integration of data from various sensors, improving the accuracy and utility of the information gathered. Utilize artificial intelligence to automate analysis of vast amounts of satellite data, turning it into actionable intelligence more efficiently.

(g) **Implement Edge Computing:** Adopt edge computing on satellites to process data on board, significantly reducing the time taken to deliver critical information to decision-makers. Implement end-to-end encryption capabilities to harden satellites and communications against cyber threats.

(h) **Enhance Real-Time Surveillance:** Develop capabilities for near real-time, all-weather situational awareness through advanced Earth observation satellites.

(i) **Invest in MIL-SATCOM:** Prioritize investments in defence specific SATCOM for flexible, low-latency communications, incorporating software-defined elements for adaptability.

(j) **Civilian Application and Strategic Implication:** Civilian satellite operations have unintended strategic implications, and there is considerable potential for utilizing civilian data for strategic military purposes.

(k) **Enhance Laser Communication:** Invest in laser technology for secure, high-speed communication essential for network-centric operations, particularly for smaller satellites.

(l) **Advance Space Situational Awareness:** Build SSA capabilities to maintain an enriched, real-time catalog of space objects, ensuring space asset protection and offensive capabilities.

(m) **Leverage AI for Data Analysis:** Integrate AI and machine learning for automated analysis of satellite data, enabling proactive intelligence gathering and decision support.

(n) **Focus on Critical Data Sets:** Identify and prioritize critical data sets required for military operations, including high-resolution Earth observation and ELINT data, to guide investment and development efforts.

(o) **Leverage AI and ML:** Integrate artificial intelligence and machine learning for improved decision support, predictive analytics, and optimization of sensor and fighting system deployment.

(p) **Develop Resilient Space & Ground Infrastructure:** Build a robust constellation of satellites, including deploy-on-demand and software-defined satellites, for enhanced connectivity, data relay, and flexible space support while upgrading ground infrastructure.

(q) **Develop Indigenous Capabilities:** Encourage the development of indigenous space technologies and capabilities to reduce dependency on foreign data sources and enhance national security.

(r) **Support Long-Term R&D:** Allocate funding for research and development in emerging technologies like quantum computing, which can offer unprecedented capabilities in data security and processing.

(s) **Adopt a Whole-of-Nation Approach:** Recognize the necessity of integrating efforts across the nation and with international partners to enhance space diplomacy and cooperation.

(t) **Focus on User-Driven Solutions:** Design and develop intelligence systems based on the operational requirements and feedback from end-users in the defense sector, ensuring that technological advancements align with practical military needs

8. If the space based smart battle systems are to be employed, it is extremely important to configure a secure decision support system by building custom made C2 web. The enhanced range and lethality of missiles, aerial platforms and delivery systems will be of no use unless there is persistent and precision guidance and monitoring of deep battle spaces. It is of imperative that ammunition and delivery systems are smart and space controlled to achieve tangible success in the battlefield. It is therefore of utmost importance that due attention is accorded to the technologies discussed above that are meshed to deliver high speed effect-based operations. Such strategic technologies, infrastructure and policies would contribute immensely towards achieving strategic and technological deterrence.