Electromagnetic Spectrum for Information Superiority of Nation's Security

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Abstract-- **Spectrum has become an essential engine for economic growth besides providing the ability for defence forces to dominate battlefield in event of conflict. In a way, spectrum is similar to** *atma***, which is** *ajar, amar* **as described in** *Shrimad Bhagwad Gita***. Like** *atma***, spectrum too does not have any physical form, yet it is omnipresent. (Para 3, pp. 5, Preamble, Explanatory Notes, Draft Indian Telecommunication Bill 2022).**

Spectrum provides the bond that integrates and enables all warfighting domains – physical, information or cognitive (pp 33, Synergy, Feb 2022). Electromagnetic spectrum superiority is a must for Military superiority to manifest and the Nation to continue in its path of progress for the welfare of citizens. In this paper, the geo political situation of our country, emerging military applications of EMS for future warfare and balancing the future Economic and Military needs of India is covered.

Keywords: Electronic warfare, Electromagnetic spectrum, National Security, 5G military applications

I. INTRODUCTION

India's Battlefields: From Kurukshetra to Balakot, a book by Ajay Singh [1], gives an account of 42 of India's battles from the epic battle of Kurukshetra fought over 3000 years ago to the present day. Virtually every battle of India's vast history is depicted. Ajay makes it clear in preface itself, "Indian warriors were invariably skilful and individually very brave and courageous. But military leaders did not adapt to new concepts of warfare and often remained rooted in the past. Nor did they embrace technology… They were too busy battling each other instead of an outsider. And that was the cause of their defeat." Battle of Mahabharata indicates "importance of real time passage of information" to remain abreast "how the battle unfolds" in the battlefield of Kurukshetra. The description of war of Mahabharata to Dhritarashtra by Sanjay is what is desired even today by the decision makers. The key aspects of Information Assurance and Information Domination ensuring Information Superiority is as relevant today as was noticed in the way, battle of Mahabharata unfolded. This today is only feasible through the Electromagnetic Spectrum (EMS) providing the necessary bandwidth for real-time relay of 4 K video in a mobile battlefield. This along with real-time functioning of all weapons and weapon supporting systems in the land, sea, air and space domain makes the role of EMS all the more relevant.

In this paper, the geo political situation of our country, emerging military applications of EMS for future warfare and balancing the future Economic and Military needs of India is covered.

II. BACKGROUND PERIOD (1757 – 857 – 1957 – 2057

The Battle of Plassey in 1757, changed India's future. The First Armed Revolution in 1857, enabled Britishers to continue their rule for another hundred years. By 1957, India as an independent country had seen the incursions in J & K in 1948 and was to see the Liberation of Goa in 1961, followed by wars of 1962, 1965 and 1971. Operation Pawan in 1986, Operation Vijay in 1999, Operation Parakram in 2002, Uri, Pulwama, Balakot, Chumar, Doklam and Galwan Valley in the recent past highlight that security concerns cannot be ignored. Are we ready for 2057 ? The progress of our country will depend on how secure we remain. "Full Spectrum: India's Wars – 1972 to 2020" by Arjun Subramaniam [2] is the second part of what is envisaged to be a holistic attempt at understanding war and conflict in contemporary India. *India's Wars: A Military History, 1947 -1971* was the first [4].

III. CHIP WARS

Chris Miller in his book *Chip Wars* [3] writes "We rarely think about chips, yet they've created the modern world. The fate of nations has turned on their ability to harness computing power. Globalization as we know it wouldn't exist without the trade in semiconductors and the electronic products, they make possible. From swarms of autonomous drones to invisible battles in cyberspace and across the electromagnetic spectrum, the future of war will be defined by computing power. China's anti-satellite weapons threaten to disable communications and GPS networks. China's cyberwar capabilities haven't been tested in wartime, but the Chinese would try to bring down entire military systems. Meanwhile, in the electromagnetic spectrum, China might try to jam communications and blind surveillance systems, leaving the military unable to see or communicate.

IV. EMS – A NEW DOMAIN OF WARFARE

(a) EMS provides means for transfer of energy and information. The demand of EMS to meet commercial and life cycle requirements to accelerate National growth and well-being is increasingly phenomenally. EMS

superiority is a new target for global competitors. Without capabilities to assert EMS superiority, Nation's security will be exposed to undue and significant risks.

(b) EMS is an invisible, essential, physical foundation of every battlefield as it unifies all war-fighting domains-land, sea, air, space and cyber space. The dependence of Militaries on EMS to gain situational awareness, information dominance, decision superiority as also to employ "Hard Kill" and "Soft Kill" weapons systems has increased manifold.

(c) Achieving 'Info dominance' and 'denying adversaries' use of EMS is necessary to seize strategic initiative in a conflict. Prowess in EMS has been demonstrated in recent conflicts in Ukraine and Syria. China has integrated capabilities in Space, Cyber and EMS domains under a 'Strategic Support Force' created in 2015. US has promulgated a reviewed 'Electromagnetic Spectrum Superiority' strategy.

(d) Stakeholders all across are aligning EMS activities with 'National Security' and 'National Defense Strategies'.

V. EMERGING MILITARY APPLICATIONS OF EMS IN FUTURE WARFARE

(a) Warfighting concepts exploit the Physical (Land, Sea, Air, Space), Information (Cyber and EMS) and Cognitive (understanding, decision making) domains to gaining Military Superiority in time and space. Military capabilities in physical domains are heavily dependent on EMS which integrates them.

(b) Militaries exploit Information and Networking Technologies to integrate dispersed decision makers, sensors and shooters. Besides growing commercial devices, sensors, drones, mobile vehicles, military requirements exist for Command and Control (C2), Identification of Friend and Foe (IFF), Radars, Guidance and Navigations systems.

(c) 5 G military applications have immense potential in autonomous vehicles, C2, logistics maintenance, AR / VR, IMT and distributed ISR systems.

(d) Technological developments today promise cognitive and adaptive Software Defined Radios and Radars, high end sensors for imagery and surveillance with AI drive SIGINT and Electronic Warfare capabilities. Converging of 5 G / 6G and IoT Technologies has ushered in new possibilities as well as vulnerabilities.

(e) In the fast-paced future battlefields, India needs to

strengthen 'Spectrum Warfare Capabilities' by formulating exhaustive strategy. Indian Armed Forces need to be part of National Strategy to enable advancement of critical emerging technologies to improve modernization.

VI. BALANCING FUTURE ECONOMIC AND SECURITY NEEDS OF INDIA

(a) The recently promulgated National Frequency Allocation Plan 2022 (NFAP 2022) highlights that necessity of digital communication and crucial role played by Spectrum Management for universal, accessible, resilient and affordable digital communication is the guiding factor for preparation of NFAP 2022. Minister of Communication has highlighted Digital Communication as essential for idea of "Antyodaya" – the Indian philosophy of inclusive development. NFAP 2022 comprises government decisions for Telecommunication, Broadcasting and other Radio Services. It provides for introduction of new Radio Spectrum for IMT / 5 G, enables regulations for satellites and introduces role of new technologies like V2X (Vehicle to anything).

(b) Spectrum has become an essential engine for economic growth as also provide the ability for Defence forces to dominate battlefield in event of conflict. Ongoing technological developments have paved way for variety of spectrum applications which has led to greater demand.

(c) It is important to balance out the requirements for future economic and security needs of India.

VII. INDUSTRY, ACADEMIA AND MILITARY COLLABORATION

(a) Artificial intelligence (AI) is moving beyond automation and is being presently used in IVRS, Virtual assistants, self-organizing network. Machine Learning techniques for 5 G are being developed.

(b) Big Data analytics for decision making being used by Netflix, Google, Starbucks are interesting case studies. The usage of Big Data for maintaining Telecommunication networks and coverage in mobile cellular networks is also being refined.

(c) It is important to understand nuances of Defence Forces with partnerships of Industry and Academia for developing cutting edge technologies and fulfill the Armed Forces modernization through indigenous development.

(d) There is need to formulate structures, organisations and road map to schedule deliverable for capacity building for optimum usage of EMS and capability building.

VIII. CONCLUSION

(a) *Technological Advancements*: The progress from CPU to GPU to TPU, with AI chips at the edge, shift from clustered to cloud and edge, learning models and by roll out of 5 G plus AI will bring out paradigm shift in the way war-fighting is conducted, along with the economic development of the nation.

(b) *Spectrum Management:* To realise Dynamic Spectrum Management (DSM) by spectrum sensing, Adaptive Modulation and coding for estimating SNR and Adaptive Beam forming are international practices where AI / ML is being implemented. These have to be progressed further.

(c) *Optimum Balance:* Critical services and Information Infrastructure as well as competitive exploitation of technologies like 5 G and IoT for citizens need assured EMS availability constraining availability for military use. EMS is increasingly getting constrained, congested and contested.

(d) *National Security:* There is no other country in the world which has such accumulation of Strategic adversity around it. Our Northern Borders are opposite a superpower that is taking on USA. New developments are happening along the Western Borders and Afghanistan. China has taken war-fighting to new domains in terms of digitization, 5 G, Military IoT.

(e) *EMS Superiority:* For Military superiority in the critical Information and C2 domain we need to adopt strategies, where EMS capabilities will play critical role. EMS provides the connective bond to integrate and enable all war-fighting domains. EMS superiority is accordingly a must for Military superiority to manifest and the Nation to continue in its path of progress for the welfare of citizens.

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Brig Sanjay Rawal (b 23 Aug 1965) was commissioned in Indian Army in Dec1985. An alumnus of National Defence Academy, IIT Kharagpur, Defence Services Staff College Wellington and Army War College, he is an M. Tech in Computer Engineering from IIT Kharagpur, M.Sc in Defence and Strategic Studies and M. Phil in Defence and Management Studies.

He has nearly four decades of experience of serving in Indian Army in difficult terrains and varied roles. He has executed challenging assignments of extending communication networks in High Altitude Areas, UN Peace Keeping Forces in Cambodia, armed forces deployed in Counter Insurgency / Counter Terrorism role and Strike formations. He has been intricately involved with issues related to Electronic Warfare, Law Enforcement Agencies, and improvement of skill sets of combatants in Signal Training Centre, Spectrum usage for Indian Army and procurement of new equipment and systems for Indian Army.