

# US RESPONSE TO ELECTROMAGNETIC SPECTRUM THREATS AND CHALLENGES: LESSONS FOR INDIA

Air Cmde T Chand (Retd)\*

## Abstract

*EMS is an important enabler of all war fighting domains today. The growing impact of the Cyber and Space domains has put the EMS at the Centre stage. US, Russia and China have well developed EMS operation capability. US which was considered a leader in the EMS capability has of late assessed that its near peers adversaries Russia and China are closing in fast and might surpass its capabilities if timely action is not taken. China with its EMS dominance strategy called The 'Winning Mechanisms of Electronic Countermeasures' and creation of its SSF is of grave concern to the US and others.*

*Therefore, the US has initiated a slew of measures to ensure its leadership and dominance of the EMS. Its new EMS Superiority Strategy 2020 has addressed most of the concerns. The loopholes in implementation of the earlier strategies have been plugged after the GAO study and Report.*

*China's EMS capabilities are of special concerns to India especially in view of the unresolved borders and China-Pakistan nexus. India has reportedly a well-structured EW capability. Many measures initiated by the US for maintaining EMS superiority are of relevance for India too.*

*There is perhaps a need for India to adopt a well thought out strategy for the country as a whole. Necessary review of the existing capabilities is needed for overcoming suboptimal preparation.*

US pioneered the fundamental research for understanding and exploitation of the Electromagnetic Spectrum (EMS), right from early days. World War II saw the major applications of the EMS by the armed forces and also adoption of measures to deny its use by the adversaries. Since World War II, holding an edge in the EMS has provided the US distinct military and economic advantages. Nevertheless, as technology has become diffused during the Fourth Industrial Revolution, US ability to maintain the advantage within this spectrum has diminished as peers gain capability. At present, the US and its allies are alarmed by this situation. In certain areas, if the US is unable to strengthen EMS capabilities, there is a likelihood of adversaries achieving parity or even dominance of the spectrum in a matter of years<sup>1</sup>. US-Soviet Union competition during cold war took the EMS exploitation to a much higher level. China also continued to develop its capabilities and have of late shown its prowess to the rest of the world in many ways. The integration of all its EMS related capabilities in the form of SSF has given a force multiplication effect to the Chinese armed forces. Alarmed by the Chinese capabilities, US has redoubled its efforts to maintain its superiority and has adopted yet another new Electromagnetic Spectrum Superiority Strategy 2020 to achieve its goals.

China's capabilities are a major cause of concern for India as well. Chinese activities and deployment along India's northern borders has raised alarm on many occasions. While Indian armed forces have evolved their EMS capability and denial measures, there are many lessons which could be learnt from the US response to the EMS threats and challenges faced by its armed forces.

---

1 Ernest "Doc" Gunasekara-Rockwell, "Electromagnetic Defense Task Force, 2018 Report", LEMAY PAPERS, [https://www.academia.edu/37985797/Electromagnetic\\_Defense\\_Task\\_Force\\_2018\\_Report](https://www.academia.edu/37985797/Electromagnetic_Defense_Task_Force_2018_Report), 13 December 2021.



Spectrum Warfare is the control, development, and use of advanced Electromagnetic (EM) spectrum technologies, both offensive and defensive, for strategic advantage and mission success in military conflicts and intelligence gathering<sup>2</sup>. All computer networks, guidance systems, sensors, electronic jammers, radios, phones, and radars are a part of electromagnetic environment, often through wireless routers and satellites, it has become increasingly essential for countries to have both advanced technologies and a well-considered approach for attaining Spectrum Warfare viability. Adoption and use of these EMS technologies in the field can vary but the need for advanced Spectrum Warfare capabilities has escalated across air, sea, ground, and C4ISR platforms as commercial telecom technologies have improved, and become less costly worldwide. While Spectrum Warfare threats have grown, the research and development of new EM technologies capable of countering those threats has been limited to relatively few defence electronics firms. These firms specialise in developing and producing next generation Electronic Warfare (EW) capabilities, including Electronic Support (ES), Electronic Protection (EP), and Electronic Attack (EA) technologies for the Defense and intelligence agencies.

### **US: EMS Threats and Challenges**

The US DOD defines Electromagnetic Warfare as ‘Military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy’. Electromagnetic Warfare was previously called Electronic Warfare (EW) as described in JP 3-85. The Electromagnetic Battle Management is defined as the dynamic monitoring, assessing, planning, and directing of operations in the electromagnetic spectrum in support of the commander’s concept of operation which is also called EMBM (JP 3-85)<sup>3</sup>.

---

2 BAE Systems. <https://www.baesystems.com/en-us/definition/what-is-spectrum-warfare>, 08 December 2021.

3 DoD Electromagnetic Spectrum Superiority Strategy 2020, [https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic\\_Spectrum\\_Superiority\\_Strategy.PDF](https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic_Spectrum_Superiority_Strategy.PDF), 08 December 2021.

Traditional EMS threats, such as nuclear-EMP and geomagnetic storms, have regained prominence once again. In 2018, the Electromagnetic Defense Task Force (EDTF) of the US DOD, published four key findings: namely; EMP and Geomagnetic Disturbance (GMD) are significant and continuing threats to the military and civil society; Risks include but are not limited to nuclear power station resilience, military installation resilience, and exercise realism and training (education); Emerging 5G technologies and the design of regional and continental networks can present strategic threats; Directed energy and high-powered microwave systems can pose threats to human biology and hardware dependent on electronics noting that EMS management is struggling to maintain pace with rapid technical evolutions within the spectrum.

The task force evaluated the functioning of the societies, it became apparent that along with cyber, the most unique and effective way to affect large segments of a modern nation without a retaliatory attack was to use the EMS to disrupt life sustaining elements such as water, food, sanitation, communications, transportation, and especially the electric power infrastructure upon which all such systems depend. During the war gaming, the task force also found that certain EMS phenomena may potentially bypass traditional strategic deterrence and present challenges to the health and economies of states<sup>4</sup>.

China reportedly, possesses ‘Super EMP Devices’ that could cause a prolonged blackout resulting in large number of deaths. US is thus vulnerable to an Electromagnetic Pulse (EMP) attack from adversaries such as China, and urgent action is needed to invest in defending the country from it<sup>5</sup>. Peter Vincent Pry, the executive director of the US Task Force on National and Homeland Security, stated during a virtual forum hosted by the Universal Peace Federation on 23 November 2021, “That China poses a real threat of possibly being able to gain advantage with an EMP attack, which would be

---

4    ibid

5    Michael Lee, “US vulnerable to Chinese electromagnetic attack, experts say”, Fox News 24 November 2021, <https://www.foxnews.com/us/us-vulnerable-to-chinese-electromagnetic-attack-experts-say>, 12 December 2021/

used in conjunction with cyberattacks and physical sabotage, and non-nuclear EMP<sup>6</sup>.” The U.S. electric grid and other infrastructures such as communications and transportation systems and water and sewer services, could all be crippled by such an attack, experts like Pry warn. In addition to possession of super EMP Devices, China recently tested a new hypersonic glide vehicle reportedly could deploy the EMP and cause a prolonged blackout that would disable infrastructure and disrupt the military’s communications<sup>7</sup>.

According to studies by the Department of Defense (DOD)<sup>8</sup>, near-peer adversaries China and Russia are aware of the importance of the Electromagnetic Spectrum (EMS) and have taken steps to improve their capabilities to threaten US ability to use and control the EMS. China is taking steps to enhance its capabilities to use the EMS through strategic, organisational, and training methods. Russian electromagnetic warfare forces, have also demonstrated their effectiveness against US and other militaries. Studies undertaken by the US DOD have also highlighted internal challenges that may affect the department’s ability to ensure superiority, or operational control, in the EMS. These include issues related to: Governance and organization, Technology acquisition and development, EMS operational concepts, Spectrum management, and Staffing and Training<sup>9</sup>. Almost every aspect of modern society is facilitated by the electromagnetic spectrum. The U.S. military “faces almost impossible odds of winning future competitions if the electromagnetic spectrum domain is insufficiently dominated by western interests,” warned the U.S. Air Force Electromagnetic Defense Task Force in its 2019 study report<sup>10</sup>.

## **US Response**

---

6    ibid

7    ibid

8    “DOD Needs to Address Governance and Oversight Issues to Help Ensure Superiority”, GAO Report to the Committee on Armed Services, House of Representatives, December 2020. <https://www.gao.gov/assets/gao-21-64.pdf>, 16 December 2021.

9    ibid

10    Marcus Clay, “To Rule the Invisible Battlefield: The Electromagnetic Spectrum and Chinese Military Power”, War on the Rocks, 22 January 2022. <https://warontherocks.com/2021/01/to-rule-the-invisible-battlefield-the-electromagnetic-spectrum-and-chinese-military-power/>. 24 December 2021.

Defence Secretary Lloyd Austin approved the implementation plan for the DOD's 2020 Electromagnetic Spectrum Superiority Strategy on 15 July 2021 which has five strategic goals, which are: Develop superior EMS capabilities; Evolve to an agile, and fully integrated, EMS infrastructure; Pursue total force readiness in the EMS; Secure enduring partnerships for EMS advantage; and Establish effective EMS governance. Through the Department's deliberate and cooperative pursuit of these goals, Defence Forces will possess the resources, capabilities, and interoperability necessary for decisive military overmatch<sup>11</sup>. The authorized plan is an important step toward modernizing EMS operations that will enable almost every aspect of modern warfare, including the DOD's Joint Warfighting Concept and All Domain Operations.<sup>12</sup> This announcement came after the House Armed Services Subcommittee on Cyber, Innovative Technologies, and Information Systems (CITIS) added to its markup of the fiscal year 2022 National Defense Authorization Act a thirty-first mission area called "spectrum operations" and a statutory requirement for the Pentagon to ensure necessary appointments for the 2020 strategy's implementation<sup>13</sup>.

Currently, US Strategic Command leads EMS operational advocacy, while the EMSO-CFT (Electromagnetic Spectrum Operations Cross-Functional Team) works to achieve the 2020 strategy's overall goals, which include: Develop Superior EMS Capabilities; Evolve to an Agile, Fully Integrated EMS Infrastructure; Pursue Total Force EMS Readiness; Secure Enduring Partnerships for EMS Advantage; and Establish Effective EMS Governance<sup>14</sup>. The US DOD is also modernizing, it's Defence Information Systems Agency (DISA). The DISA is actively working for development of a new Joint Electromagnetic Battle Management System<sup>15</sup>. Earlier, Former President Donald Trump

---

11 "DoD Electromagnetic Spectrum Superiority Strategy 2020", [https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic\\_Superiority\\_Strategy.PDF](https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic_Superiority_Strategy.PDF), 14 December 2021.

12 Brad D. Williams, "Secretary Austin Approves Spectrum Superiority Strategy Implementation Plan, 05 August 2021", All Domains, <https://breakingdefense.com/2021/08/secretary-austin-ap-proves-spectrum-superiority-strategy-implementation-plan/>, 08 December 2021.

13 *ibid*

14 *ibid*

15 *ibid*

## US RESPONSE TO ELECTROMAGNETIC SPECTRUM THREATS AND CHALLENGES: LESSONS FOR INDIA

---

took steps in 2019 to begin addressing the EMP challenge, by signing an executive order that directed government-wide coordination to defend against an EMP attack. US DOD is also increasing cooperation with the Japan in space, cyberspace, the EMS, and AI as well as cross-domain operations<sup>16</sup> besides cooperating actively with Taiwan, Vietnam, Singapore and India.

Recently, US GAO (Government Accountability Office) made five recommendations, advising that DOD should identify processes and procedures, reform governance structures, assign leadership for strategy implementation, and develop oversight processes. DOD concurred with the first two recommendations and partially concurred with the last three recommendations. In response to these three latter recommendations, DOD stated that it will take action once the department has developed and the Secretary of Defense has reviewed organizational reform recommendations<sup>17</sup>.

Earlier, US national and international policies focused on managing spectrum to stimulate economic growth through commercial applications. Federal policymakers are making a large amount of spectrum available for commerce across many radiofrequency ranges in large contiguous spectrum blocks for fifth-generation (5G) and future broadband technologies. At the same time, DOD's requirements for spectrum access continue to grow to test, train with, and employ emerging national security capabilities. The DOD recognizes the importance of the EMS especially for reaping the benefits of the 5G technology for security agencies as well. The DOD believes that the traditional model of static frequency allocation is not sufficient, and a new model is needed to address the growing demand for access to an increasingly congested and constrained EMS<sup>18</sup>.

---

16 David Vergun, "U.S. Bolsters Indo-Pacific Alliances in Face of Threats" 05 December 2019, DoD News, <https://www.defense.gov/News/News-Stories/Article/Article/2032957/us-bolsters-indo-pacific-alliances-in-face-of-threats/>, 12 December 2021.

17 "DOD Needs to Address Governance and Oversight Issues to Help Ensure Superiority", GAO Report to the Committee on Armed Services, House of Representatives, December 2020. <https://www.gao.gov/assets/gao-21-64.pdf>, 16 December 2021.

18 "US DOD Electromagnetic Spectrum Superiority Strategy 2020", [https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic\\_Spectrum\\_Superiority\\_Strategy.PDF](https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic_Spectrum_Superiority_Strategy.PDF), 20 December

While, EMS maneuver focuses on gaining advantage over adversaries, spectrum sharing focuses on mitigating interference through agreement. Increased spectrum sharing remains a critical priority for the DOD to meet the growing demands for spectrum access from both commerce and Defence Forces. This sharing should include implementation of dynamic and bidirectional sharing for facilitating access to commercial spectrum while addressing the cybersecurity risk of an information sharing infrastructure outside of the DOD Information Enterprise. It also envisages pursuing machine to-machine technologies that enable cognitive cohabitation in the spectrum. International and domestic spectrum policy and regulations are expected to evolve to enable spectrum sharing to keep pace with rapidly changing technologies and increased mission requirements<sup>19</sup>.

### **Lessons for India**

Freedom of action in the EMS, at the time and place, of our choosing, is a prerequisite to the successful conduct of operations in all domains. EMS environment in India is also contested where enemy activities detect, disrupt, exploit, degrade, deny, deceive, or destroy EMS capabilities for the purpose of military advantage. It is congested as military and civilian EMS-dependent systems continue to be added to the spectrum and the extent of unintentional interference keeps on increasing. The EMS is also constrained by domestic and international regulations which causes the magnitude of spectrum available for military use to decrease.

Both India and the US have a common adversary, China. EMS Threats and Challenges posed by China to the US are also applicable for India. India shares a long 3488 km long unresolved border with China. Therefore EMS threats posed by China become even more serious for India. Close defence cooperation between China and Pakistan and extent of interoperability developed by their defence forces revealed through their joint exercises also poses a serious EMS

---

2021.

<sup>19</sup> ibid



threat from China assisted Pakistan as well. China has adopted an EMS dominance strategy called The ‘Winning Mechanisms of Electronic Countermeasures’ which expresses in detail the PLA EW ideas and stratagems on achieving electromagnetic dominance, which is defined as “guaranteeing the information activity needs of friendly forces in the EMS, while rendering the enemy’s information activities in the EMS ineffective<sup>20</sup>.” The strategy specifically emphasizes the use of offensive electronic measures to achieve such goals. The PLA’s strategy is divided into four principles and stages: First, “gather one’s strengths and advantages to achieve a superior starting position; Second, pursue multi-level integration; Three, employ precise release of energy; and four, demonstrate effects in multiple areas”. The fourth and final stage is the most important one in securing victory, and it is the focus for the majority of EMS stratagems<sup>21</sup>. Chinese strategists consider national and military decision-makers as key targets for strikes under its electronic warfare operations and other targets include “national information infrastructure, strategic early warning systems, the military information system, and communications systems within the adversary’s national financial, energy, and transportation systems<sup>22</sup>.”

US response to Chinese EMS threats and challenges have many lessons for India too. There is perhaps an urgent need to recognise EMS threat as a national threat and prepare a whole of government response to it. EMS challenges go well beyond the military battlespace. The EMS is needed for commercial mobile broadband technologies for facilitating economic growth and prosperity, which also restricts the spectrum available for the Indian Defence Forces. It is worth remembering that EMS exploitation provide capability, capacity, and potentially persistent

---

20 Zi Yang, “PLA Stratagems for Establishing Wartime Electromagnetic Dominance: An Analysis of The Winning Mechanisms of Electronic Countermeasures.” The Jamestown Foundation China Brief, Volume: 19 Issue: 3, 01 February 2019. <https://jamestown.org/program/pla-stratagems-for-establishing-wartime-electromagnetic-dominance-an-analysis-of-the-winning-mechanisms-of-electronic-countermeasures/>. 26 December 2021.

21 *ibid*

22 Marcus Clay, “To Rule the Invisible Battlefield: The Electromagnetic Spectrum and Chinese Military Power”, War on the Rocks, 22 January 2022. <https://warontherocks.com/2021/01/to-rule-the-invisible-battlefield-the-electromagnetic-spectrum-and-chinese-military-power/>. 26 December 2021.



access to targets at the speed of light, where many other capabilities require extended time, resources, and movement of forces to employ. A study akin to the US Electromagnetic Defence Task Force (EDTF) would help India to understand this dormant but all pervading EMS threat in its entirety and enable the MoD to prepare a comprehensive response quite akin to the US 'DOD Electromagnetic Spectrum Superiority Strategy 2020'<sup>23</sup>. There is perhaps a need for transitioning from the traditional consideration of Electromagnetic Warfare (EW) as separable from spectrum management to a unified treatment of these activities as Electromagnetic Spectrum Operations (EMSO) as planned by the US. The purpose of the comprehensive MoD response should be to align MoD EMS policies with the objectives of the National Security Strategy (NSS), National Defense Strategy (NDS), and national economic and technology policy goals, in whatever forms they are existing.

EMS superiority brings important advantages to any cost imposition strategy. By developing innovative asymmetric EMS capabilities, MoD can protect expensive friendly capabilities from disruption or attrition, while simultaneously denying or degrading the effectiveness of adversaries' sophisticated systems. Because many EMS capabilities are employed, not expended, concerns about cost may be reduced, which in turn affords decision makers more sustainable options. This is especially significant as India and its adversaries all increasing investment in space-based capabilities and dependencies. India must exploit adversaries' EMS vulnerabilities through advanced EW to offset their capacity.

India's policymakers are making a large amount of spectrum available for commerce across many radiofrequency ranges for 5G and future broadband technologies. At the same time, MoD's requirements for spectrum access continue to grow. The traditional model of static frequency allocation is not sufficient, and a new model incorporating spectrum sharing is needed to address the growing demand for access to

---

23 "DoD Electromagnetic Spectrum Superiority Strategy 2020", [https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic\\_Spectrum\\_Superiority\\_Strategy.PDF](https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/Electromagnetic_Spectrum_Superiority_Strategy.PDF), 14 December 2021.

an increasingly congested and constrained EMS, in India too. Spectrum sharing offers a new model for greater freedom of action within the EMS. Spectrum sharing is the simultaneous usage of a specific frequency band in a specific geographical area and time by a number of independent entities where harmful electromagnetic interference is mitigated through agreement.

Successful engagement in the International Telecommunication Union (ITU) treaty processes, including the World Radio-communication Conference (WRC), will help to maximize India's EMS access to meet wartime and peacetime national security objectives. India should also ensure EMS exploitation in congruence with COMCASA standards for facilitating interoperability when required. This would require interoperable data sources and architectures.

EMS Superiority requires effective intelligence collection, analysis, and validation of the following key areas such as : parametric data, which encompasses all EMS sensors, communications, datalinks, radars, jammers, directed energy, electro-optics, and infrared systems; engineering data, which describes the performance, characteristics, and signature information of the associated equipment, weapons, and platforms; order of battle data; combat support data; and modeling and simulation support. Modeling and simulation fidelity must support all levels of operations, up to and including campaign modeling and support to operational war gaming. Validated intelligence data and accurate and current assessments underpin the success of EMS dependent systems.

EMS Operations or EW operations in India like most other countries tend to be very secretive and have the risk of remaining sub optimal. Therefore, a GAO like study and analysis of the Indian Defence Forces and the MoD would be in order to ensure superiority or at least parity with the fast growing capabilities of the adversaries especially China.

**\*Air Cmde T Chand (Retd)** is a Senior Fellow, Centre for Joint Warfare Studies (CENJOWS), New Delhi.