



DEPARTMENT OF DEFENSE

Electromagnetic Spectrum Superiority Strategy

OCTOBER 2020



Our task is to ensure that American military superiority endures, and in combination with other elements of national power, is ready to protect Americans against sophisticated challenges to national security.

— 2017 National Security Strategy

It is the policy of the United States to use radiofrequency spectrum (spectrum) as efficiently and effectively as possible to help meet our economic, national security, science, safety, and other Federal mission goals now and in the future.

— Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future, October 25, 2018

Foreword

The Nation has entered an age of warfighting wherein U.S. dominance in air, land, sea, space, cyberspace, and the electromagnetic spectrum (EMS) is challenged by peer and near peer adversaries. These challenges have exposed the cross-cutting reliance of U.S. Forces on the EMS, and are driving a change in how the DoD approaches activities in the EMS to maintain an all-domain advantage.

EMS challenges go well beyond the military battlespace. The EMS is being repurposed for commercial mobile broadband technologies to bolster economic growth and prosperity, which further restricts DoD's freedom of action. These sophisticated technologies represent new opportunities for the Department and our national economy. However, they also present new challenges across the competition continuum as the electromagnetic operational environment becomes increasingly congested, contested, and constrained (i.e., complex).

The Department is 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). Consequently, this 2020 Department of Defense EMS Superiority Strategy builds on essential objectives from the 2013 DoD EMS Strategy and the 2017 DoD Electronic Warfare (EW) Strategy, and takes the Department another critical step forward in implementing the 2018 National Defense Strategy. This Strategy seeks to align EMS resources, capabilities, and activities across the DoD to support our core national security objectives while remaining mindful of the importance of U.S. economic prosperity. Additionally, this Strategy lays the foundation for a robust EMS enterprise, prepares EMS professionals to leverage new technologies, and focuses on strengthening alliances to achieve the Department's vision of Freedom of Action in the Electromagnetic Spectrum.

This Strategy addresses how DoD will: 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 to support strategic and operational objectives. Investment in these areas will speed decision-quality information to the warfighter, establish effective electromagnetic battle management (EMBM), enable EMS sharing with commercial partners, advance EMS warfighting capabilities, and ensure our forces maintain EMS superiority.

To realize this enterprise-level change in the Department and achieve EMS superiority, the Senior Designated Official (SDO) of the EMSO Cross-Functional Team (EMSO CFT), in partnership with the DoD Chief Information Officer (CIO), will oversee the implementation of this Strategy. Within 180 days of signature, the SDO will create a Roadmap and Implementation Plan to achieve the vision, goals, and objectives of this Strategy and report to me quarterly on its progress. All DoD components will support the implementation of this Strategy.



Mark Esper
Secretary of Defense

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INTRODUCTION

“A more lethal force, strong alliances and partnerships, American technological innovation, and a culture of performance will generate decisive and sustained U.S. military advantages.”

— Summary of the 2018 National Defense Strategy: Sharpening the American Military’s Competitive Advantage

The Department is challenged to assure and maintain access, use, fires, and maneuver within the Electromagnetic Spectrum (EMS) at home and abroad. This jeopardizes the U.S. military’s ability to sense, command, control, communicate, test, train, protect, and project force effectively. Without the capabilities to assert EMS superiority, the nation’s economic and national security will be exposed to undue and significant risk.

Adversary actions, commercial development, and regulatory constraints impede U.S. forces’ freedom of action in the EMS. Ensuring such freedom of action will require new ways of thinking about access, sharing, and maneuver in the EMS. Our adversaries have recognized DoD’s reliance on EMS-dependent capabilities and are seeking to exploit this vulnerability. They seek to restrict U.S. spectrum access through international forums while they organize, train, and equip their forces for EMS advantage. The Department must also account for the EMS requirements of coalition and commercial partners. These competing spectrum needs result in an increasingly congested, contested, and constrained electromagnetic operational environment (EMOE). Combined, these factors require DoD to reexamine how it gains and maintains control of the EMS.

The Department seeks to maintain military overmatch against its adversaries, while sharing the spectrum with commercial partners. Increased adversary competition and commercial congestion drives the need to develop new capabilities, new techniques, and better integration within DoD and with its partners to enhance spectrum efficiency, maximize spectrum compatibility, and ensure EMS superiority. The shift in these activities to a sharing and maneuver focus must tightly align with efforts across the EMS enterprise to achieve U.S. military readiness, integration across warfighting domains, and increased lethality of U.S. forces.

Purpose and Scope

The purpose of the 2020 Department of Defense EMS Superiority Strategy is to align DoD EMS activities with the objectives of the 2017 National Security Strategy (NSS), the 2018 National Defense Strategy (NDS), and national economic and technology policy goals. This Strategy embraces the enterprise approach required to ensure EMS superiority by integrating efforts to enhance near-term and long-term EMS capabilities, activities, and operations. The Strategy informs the Department’s domestic EMS access policies and reinforces the need to develop cooperative frameworks with other EMS stakeholders in order

to advance shared national policy goals. The traditional functions of Electromagnetic Spectrum Management (EMSM) and Electromagnetic Warfare (EW)—integrated as Electromagnetic Spectrum Operations (EMSO)—are addressed within the document’s strategic goals. This 2020 Strategy builds upon the successes of and supersedes both the DoD’s 2013 EMS Strategy and 2017 EW Strategy.



Next Generation Jammer Mid-Band flies for the first time on an EA-18G Growler, Naval Air Station Patuxent River, MD

VISION: Freedom of Action in the Electromagnetic Spectrum

Freedom of action in the electromagnetic spectrum, at the time, place, and parameters of our choosing, is a required precursor to the successful conduct of operations in all domains. Forces in 2030 and beyond will be ready to fight and win through the deliberate, institutional pursuit of EMS superiority. This enterprise-wide condition of strategic advantage will result from unified efforts to create conditions for success in congested, contested, and constrained EMOEs.

GUIDING PRINCIPLES

This Strategy builds upon existing joint and Service doctrine and operational concepts that incorporate the full range of military activities in the EMS. The guiding principles of this Strategy include:

- The NDS strategic approach of *lethality, partnering, reform, and expanding the competitive space* to command strategic advantage in any great power competition;
- The long-term success of the Department requires combining EMSM and EW into a single EMSO community as part of the EMS Enterprise;

- Economic growth, which includes the need for commercial EMS access, is in the national security interest of the United States;
- The United States is resolved to “... remain the preeminent military power in the world [and] ensure the balances of power remain in our favor.” – NDS Strategic Aim;
- “[The United States] cannot expect success fighting tomorrow’s conflicts with yesterday’s weapons or equipment. To address the scope and pace of our competitors’ and adversaries’ ambitions and capabilities, we must invest in the modernization of key capabilities” – NDS Summary.



Aircraft Carrier USS Ronald Reagan

The Modern Electromagnetic Operational Environment

The EMS, as the range of all types of electromagnetic radiation, is a fundamental component of the natural environment, and the EMOE is a space in which military functions are performed. The EMOE is a maneuver space, a battlespace, a place where competition and warfare, as well as commerce and other non-military activities, are conducted. The EMS is not a separate domain of military operations because the EMS is inseparable from the domains established in joint doctrine. In modern warfare, EMS superiority is a leading indicator and fundamental component of achieving superiority in air, land, sea, space, or cyberspace. As U.S. forces are organized around domains, the EMS not only provides the critical connective tissue that enables all-domain operations, but represents a natural seam and critical vulnerability across joint force operations. This Strategy aims to mitigate vulnerability by creating the conditions to ensure EMS superiority. As such, operations in the EMS require prioritization, resourcing, and governance as an enterprise.

The modern EMOE is increasingly congested, contested, and constrained (henceforth referred to as complex). This Strategy addresses EMOE complexity by advancing EMS sharing and maneuver to ensure continued spectrum access, as emphasized in the NSS and the *2018 Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future*. The Strategy supports the full range of activities DoD must conduct in the EMS across the competition continuum. It recognizes that the same technology used to enable the maneuverability required in the highly contested near-peer environments can also be used to enhance access in highly regulated peacetime environments. It incorporates an EMS enterprise focus on superiority in congested and contested EMOEs of conflict as well as the need to test, train, and operate in congested and constrained peacetime EMOEs.

EMOE Complexity

- **Contested** – Enemy activities detect, disrupt, exploit, degrade, deny, deceive, or destroy friendly EMS capabilities for the purpose of military advantage.
- **Congested** – Military and civilian EMS-dependent systems continue to crowd the spectrum and increase the amount of unintentional interference.
- **Constrained** – Domestic and international regulations cause the amount of spectrum available for military access to decrease.

EMS Superiority in an Era of Great Power Competition

Global competitors also recognize the EMS as a complex maneuver space that factors into a nation's economic prosperity and relative military advantage. Recognizing U.S. reliance on the EMS, our adversaries have spent 30 years studying, investing, and implementing policies, capabilities, and procedures with the single focus of gaining military advantage over U.S. forces. These adversaries are developing and fielding advanced technology that targets U.S. capabilities across the EMS. In order to maintain warfighting superiority, DoD must look to revolutionary, leap-ahead technologies and capabilities to be able to compete against a range of adversaries throughout the competition continuum.

The dynamics of great power competition demand increased appreciation and focus on freedom of action in the EMS. There is tremendous advantage afforded to the competitor that gains and maintains EMS superiority across the competition continuum. Establishing assured access (i.e., access with a level of confidence that harmful electromagnetic interference will be mitigated) and preventing access by adversaries across the competition continuum are foundational to achieving EMS superiority. At the same time, nations are harnessing the EMS to promote economic development. The rapid rise of commercial mobile broadband technologies continues to transform national economies and connect people around the world. However, new commercial technologies have resulted in increased demand for bandwidth, competing with DoD for essential access.

EMS superiority grants additional options and increased flexibility in competition short of armed conflict in addition to greater control of the escalation ladder. It grants policymakers and senior military leaders the decision space to handle real-time events while simultaneously denying equivalent decision space to our adversaries. Both traditional overt actions and clandestine employment offer expansive options

for the side that possesses EMS superiority. EMSO provides capability, capacity, and potentially persistent access to targets at the speed of light, where many other capabilities require extended time, resources, and movement of forces to employ.

EMS superiority brings important advantages to any cost imposition strategy. By developing innovative asymmetric EMS capabilities, DoD can protect expensive friendly capabilities from disruption or attrition, while simultaneously denying or degrading the effectiveness of adversaries' high-priced systems. Because many EMS capabilities are employed, not expended, concerns about magazine capacity or cost of munitions may be reduced, which in turn affords commanders and decision makers more sustainable options. This is especially significant as the United States, its allies and partners, and its adversaries all increase investment in space-based capabilities and dependencies.



An EC-130H Compass Call flies a training mission over Lake Mead, AZ

EMS Maneuver

The Department recognizes the EMS as a critical battlespace in its own right, where DoD must conduct fires, maneuver, and communicate to achieve dominance in the presence of ever-increasing military and civilian use. EMS maneuver is the movement in three-dimensional positioning, time, and EMS operating parameters (e.g., frequency, power, modulation) to gain an advantage over the enemy. An EMS maneuver mindset views all actions in the EMS as a fundamental part of the commander's scheme of maneuver and is focused on creating advantage over the enemy. Inclusive within EMS maneuver is the ability to coordinate EMS fires through EMS command and control methods and means.

To realize the objectives of EMS maneuver via agile EMS operations and activities, future Service and joint warfighting systems will rely heavily on a fully integrated EMS infrastructure and a renewed focus on all-domain interoperability. DoD will update its EMS-related policies, enhance cooperative processes, pursue emerging technologies, and incorporate commercial innovations to adapt its EMS-dependent

systems. This will make systems operating in the EMS more maneuverable and able to operate in complex EMOEs. To support EMS maneuver, the Department, with emphasis on the Services, will need to evolve and harmonize their requirements for new acquisitions, perhaps incorporating major modifications to existing systems.



F-35 Lightning II fires an AIM-120 AMRAAM during a weapons test at Edwards Air Force Base, CA

Spectrum Sharing

National and international policies have focused on repurposing spectrum to stimulate economic growth through commercial applications. Federal policymakers are making an unprecedented amount of spectrum available for commerce across many radiofrequency (RF) 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 Department recognizes the importance of U.S. wireless leadership to the nation's economic prosperity, and 5G technologies mark a critical pivot for spectrum policy, technology innovation, and national security. 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.

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 (i.e., policy, protocol, and/or process). To contrast, EMS maneuver focuses on gaining advantage over adversaries, while spectrum sharing focuses on mitigating interference through agreement. Increased spectrum sharing remains a critical priority for the Department to meet the growing demands for spectrum access from both commerce and DoD. This sharing should include implementation of dynamic and bi-directional sharing for facilitating access to commercial spectrum while addressing the cybersecurity risk of an information sharing infrastructure outside of the DoD Information Enterprise, and pursuing machine-

to-machine technologies that enable cognitive cohabitation in the spectrum. International and domestic spectrum policy and regulations must continue to evolve to enable spectrum sharing to keep pace with rapidly changing technologies and increased mission requirements.

STRATEGIC GOALS

The Department's ability to achieve *Freedom of Action in the Electromagnetic Spectrum* at the time and place of its choosing is critical to all-domain advantage for U.S. allied, and partner forces. To achieve this, DoD must focus efforts on the following five interdependent goals: 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, military commanders will possess the resources, capabilities, and interoperability necessary for decisive military overmatch.

Goal 1: Develop Superior EMS Capabilities

Objective 1.1: Improve Technologies to Enable Systems to Sense, Assess, Share, Maneuver, and Survive in Complex EMOEs

Research is a springboard for innovation in future EMS capabilities. DoD must continue to invest in academic and research laboratories, and in industry, to drive advances in technologies that improve our ability to operate within complex EMOEs while denying our enemies the ability to do the same. This will include technologies specifically designed for EMS superiority via sharing and maneuver. As such, EMS-dependent systems will need to become more resilient, agile, and efficient. DoD must also continue to lead the way on the development of dynamic spectrum sharing technologies and techniques. In addition, EMS-dependent systems and networks must incorporate sensing, assessing, sharing, and maneuver technologies to enable coexistence with incumbent entities, globally.

EMS-dependent systems must be designed to be functionally and physically survivable while accomplishing their intended functions. These electromagnetic protection (EP) features must be sufficiently adaptable to adjust operating parameters to optimize performance and counter threats while protecting against the disruptive or destructive effects of intended or unintended electromagnetic (EM) energy. They should be flexible and access spectrum through frequency agility, frequency diversity, and wide tuning ranges. They must minimize their EMS footprint and reduce vulnerability to detection. Finally, they must be resilient against the effects of RF-enabled cyberspace attack.

The Department's emphasis should be on revolutionary leap-ahead technology and capabilities. If DoD relies on evolutionary EMS capabilities, there is increased risk of vulnerabilities due to the explosive pace of dual-use technology, especially in the computer and tele-communications sectors. Collectively, these technologies, when adequately matured and integrated into future warfighting systems, will improve DoD's capability to survive and operate in the presence of adversary EW systems, highly congested spectrum, and relevant environmental phenomena.



Electronic warfare specialists conduct radio checks before fielding new equipment

Objective 1.2: Use a Comprehensive Approach to Acquire EMS Capabilities Suitable for Great Power Competition

The Department will develop an EMS enterprise that is fully integrated, operationally focused, and designed for great power competition. Future EMS capabilities must be able to perform, operate, and adapt in complex EMOEs. They must maintain interoperability with other systems and be capable of rapid software and hardware upgrades to remain relevant against the evolving near-peer threat. These aspects must be considered in system requirements definitions and implemented in design and development with emphasis on a modular open systems approach (MOSA). DoD must evaluate campaign-level and operational scenarios through modeling, simulation, and testing in representative environments to prescribe appropriate levels of performance and be willing to embrace leap-ahead technology rather than evolutionary acquisition paths. It will utilize the flexibility provided by the Adaptive Acquisition Framework to accelerate delivery of superior EMS capabilities to the warfighter, including rapid prototyping and rapid fielding pathways.

The Department will leverage systems engineering and mission engineering disciplines to achieve a comprehensive approach for development of EMS capabilities across all functions, domains, and levels of warfare. Systems engineering will be utilized to develop the rapid and real-time reprogramming capabilities and system architecture standards required to deliver operationally relevant EMS capabilities to the warfighter and maximize the efficient use of resources. Mission engineering will be utilized to define effects chains, identify capability gaps and dependencies, determine and evaluate system and system-of-system

performance, and inform investment decisions for EMS capabilities. This must be supported by analysis from the engineering and system level up to the campaign level. Analytic tools such as modeling, simulation, experiments, exercises, testing, and wargaming are required to provide analysis and decision support for research and development (R&D) and acquisition.

Objective 1.3: Leverage and Adapt Commercial Technologies

Emerging commercial hardware, applications, and operating systems provide EMS-dependent system capabilities in small, low-cost, adaptable packages. However, some commercial technologies are designed for specific purposes and use cases that may not be suitable or meet unique warfighter requirements. DoD will continue to evaluate commercial technologies for mission suitability, flexibility, and adaptability for adoption when appropriate. DoD will also participate in national, international, and industry-specific standards bodies associated with spectrum innovation to collaborate on emerging technologies and their adoption, including national security preemption and priority mechanisms for commercial systems. DoD expects that military investments in EMS technologies will both leverage and augment commercial innovation to the benefit of DoD operations and the national EMS ecosystem as a whole.

Objective 1.4: Develop Robust Electromagnetic Battle Management (EMBM) Capabilities

EMBM is a comprehensive framework for dynamic monitoring, assessing, planning, and directing of operations in the EMS in support of the commander's concept of operations. EMBM leverages trusted data sources to provide EMS situational awareness and decision support and interfaces with systems and networks (including broadband and software-defined). The Department must develop EMBM capabilities that can monitor, identify, characterize, and adapt to the operational environment, while providing dynamic control of real-time operations in the EMS via machine-machine and human-machine collaboration. It should provide for automated adjustments to operations based on changing EMOE conditions within the joint planning cycle.

Future EMBM will feature digital modernization, artificial intelligence (AI), cloud-based data and tools, and integration of the Joint All-Domain Command and Control family of systems with EMBM requirements. This capability ensures timely, decision-quality information is provided at varying levels of classification at all levels of command. Additionally, EMBM must address information sharing requirements with industry and partner nations to maximize spectrum sharing opportunities. This will require analysis using modeling, simulation,



The Electronic Warfare Planning and Management Tool enhances the ability to plan, coordinate, and synchronize electronic warfare, spectrum management , and cyber operations

experiments, exercises, testing, and wargaming that assesses the performance and vulnerabilities of new systems to advanced attack and exploitation techniques. These tools will also be integral in the development of EMBM automated capabilities and in supporting architectures that use enhanced data standards, exchange protocols, business analytics, and adaptive stakeholder relationships. EMBM will enable flexible spectrum maneuver, responsive interference mitigation techniques, and integrated EMS features to enable agile operational functionality. At the tactical level, EMBM will enable real-time EMSO to meet engagement timelines required to defeat peer adversaries.

Objective 1.5: Field Disruptive EMS Capabilities

The Department recognizes its adversaries are also reliant on EMS-dependent capabilities and plans to target their vulnerabilities with advanced electromagnetic attack (EA) capabilities designed to keep the enemy in a defensive posture and offset adversary capacity overmatch. Disruptive capabilities will impose cost and create chaos for our adversaries, in ways they cannot predict, by denying or deceiving their EMS capabilities at the time and place of our choosing. Developing disruptive EW capabilities and attributes requires the most advanced technology the Department can bring to bear and must incorporate autonomous, cognitive, and asymmetric capabilities by harnessing cutting edge technologies such as AI and photonics. Advanced capabilities in directed energy, RF-enabled cyber, and multifunctional EMS systems all networked and operating at machine speed are required to provide future commanders with scalable options to achieve EMS superiority and military overmatch.

To enable offensive EMS activities, DoD must field the electromagnetic support (ES) and analytic capabilities that enable full EMS battlespace awareness. These capabilities need to detect, identify, locate and replicate complex emitters/signals of interest rapidly to build situational awareness and enable targeting for both kinetic and non-kinetic fires. These vital corollary systems will unravel the chaos of a congested and contested EMOE and provide near-real-time situational awareness for EMBM as well as real-time targeting information to attack adversary forces as they use the EMS. Networked, adaptive, and distributed, both traditional and non-traditional sensors will provide the integrated data, enabled by machine learning

and assured EMS distribution to the warfighter, required to implement disruptive EW and ensure joint lethality. Operational forces must also be capable of sharing EMS data to and from the Defense Intelligence Enterprise (DIE) at machine speed. Only through informed EMBM and highly interoperable (cooperative and complementary) EMS-dependent systems throughout the joint force can this level of EMS superiority be achieved.



Programming a counter-unmanned aircraft system on a Light Marine Air Defense Integrated System

Goal 2: Evolve to an Agile, Fully Integrated EMS Infrastructure

Objective 2.1: Accelerate EMS Information Integration into Operations and Planning

The Department requires a paradigm change in how it processes large quantities of EMS data in rapidly changing EMOEs. DoD must aggregate, analyze, and deliver fused operator and machine-readable system data for all of its own forces', allied, neutral, and adversary EMS-dependent systems to support EMBM. EMSO expertise at the operational and tactical levels (e.g., joint EMSO cells (JEMSOCS) at Combatant Commands) require this fused information to plan and synchronize EMS operations in support of the commander's scheme of maneuver. Commanders require scalable options to control conflict escalation, protect U.S. forces, and ensure military success.

DoD should invest in autonomous/semi-autonomous systems that use AI/machine learning and access cloud-based tools without being constantly dependent on them. Storing and processing information from the disparate sources and multiple security levels must be evaluated against real-time impacts on operations. DoD must have the operational capability to assess the EMOE rapidly and adapt to emergent adversary capabilities and environmental challenges. In addition to near-real-time analysis, accurate operational information assists in modeling across multiple EMOE scenarios that will drive spectrum requirements in the early stages of R&D, capability development, system reprogramming, and operational planning. This operational information is required to support analysis from the engineering and system levels to the campaign level. Analysis tools, including modeling, simulation, experiments, exercises, testing, and wargaming, are required.

Objective 2.2: Dedicated Intelligence for EMS Superiority

EMS Superiority requires robust intelligence collection, analysis, and validation of the following key areas: 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 wargaming.

The DIE is responsible for the collection, analysis, validation, and dissemination of threat data and information for all facets of military operations and acquisitions. The DIE, the Military Services, and the acquisition community must integrate their data and processing



U.S. Air Force Advanced Extremely High Frequency joint service communications satellite

capabilities for sharing at machine speed to benefit both in the buildout of cognitive EMS systems, near-real-time processing schemas, and data mining and fusion capabilities. Integration is essential to construct, compose, train, and effectively manage forces at the speed of 21st Century combat.

Validated intelligence data and accurate and current assessments underpin the success of EMS-dependent systems. Systems and capabilities supported by DIE-generated intelligence data and information include ES sensors and radar warning; EA active and self-protect jammers; near-real-time operations, and Battle Management planning; EP and inherent safety; and integrated cyber and EMS operations. The data requirements to support operations and analysis span all red (adversary/hostile), blue (U.S.), gray (coalition or potentially friendly), and white (commercial/non-military) EMS sensor systems, associated support equipment, weapons and space platforms, order of battle, RF telecommunications, combat support, and modeling, simulation, experiments, exercises, testing, and wargaming.

Objective 2.3: Establish and Manage Architectures and Standards that Enable Interoperability, Efficiency, and Information Sharing

To build an integrated EMS enterprise, the Department must establish and enforce architectures and standards for all systems that interface with the EMS in order to support EMSO and enable international spectrum sharing, coalition and joint force interoperability, and the rapid exchange of information on EMSO-relevant timescales. The EMS architectures must follow a common methodology, with products and outputs that are compatible with higher-level architectures for developing the overall picture and supporting mission analysis. Information must be managed within multiple security domains and shared external to DoD when appropriate with allies, mission partners, and the commercial sector. In addition, DoD must manage EMS data consistent with current DoD-level data guidance to ensure it is accessible, understandable, and reliable among all Services and agencies. Personnel and applications will be able to locate and access trusted spectrum data in standardized formats, seamlessly integrated across all levels of EMSO-related military activities.

Objective 2.4: Modernize EMS Live, Virtual, Constructive (LVC), Infrastructure for Testing, Training, and Analysis

As EMS-dependent capabilities become more complex, the testing infrastructure (which includes modeling and simulation) needs to evolve and expand to pace adversary capabilities. It must sufficiently stress systems to the limits of their operational expectations. Capabilities need to be developed and tested in operationally realistic EMOEs, which will also allow for experimentation of new concepts and capabilities. The Department requires the ability to analyze and test EMS-dependent capabilities under a range of realistic scenarios, from peacetime to wartime, against near-peer competitors, all while protecting classified information.

A modernized DoD test and training infrastructure should contain an optimized mix of LVC capabilities and blend realistic adversary, friendly, and environmental simulators/emulators with the capability to inject synthetic entities into live platforms and provide operationally realistic EMOEs. This infrastructure must leverage the DIE to ensure accurate modeling and simulation of current and anticipated adversary capabilities. LVC components (e.g., models and simulation) should be validated to the maximum extent possible by robust open air, land, and sea testing and support all levels of analysis.

To ensure personnel possess the tools, knowledge, and threat awareness needed, training should be conducted in operationally representative EMOEs, including up to that expected with near-peer competitors. Training infrastructure must prepare the joint force to operate when freedom of action in the EMS is denied or contested. Secure LVC environments should be leveraged in order to protect classified information from the soon to be ubiquitous observation of adversaries while training in complex EMOEs. Training infrastructure should upgrade to pace our adversaries and include individual proficiency training through large force exercises that challenge the joint force in high-end, near-peer environments.

Goal 3: Pursue Total Force EMS Readiness

Objective 3.1: Train and Sustain EMS Expertise

The Department will ensure all personnel are indoctrinated and trained at the appropriate level on EMS core concepts that enable an EMS maneuver mindset. They should understand the EMS impacts on their capabilities, operations, and plans. Training will be tailored to meet the needs of personnel at each level of Department structure – from technicians, to requirements personnel, to operators, and to top-level commanders. The Department will ensure all identified members of the EMS workforce are appropriately trained and retain relevant EMS skills and expertise.

The professionals of the EMS workforce maintain EMS-related specialties in technical and operational EMSO communities (traditionally EMSM and EW). These military and civilian professionals are specially trained and possess EMS expertise that spans the continuum from industry engineer, to tactical employer, to operational commander. All members identified as EMS professionals will be deliberately tracked to enable the Department to sustain a posture of EMS superiority. DoD will update existing and planned formal training and education to ensure the availability of well-rounded EMS Professionals to fill critical billets.



Electronic Warfare Tactical Vehicle

Objective 3.2: Incorporate EMS Concepts and Doctrine into Formal Education

The EMS enterprise will routinely engage with formal military education institutions to ensure coursework at all levels includes a wide span of EMS activities and reflects changes as new technology, doctrine, and threats emerge. EMS curricula should encompass understanding of the acquisition, policy, and support structure behind EMS capabilities, as well as developing proficiency in operational planning and execution for EMS superiority. DoD will develop EMS professionals with deep knowledge of EMSO concepts, doctrine, and tactics. DoD will also develop EMS professionals versed in domestic and international spectrum policy and regulations to participate in those fora to advocate for and protect national security objectives.

Objective 3.3: Evaluate and Track EMS Readiness

Total force readiness in the EMS will be grown, tracked, and sustained. DoD Components will be evaluated to ensure they are prepared for their missions. Achieving EMS readiness in complex EMOEs requires demonstration of effective operation and integration of DoD EMS-based tools and capabilities. Periodic individual and unit-level training, joint force exercises, rehearsals, and war-games must occur under, or simulate, realistic operational conditions (live, virtual, and constructive modes) and must integrate all EMS capabilities and challenges, including interference and jamming scenarios.

Goal 4: Secure Enduring Partnerships for EMS Advantage

Objective 4.1: Increase Leadership in International Fora

Strong international alliances and partnerships are foundational to the Department's ability to execute its complex global missions and conduct effective operations in the EMS as referenced in the NDS. The Department must rely on strong international alliances and partnerships to ensure EMS access policies support the U.S. military in conducting its full range of global operations. Successful engagement in the International Telecommunication Union (ITU) treaty processes, including the World Radio-communication Conference (WRC), will help to maximize DoD EMS access where and when needed to meet wartime and peacetime national security objectives. Of note, this successful international engagement begins with effective Department participation in domestic processes.

Objective 4.2: Enhance Access, Interoperability, and Capacity with Allies and Partners

U.S. military operations are rarely conducted unilaterally and are increasingly reliant on contributions from our allies and partners. DoD must ensure EMS enterprise development efforts are interoperable and aligned with our allies and partners and should remove barriers limiting collaboration. This requires interoperable data sources and architectures. The Department will help develop military-to-military agreements, host nation agreements, agreements with the North Atlantic Treaty Organization (NATO), and other allies and partners focused on enabling coalitions the use of their full portfolio of EMS capabilities. This requires the means (software, data standards, transport channels, etc.) to move and process data at machine speeds with allies and partners. DoD must encourage our allies and partners to adopt, build, or

enhance EMS capabilities that will increase our combined coalition EMS capability and capacity with particular focus on near-peer threats. This cooperation includes the need to expand opportunities for coalition EMS testing, training, and education in the United States and abroad.



U.S. Navy Los Angeles-class attack submarine

Objective 4.3: Increase Leadership in Domestic Processes

DoD engages with the White House, Congress, the State Department, the National Telecommunications and Information Administration (NTIA), the Federal Communications Commission (FCC), other Federal departments and agencies, academia, and industry to ensure U.S. leadership on commercial and government uses of the EMS. This engagement includes: EMS access policies and regulations, developing technology, educating key stakeholders, and fostering close collaboration with the academic community, leading research centers, and the U.S. industrial base. DoD's industrial manufacturing base relies on aligned policies and clear guidance to provide investment certainty as they build critical DoD capabilities. The *2018 Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future* makes clear that "access to spectrum is a critical component of the technological capabilities that enable economic activity and protect national security."

The Department continues to view spectrum sharing as critical to reaching DoD and national goals. To that end, DoD must continue to reform regulatory proposals, remain active in regulatory and policy fora, and take proactive measures to implement regulatory and policy changes. Additionally, DoD must continue to widen engagement to advance development of sharing technologies to satisfy the growing commercial

and national security requirements for spectrum access. Partnerships with other Federal departments and agencies, industry, and academia, including the National Advanced Spectrum and Communication Test Network and the National Spectrum Consortium, are bearing fruit to solve some of DoD's most challenging EMS issues related to increased sharing.

Goal 5: Establish Effective EMS Governance

Objective 5.1: Unify Department-wide EMS Enterprise Activities

DoD will embrace an enterprise approach to align EMS resources and synchronize activities. An effective EMS enterprise requires strong governance in force development as well as operations. Effective EMS Enterprise governance harmonizes EMS policies and capability development at the earliest stages. It must align broader organizational principles and set priorities across the Department. The development and sustainment of an EMS Workforce that can effectively mitigate threats and provide operational advantages over a range of adversaries and differing EMOEs will be a key requirement.

The EMS enterprise will achieve effective EMSO by establishing priorities and providing capabilities necessary for EMS superiority. As warfighter needs and operational threats continue to evolve, the DoD EMS enterprise must be responsive. The DoD must identify the industrial base barriers to producing game-changing EMS capabilities, including the need for secure supply chain and trusted production of critical technologies. Research, development, acquisition, and sustainment of future system portfolios must be synchronized across the DoD components to identify and manage spectrum risks and opportunities, avoid duplication of effort, and increase affordability.

Objective 5.2: Develop a Continuous Process Improvement (CPI) Culture

DoD EMS Enterprise will institutionalize a CPI mindset to create a long-lasting culture of innovation, empowerment, and improvement. It will do this by implementing common iterative and disciplined CPI activities throughout an EMS superiority campaign that is held accountable through status reporting to the Secretary of Defense. This will reduce the cost of doing business while maximizing DoD's agility and EMS capabilities, while harmonizing the Services' EMS capabilities and process development.

DoD must align and develop business processes and prioritize resources to counter threats. As threats evolve or new ones emerge, the EMS enterprise must adapt to ensure the Department is prepared to meet the new challenges efficiently and effectively. An organizational mindset geared to continuous improvement and based on data analytics capabilities is necessary to cultivate data-driven solutions that will ensure superiority over our adversaries and keep pace with technology and industry.



RC-135V/W Rivet Joint reconnaissance aircraft

Objective 5.3: Promote Policies That Support DoD EMS Capabilities and Operations

DoD must develop, advocate, harmonize, and provide oversight of spectrum policies that minimize constraints to DoD global operations. Domestically, EMS Enterprise governance will ensure policies allow DoD to conduct R&D, testing, training, exercises, and homeland defense operations. As forces deploy globally, international spectrum policies are also a priority due to their potential impact on basing and operations of U.S. forces abroad. Policies must balance important U.S. economic development objectives, while preserving military capabilities and limiting constraints to the use of those capabilities. As spectrum demands continue to increase, policies that promote more efficient use of spectrum through sharing technologies are vital. As the Department is only authoritative regarding its own spectrum policies, DoD must work with partners across the U.S. Government (including NTIA and FCC) and internationally to shape favorable outcomes.

IMPLEMENTATION

Achieving the vision outlined in this Strategy will require a Department-wide effort to develop the envisioned capabilities and EMS Enterprise. The Secretary of Defense (SecDef) created the EMSO Cross-Functional Team (CFT), in response to statutory requirements, to address “all the requirements necessary to successfully conduct EMSO” The Vice Chairman of the Joint Chiefs of Staff, as the Senior Designated Official (SDO) of the EMSO CFT, is tasked with oversight of the execution of this Strategy until oversight responsibility transitions to a permanent governing entity. The SDO will develop a Roadmap and Implementation Plan (RM/IP) in partnership with the DoD CIO as the Principal Staff Assistant for the EMS.

The RM/IP will provide the authoritative tasking from the SecDef to all entities within DoD in support of this Strategy. It will reflect a thorough task analysis of this document and other SecDef-level tasking and responses to Congress for all specified and implied tasks relating to EMS superiority, EMSO, and EMS sharing. All tasks will include an office of primary responsibility (OPR), clarifying instructions, and a suspense date. One or more offices of collateral responsibility (OCR) may be included with tasks.

SUMMARY

DoD faces rapidly increasing challenges to its historical EMS dominance due in part to increasingly complex EMOEs. Threats to DoD capabilities due to EMS vulnerabilities have become increasingly sophisticated and easily attainable. Commercial technology advancements are proliferating wireless devices and services that are eroding DoD's freedom of action in the EMS. At the same time, the U.S. military has increasing spectrum requirements for the operations, testing, and training of advanced warfighting capabilities. Finally, DoD must exploit near-peer adversaries' EMS vulnerabilities through advanced EW to offset their capacity overmatch.

To cope with these challenges and achieve the vision of *Freedom of Action in the Electromagnetic Spectrum*, the DoD will actively pursue the areas outlined herein. DoD will enhance the ability to plan, sense, manage, and control military operations with advanced EMS technologies to ensure EMS superiority. The Department will also proactively engage with spectrum policymakers and partners to ensure spectrum policies support U.S. capability requirements. DoD will perform the governance functions needed to ensure our efforts are aligned and coordinated to maximize the results of our efforts.

The NDS directs the Department to "determine an approach to enhancing the lethality of the joint force against high end competitors and the effectiveness of our military against a broad spectrum of potential threats." Realization of the NDS requires DoD to actualize the vision of this DoD EMS Superiority Strategy by implementing its goals and objectives through an empowered EMS enterprise. Advancing how DoD conducts operations in the EMS, and generates EMS superiority, will be critical to the success of all future missions for the United States, its allies, and partners.

GLOSSARY

The terms defined herein are for the purpose of clarity in this document only. Where a more authoritative source definition is used, that source is indicated.

Competition Continuum – Describes a world of enduring competition conducted through a mixture of cooperation, competition below armed conflict, and armed conflict. This is the environment in which the United States applies the instruments of national power (diplomatic, informational, military, economic) to achieve objectives. (JDN 1-19)

Electromagnetic Attack – Division of electromagnetic warfare involving the use of electromagnetic energy, directed energy, or anti-radiation weapons to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability and is considered a form of fires. Also called EA. [previously Electronic Attack] (JP 3-85)

Electromagnetic Battle Management – The dynamic monitoring, assessing, planning, and directing of operations in the electromagnetic spectrum in support of the commander’s concept of operation. Also called EMBM. (JP 3-85)

Electromagnetic Protection – Division of electromagnetic warfare involving actions taken to protect personnel, facilities, and equipment from any effects of friendly or enemy use of the electromagnetic spectrum that degrade, neutralize, or destroy friendly combat capability. Also called EP. [previously Electronic Protection] (JP 3-85)

Electromagnetic Spectrum (EMS) – The range of all types of electromagnetic radiation. (National Aeronautics and Space Administration (NASA))

Electromagnetic Spectrum Access – The ability of spectrum-dependent systems to enter the electromagnetic spectrum and occupy a frequency, or band of frequencies, in space and time for the purpose of transmission and/or reception of electromagnetic energy.

Electromagnetic Spectrum-Dependent Systems – All electronic systems, subsystems, devices, and equipment that depend on the use of the spectrum to properly accomplish their functions. (DoDD 3610.01)

Electromagnetic Spectrum Enterprise – The organizing construct consisting of DoD EMS assets, processes, activities and resources required to enable EMS superiority through the conduct of DoD EMSO. This includes policy, governance, organization, equipment, procedures, doctrine, information, facilities, training, and material responsibilities to ensure that DoD maintains access and control of EMS across the full spectrum of operations. (DoDD 3610.01)

Electromagnetic Spectrum Management – The operational, engineering, and administrative procedures to plan, and coordinate operations within the electromagnetic operational environment. [previously Spectrum Management] (JP 3-85)

Electromagnetic Spectrum Maneuver – The movement in three-dimensional positioning, time, and EMS operating parameters (e.g., frequency, power, modulation) to gain an advantage over the enemy. (JP 3-85)

Electromagnetic Spectrum Operations – Coordinated military actions to exploit, attack, protect, and manage the electromagnetic environment. Also called EMSO. (JP 3-85)

Electromagnetic Spectrum Professional – A member of the EMS Workforce who has achieved and maintained a demonstrated standard of expertise in EMS-related core skills.

Electromagnetic Spectrum Sharing – 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 (i.e., policy, protocol, process.)

Electromagnetic Spectrum Superiority – That degree of control in the electromagnetic spectrum that permits the conduct of operations at a given time and place without prohibitive interference, while affecting the threat's ability to do the same. (JP 3-85)

Electromagnetic Spectrum Workforce – The totality of personnel required to staff the EMS Enterprise.

Electromagnetic Support – Division of electromagnetic warfare involving actions tasked by, or under direct control of, an operational commander to search for, intercept, identify, and locate or localize sources of intentional and unintentional radiated electromagnetic energy for the purpose of immediate threat recognition, targeting, planning, and conduct of future operations. Also called ES. [previously Electronic Warfare Support] (JP 3-85)

Electromagnetic Warfare – Military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy. Also called EW. [previously Electronic Warfare] (JP 3-85)

