DoD Electromagnetic Spectrum Strategy

Kathleen M. Kaplan
Air Force Office of Scientific Research
Arlington, VA, USA
Email: kathleen.kaplan@us.af.mil

Abstract—In this paper, the electromagnetic spectrum strategy for the Department of Defense (DoD) is discussed. The desired outcome of this strategy is to improve mission success by effectively accessing the spectrum and denying adversarial usage. This overall challenge offers many opportunities for business and research.

Keywords—electromagnetic spectrum, EMS, DoD

I. INTRODUCTION

The electromagnetic (EM) spectrum (EMS) is a valuable finite resource which is becoming more limited every year. This is especially relevant for the Department of Defense (DoD) as military operations are implemented in complex EMS situations, or EM operational environments. Battlefield operations depend upon emitters with functions that depend upon EM energy are increasingly used for attack; command and control; communications; intelligence; position, navigation, and timing; sensing; ranging; unmanned aircraft systems; etc. There is a recognized need for military forces to have unimpeded access to, and use of, the EMS. The DoD has a strategy to mitigate any challenges presented by the limited EMS.

In this paper, the DoD EMS strategy is discussed including the areas of research goals for the DoD.

II. EMERGING ISSUES

A. Current State

In order for the DoD to retain its military superiority, EMS access when and wherever needed is required for mission success. All current DoD systems for air, land, maritime, space, and cyberspace operations depend on EMS access. Thus, the DoD need for EMS use is increasing. However, commercial broadband use is increasing as well, which puts an additional strain on the congested EMS. Moreover, adversaries are attacking electronically which erodes the ability of the DoD to perform necessary military operations. Thus, the current state of the EMS is both congested and contested [1].

B. DoD EMS Access

The Federal government has exclusive use of approximately 18% of the EMS between 300 MHz and 3 GHz [1]. This range includes Very High Frequency (VHF), Ultra High Frequency (UHF), and Super High Frequency (SHF), which is highly desired by the wireless commercial community. As such, President Obama issued a memorandum which requires the Federal Communications Commission (FCC) to make 500 MHz of Federal and nonfederal EMS available for mobile and wireless broadband use. The FCC is to license this 500 MHz for either exclusive use or shared access by commercial or Federal government users. President Obama stated that this 500 MHz must be made available by 2020 [2].

Additionally, President Obama also allowed for the access and shared use of the EMS that is currently exclusively for Federal use [3]. This puts additional constraints on the DoD regarding EMS.

Thus, the amount of exclusive access to EMS for the DoD may substantially decrease over the next six years.

C. Adversary Usage

The nation’s adversaries are technologically savvy. One of an adversary’s main goals is to significantly impede or eliminate the DoD’s ability to use EMS to conduct military operations [1]. This is not difficult, in fact, non-malicious interference has occurred in many military instances. For example, the DoD’s Land Mobile Radios operated in the frequency range 380 MHz to 399.9 MHz. However, this was the same frequency range as garage door openers in the geographic area. Since the DoD had authorized usage of the frequency range, the unauthorized door opener devices had to accept interference from the Land Mobile Radios. In order to counter the effects of the interference, the garage door opener manufacturers would have to retrofit the apparatuses at a cost of $50 to $80 per customer. This non-malicious example illustrates a simple issue of interference, which has significant cost to the consumer. Additionally, this simple non-malicious example shows that a malicious adversary with ability and means available can cause much more serious consequences [4].

Electronic warfare (EW) is defined as any military action involving the use of EM and directed energy to control the electromagnetic spectrum or to attack the enemy. Therefore, multiple interference problems may indicate adversary EW operations, unintentional impact of friendly EW operations, or errors in spectrum maintenance (SM). In the case of adversarial interference, the goal of the military is to influence, disrupt, corrupt, or usurp the decision making of adversaries and potential adversaries while protecting our own lines of operation [5, 6].

III. DoD GOALS

The DoD needs to increase access efficiency, flexibility, and adaptability with respect to its spectrum usage. Spectrum efficiency is the use of the minimum amount of EMS resources
necessary to ensure maximum operational effectiveness. Spectrum flexibility and adaptability are the capabilities to exploit in accessing the EMS, such as spectrum sharing. The DoD has three stated goals with many objectives to meet the challenges presented by the EMS requirements.

A. Spectrum Dependent System Capability Development

As stated, the EMS is a limited resource which is becoming more limited every year. To meet its demands, the DoD will expedite the development of spectrum dependent system capabilities, such as utilizing less-used spectrum, using commercial services when possible, and exploring spectrum sharing technologies [1].

Under this goal, the DoD plans to expedite the development of technologies that increase a spectrum dependent system’s ability to: access wider frequency ranges; exploit spectrum efficiency gains; utilize less congested bands; and adapt rapidly to changing electromagnetic environments. The DoD also plans to accelerate the fielding of technologies that enable spectrum sharing and improve access opportunities. Additionally, the DoD will cultivate and adopt commercial service capabilities and strengthen enterprise oversight of DoD spectrum use [1].

B. DoD Spectrum Operations Agility

Agility in spectrum operations means the ability of DOD systems to have the flexibility and adaptability to achieve mission success in rapidly changing EM environments. To accomplish this, DoD will improve its capabilities to plan, manage, and control all dimensions of spectrum use to preserve access to and maneuver within the EM environment. For example, the DoD will explore spectrum sharing for certain systems while advocating for exclusive spectrum access for those military systems that cannot share [1].

Under this goal, the DoD plans to develop the ability to perform near-real-time spectrum operations, advance the ability to identify, predict, and mitigate harmful interference, and modify policies, regulations, and standards to enable DoD to exploit improvements to a spectrum dependent system’s spectrum flexibility and facilitate sharing spectrum [1].

C. Spectrum Regulatory and Policy Responsiveness

Policy and regulations regarding the EMS change frequency, and thus, the responsiveness of the DoD must be improved. The DoD will upgrade its ability to assess, contribute to, and adjust to proposed worldwide regulatory and policy changes. In its assessments, the DoD will include such quantifiable data as frequency used, location, space, time, use parameters, etc. at any point in time. After understanding a system’s footprint, the DoD will identify and suggest innovative alternatives to balance military requirements and the EM environment, along with identifying systems where spectrum sharing is a possibility, such as systems that can operate with systems in adjacent spectrum bands without compromising the system. The DoD will investigate new technologies, establish policies, and adopt standards to lessen interference while maintaining the mission [1].

The DoD will also improve its ability to implement directed spectrum changes in an orderly and non-disruptive manner. Overall, this goal includes reforming DoD’s ability to assess regulatory proposals, expanding DoD’s participation in and contributions to regulatory and policy discussions, and institutionalizing DoD’s ability to adapt to and implement regulatory and policy changes [1].

IV. RESEARCH OPPORTUNITIES

The challenges that the DoD faces with respect to EMS requirements become opportunities for research and business. The DoD needs to acquire more efficient, flexible, and adaptable systems while developing more agile and opportunistic spectrum operations to ensure mission success. In doing so, the DoD must improve the way to access the spectrum and the ability to deny adversary use without degrading DoD use. Therefore, the DoD needs to leverage commercial technologies and invest in spectrum technologies to augment commercial innovation [1]. Some areas of research are included in this paper, but certainly not all.

A. Business Ventures

The DoD plans to leverage commercial technologies that are mature, advanced, and affordable. DoD will evaluate commercial capabilities, such as hardware, applications, and operating systems, for mission use and to meet other spectrum requirements. In working with industry, DoD expects that military investments in commercial spectrum technologies will leverage and improve commercial progress for the benefit of DoD’s and the nation’s EM innovations [1].

B. Modeling and Simulation Research

Prior to implementing, the DoD will utilize modeling and simulation to ensure that operations run smoothly. In order to exploit multi-dimensional access opportunities of spectrum use, increase spectrum efficiency, and move some functions to uncongested portions of the spectrum, the DoD will develop operational scenarios to evaluate the performance and vulnerabilities of advanced technologies to various techniques of attack, denial, interference, and deception [1].

C. Spectrum Sharing and Interference Research

The risk of EMS sharing is interference. This can be inadvertent or adversarial. In any case, innovation will solve the interference hazards. Additionally, the DoD will identify systems where spectrum sharing is a possibility, such as systems that can operate with systems in adjacent spectrum bands without compromising the system. The DoD will investigate new technologies, establish policies, and adopt standards to lessen interference while maintaining the mission [1].

D. Real-Time Operations Research

For a spectrum dependent system to be completely agile, it must be able to manage its EMS usage in near-real-time. In order to do this, the DoD will have to quantify spectrum requirements and the EM environment, along with identifying and mitigating spectrum issues and limitations that could affect operations. A spectrum dependent system footprint includes such quantifiable data as frequency used, location space, time, use parameters, etc. at any point in time. After understanding a system’s footprint, the DoD will develop develop near-real-time tools and techniques for spectrum dependent systems with the requirements, issues, and limitations known [1].
The DoD also needs the ability to identify and model the spectrum to assess mission impacts due to denial of spectrum quickly; this must also be achieved in near-real-time. Additionally, the DoD needs to improve the ability to deny adversary use of spectrum without degrading use by friendly forces or non-aligned entities, again in near-real-time [1].

E. EMS Hardening Research

EM hardening is an action taken to protect personnel, facilities, and/or equipment by blanking, filtering, attenuating, grounding, bonding, and/or shielding against undesirable effects of EM. In order to operate more efficiently and effectively in a congested and contested EM environment, the DoD will improve its ability to predict, identify, and mitigate harmful interference in planning and during operations. This requires implementing interference hardening requirements in DoD systems, establishing definitions of mission limiting interference specific to DoD missions and spectrum dependent systems, implementing advanced interference mitigation technologies, and implementing battlefield interference detection technologies, reporting processes, enforcement policy, and resolution mechanisms [1,5].

F. Policy Research

There is a great deal of policy research that must be accomplished to go hand-in-hand with the technical research. This must include interaction and collaboration with national, international, and industry-specific standards bodies. These partnerships will discuss emerging technologies and their adoption, including national security preemption and priority mechanisms for commercial wireless systems [1].

Additionally, the DoD will have to address oversight and enforcement early in the development of Spectrum Dependent Systems. This early intervention will ensure that future systems align with the overall DoD spectrum strategy, that spectrum technology investments are synchronized across DoD Components, and that spectrum availability risks are identified and managed. This will include expanding and requiring adoption of spectrum standards and protocols, establishing policy requiring spectrum sharing, efficiency, flexibility, and adaptability to be addressed in DoD requirements, acquisition, and procurement processes, conducting reviews of Component spectrum-related research and development portfolios, and establishing a spectrum risk review board to support Defense Acquisition Board decisions [1].

DoD, national and international policy and regulatory changes are needed to improve spectrum access, including DoD access to spectrum allocated in the United States for non-federal use. This will include developing spectrum policy (spectrum rights, service level agreements, and enforcement mechanisms) to share spectrum through agreements and on an on-demand basis with an understanding of potential risks of spectrum sharing.

V. Conclusion

The DoD must remain militarily superior in all environments – air, space, cyberspace, land, or maritime. In today’s technological environment, nearly all military operations require the use and control of the EMS. Moreover, the denial of one spectrum dependent system could lead to the denial of another. In a military environment, this interference could be disaster to our warfighter and the mission. With the growing need of the EMS for commercial use, the DoD can no longer rely upon its allocated spectrum. Additionally, even if the DoD was allowed specific allocated access, there is still the threat of adversarial EW. Thus, the DoD has implemented a three goal strategy to combat EW and ensure that spectrum dependent systems remain operational. These three goals include expediting the development of spectrum dependent system capabilities with increased spectrum, efficiency, flexibility, and adaptability, increasing the agility of DoD spectrum operations, and sharpening the responsiveness to ongoing spectrum regulatory and policy changes.

The challenges for the DoD are opportunities for business, research, and development. There are many research and development areas that will be relied upon for technological break-throughs, such as modeling and simulation, spectrum sharing and interference, real-time operations, and EMS hardening, to name a few. Additionally, there is a need for policy research in national and international agreements, rights management, and other areas. Commercial products will have to be procured for the DoD as well, which requires contracts and grants. Moreover, the DoD will leverage commercial research and development and products in order to keep financial resources at a minimum.

In short, DoD spectrum dependent systems must be efficient, flexible, and adaptable, and DoD operations must be more agile in the ability to access the EMS. With respect to EM technology, research and development, the DoD must be opportunistic.

REFERENCES